THE ARCHAEOLOGY OF HIDDEN CAVE, NEVADA

DAVID HURST THOMAS

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THE ARCHAEOLOGY OF HIDDEN CAVE, NEVADA

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ABSTRACT

Hidden Cave (26-Ch-16) was formed about 21,000 years ago when the waves of rising Lake Lahontan excavated a huge cavity beneath the tufa-cemented gravels of Eetza Mountain, an extension of the Stillwater Range, Churchill County, Nevada. The newly formed cave was filled with water until about 16,000 years ago, when it was briefly exposed. Lake Lahontan flooded Hidden Cave yet again about 15,000 years ago, and the cave was underwater about 10,000 years ago. Between 10,000 and 7500 B.P., the cave remained moist, with debris accumulating at both the entrance and at the rear. After about 7500 B.P., the interior of Hidden Cave was relatively dry, and increasing torrential rainfall carried silt in as small flood episodes. About 6900 years ago, the Tsoyawata and Mazama tephras fell and were washed into Hidden Cave. After that time, both natural sediments and cultural deposits continued to accumulate inside. The entrance to the cave gradually became plugged up by a debris cone. Hidden Cave was rediscovered in the 1920s.

The archaeology of Hidden Cave was first explored in 1940 by S. M. and G. N. Wheeler, under the sponsorship of the Nevada Highway Commission. Further excavations were carried out in 1951 by N. L. Roust and G. L. Grosscup (University of California, Berkeley), in collaboration with Roger B. Morrison (U.S. Geological Survey). The most recent excavations, reported herein, were conducted in 1979 and 1980 by an interdisciplinary team, co-sponsored by the American Museum of Natural History and the Bureau of Land Management. This monograph discusses this new research and the complete reanalysis of the 1940 and 1951 Hidden Cave collections.

Radiocarbon dates for the cultural strata range from 810 to 5365 B.P., but most of the usage of Hidden Cave seems to have occurred during the Devils Gate phase (*ca.* 3200–5000 B.P.).

Diverse seasonal indicators demonstrate that Hidden Cave was utilized from spring through fall; the most intensive activity occurring during midsummer. This site served as both a complex, multifunctional storage node and as a limited logistic outpost. Hidden Cave was primarily used for storage of personal gear that had temporally and temporarily passed into a "passive" state. Three secondary activities can likewise be defined: (1) as a burial locus; (2) as a diurnal way station; and (3) as a resource cache. Adverse conditions of lifespace ruled out effective residential usage.

INTRODUCTION

My initial visit to Hidden Cave was in August 1967, en route to the First Annual Austin Archaeological Conference, sponsored by the newly formed Nevada Archaeological Survey. Collaborating at the time with the Peabody Museum–Nevada State Museum expedition to the High Rock Country (Layton, 1970; Thomas, 1969a), Thomas Layton and I were anxious to examine the deposits remaining in this well-known cave site.

We knew that when S. M. Wheeler concluded his excavations in 1940, he had placed a large, jail-like iron gate in the mouth of Hidden Cave. That gate was still in place in 1967, although it was propped open by rocks. We climbed into the mouth, and, using small flashlights, explored the interior. But because our light was limited, we were unable to see the extent of the cave, or even the black-stained walls.

Despite the dim light, we easily located the sidewalls of the U-shaped trenches excavated by Gordon Grosscup and Norman Roust in 1951. Aided by Roger Morrison's (1964) stratigraphy, we could trace the major stratigraphic units throughout the cave. We were surprised by the clarity of the stratigraphy and also by the excellent state of preservation of the 1951 trenches. Despite evidence of recent vandalism and pothunting, Layton and I agreed that Hidden Cave still contained a large portion of intact deposits. We sat down at the mouth of the cave and pondered the possibilities of returning someday to reexcavate Hidden Cave.

Over the next decade, I often went back to Hidden Cave on the way to fieldwork at Reese River and, somewhat later, at Gatecliff Shelter and Monitor Valley. Most of this fieldwork was conducted as a summer field school, and we always took the students to Hidden Cave to look at the classic exposure of Sehoo Lake and Holocene stratigraphy, as well as to examine the amazing rock art at nearby Grimes Point.

In the summer of 1970, we took our stu-

dents to visit the University of California field school and camped not far from Hidden Cave. L. K. Napton, who was directing the excavations, wanted to excavate Hidden Cave that summer, but the problems of providing adequate lighting and ventilation ultimately prevented such work (Napton, 1971b).

On a number of occasions I discussed with colleagues how we should approach the archaeology of Hidden Cave; one suggestion—seriously considered for a while—was to blast the front of Hidden Cave with dynamite, literally converting the cave into a rock-shelter. That way, both light and fresh air would be available to the excavators. The cost, dangers, and destruction involved in such a plan discouraged us from proceeding along that course.

We did not get serious about excavating Hidden Cave again until the summer of 1978 when Brian Hatoff, District Archaeologist for the Bureau of Land Management, mentioned the possibility that the BLM might fund limited salvage excavations at Hidden Cave; the objective was primarily to mitigate the increasing impact of vandalism. Hatoff knew of our interest in ultimately working at Hidden Cave, and inquired whether we would be interested in pooling forces for a more comprehensive dig than the BLM was able to sponsor alone. After visiting the site together in October 1978, we agreed to proceed jointly on plans for initiating a new round of excavations at Hidden Cave (Hatoff and Thomas, 1982; Appendix A, this volume).

Two pragmatic stipulations guided the project from the beginning. We agreed at once that an interdisciplinary approach to Hidden Cave was mandatory, and we set about assembling a team of specialists in early 1979. Beyond the obvious and well-known geological and anthropological potential, we knew that the remaining Hidden Cave deposits probably also contained significant paleontological and paleobotanical data. But rather than merely collecting samples to be shipped to appropriate specialists, we attempted to include the major collaborators from the earliest planning stages.

We also decided that our research at Hidden Cave should include a reanalysis of previously excavated materials from the site. The 1940 excavation had never been published, and few Great Basin archaeologists seemed aware of the vast Hidden Cave collection curated at the Nevada State Museum. Similarly, although Roger Morrison (1964) had published the major stratigraphy of the site and a few papers were available on selected aspects of material culture, the 1951 excavations were largely not analyzed and not reported. From the outset, we planned to reanalyze both collections, in hopes of tying them in with the more refined chrono-stratigraphic and paleoenvironmental data obtained in the new excavations.

We report here the substantive and theoretical findings of the 1979–1980 excavations and reanalysis of Hidden Cave. This research explores the environmental and anthropological implications of the lacustrine biome, as viewed from the margins of the Carson Sink.

The intensive excavations at Hidden Cave were also coordinated with a regional random sampling program in the Carson Sink/Stillwater Mountain area. This areal adjunct was conceived and executed by Robert L. Kelly in 1980 and 1981. Both projects were jointly sponsored and funded by the American Museum of Natural History and the Bureau of Land Management. The data from the regional survey is currently being analyzed by Kelly and his associates.

We elect to publish the Hidden Cave research in the present format. But we emphasize that Hidden Cave is but a single node through which we attempt to monitor the regional fabric of the lacustrine adaptation in the Carson Sink area. With any luck at all, Kelly's archaeological survey should vastly enhance, and in many ways surpass, most of the anthropological findings from the Hidden Cave excavations.

ACKNOWLEDGMENTS

We begin at the beginning, by expressing our sincere appreciation and gratitude to Mr. Brian Hatoff, Carson City District Archaeologist for the Bureau of Land Management. Employing an exceptionally creative approach to bureaucracy, Hatoff quite literally parlayed a two-week, quick-and-dirty contract job at Hidden Cave into a full-blown research effort involving two seasons of field-

work and two additional years of laboratory analysis. The 1979–1980 Hidden Cave project would not have happened without Hatoff's drive, imagination, and resourcefulness.

The Bureau of Land Management contributed about 40 percent of the total funding for the 1979–1980 research at Hidden Cave. We are particularly grateful to Dr. Richard Hanes and Mr. Thomas Owen for their unstinting guidance and support throughout the project.

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of Hidden Cave for toxic spores, nursed several of our walking wounded, and provided much-needed lodging for crew members.

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From the outset, we planned to reanalyze the previously excavated collections from Hidden Cave, and we were lucky to have the cooperation of those who could make this possible. Mr. Donald Tuohy, Curator of Anthropology, Nevada State Museum (Carson City) was helpful throughout the project, generously granting us permission to borrow, study, and publish the 1940 collection excavated by S. M. Wheeler. Don Tuohy understood the special problems we encountered and helped on many occasions to locate difficult-to-find field notes, artifact cards, photographs, and maps necessary for our reanalysis of the Wheeler collection. Without his help, this monograph would have been handicapped from the start.

We also thank the staff of the Lowie Museum of Anthropology (Berkeley) for making the 1951 Roust and Grosscup collection available to us for restudy. We were fortunate in enlisting the help of Dr. Gordon Grosscup in reconstructing many of the details of the 1951 University of California excavations at Hidden Cave. Not only did he send us the original field notes and stratigraphies, but he kindly consented to visit Hidden Cave while we were excavating there in 1979. His generous and candid advice has been a most useful source of guidance in our own study of the Hidden Cave puzzle.

Several Fallon residents made our stay both enjoyable and scientifically worthwhile. The United States Navy provided and maintained a large generator for the 1980 excavation, and the Army National Guard allowed us to use their shower facilities both summers. The Churchill County Telephone Company permitted us to store archaeological field equipment in one of their large warehouses. We also thank the Busboom family for permitting us to camp on their land during the 1979 field season. We thank Mr. Elmo Dericco, Superintendent of Schools, for permitting us to use the Churchill County High School as a field laboratory and classroom in 1979 and 1980.

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Too often it seems that scientific teams simply hit town, conduct their research, then disappear with no attempt to communicate the findings to those townspeople who live with their archaeology everyday. From the beginning of our involvement at Hidden Cave, we planned to convey the results of our research to the people of the area. Our primary means for this became two interpretive centers, one installed in the Churchill County Museum (Fallon) and the other inside Hidden Cave itself. Mr. Dennis O'Brien directed this project, planning and installing both exhibits. Thanks to the dogged efforts of O'Brien, assisted by Deborah Mayer O'Brien, the underfunded Hidden Cave exhibit opened in Fallon on September 29, 1982. As of this writing, thousands of visitors have been guided through the on-site interpretive center inside Hidden Cave (see Appendix B, this volume). We gratefully acknowledge the vital assistance of Ms. Sharon Edaburn Taylor (Curator, Churchill County Museum), Mr. Donald Tuohy (Curator, Nevada State Museum), and Mr. Brian Hatoff (Archaeologist, BLM) in making the interpretive efforts happen. We also thank the Hawkins Foundation for generous support of the Hidden Cave exhibits.

This manuscript was prepared by a number of people, and we especially thank Ms. Margot Dembo for her last-ditch effort in making this manuscript publishable. Ms. Joan Buttner, Ms. Pat Bramwell, Ms. Clarissa Wilbur all assisted, at one time or another, in preparing the typescript. We are especially grateful to Mr. Nick Amorosi, who illustrated the artifacts for this report, and to Ms. Judith Silverstein and Mr. Tom Roe for assistance

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Finally, we dedicate this volume to Mrs. Margaret Wheat, whose unflagging interest in the archaeology of Hidden Cave has spanned nearly half a century. As we recount later in this volume, it was Peg Wheat who enticed S. M. Wheeler to come to Fallon in 1940 to conduct the first excavations at Hidden Cave. It was Peg Wheat who inspired and assisted those involved in the 1951 excavations at Hidden Cave. It was the same Peg Wheat who helped us with so many personal, logistic, geological, and historical matters during our own excavations at Hidden Cave in 1979 and 1980.

Over the last five decades, archaeologists have come and gone at Hidden Cave, but Peg Wheat has always been there to lend a hand and a word of encouragement. On behalf of all the archaeologists who have labored through the years at Hidden Cave, we want to express our most sincere appreciation to Mrs. Margaret Wheat.

Thanks, Peg.

CHAPTER 1. "WHY BOTHER DIGGING HIDDEN CAVE AGAIN???"

DAVID HURST THOMAS

The title of this chapter is a direct quote from a colleague. Why, indeed, bother digging Hidden Cave, when it had already been dug twice? Don't we already understand what's going on at Hidden Cave? I hope that this monograph will satisfactorily answer that question.

TOWARD A GENERAL THEORY OF HUNTER-GATHERER ADAPTATION

A number of recent studies have attacked problems of theory formation by attempting to explain the observed variability in hunter-gatherer adaptations throughout the world (e.g., Wagner, 1960; Lee, 1972; Jochim, 1976, 1981; Bettinger, 1976, 1980; Binford and Binford, 1966; Binford, 1980; Kelly, 1980a, 1983b; Smith and Winterhalder, 1981; Hayden, 1981; Thomas, 1983a). Although we are still a long way from having a comprehensive body of relevant theory, these are promising avenues of inquiry; more important, some of these studies provide insights that are directly relevant to the archaeological record.

Linking acceptable theory to something actually observable in the archaeological record turns out to be a very difficult matter. In fact, the linkage problem may be the greatest challenge facing archaeologists in the upcoming decade (Thomas, 1983a, chap. 1).

One fruitful research direction has emphasized mobility as a key to understanding human adaptation (e.g., Binford, 1978b, 1980; Kelly, 1980a, 1983b; Schalk, 1981; Thomas, 1981b, 1983a). Studying patterns of mobility holds real promise for archaeology because such patterns are sometimes—though hardly always—encoded in the archaeological record. But even when such data are present, how does one go about monitoring them?

Binford's (1980) paper was an important milestone because it translates a general concern with hunter-gatherer dynamics into an archaeologically visible medium. Binford distinguished between residential mobility and logistic mobility by looking at hunter-gatherers along an adaptive continuum. At one end of this continuum are the foragers, groups employing a highly mobile strategy—in effect moving consumers to resources. Collectors exist at the other end of the adaptive continuum, employing a strategy of minimal residential mobility. Collectors, in effect, attempt to move key resources to relatively immobile consuming groups. The extensive use of temporary field camps allows collectors to maintain relatively sedentary base camps, while at the same time exploiting a temporally and spatially disparate resource base.

One characteristic of a collecting strategy is the relatively heavy reliance on storage as a means for coping with spatial and temporal incongruity in resource distribution. Seasonally available resources are commonly stored (or cached) during times of abundance, and low bulk commodities are transported to residential areas for consumption. But high bulk resources can involve high transport costs, requiring the consuming group to make a decision: either pay those higher transport costs and carry the resource from the area of procurement or else move the residential base to the procurement area. Collecting strategies can take many forms—depending on the quality, quantity, and geographical location of consumable resources—but collectors commonly employ relatively low residential mobility and large-scale movement of storable resources (Kelly, 1983b).

Foraging ("mapping on") and collecting ("logistic") strategies may merely represent polar extremes along an adaptive continuum; any given group of hunter-gatherers can be characterized as residentially mobile, logistically mobile, or as some mix of the two. These structural poses are not temporally fixed either, since ecological requirements sometimes are such that a given group must shift seasonally and/or annually along the foraging–collecting continuum. As Binford (1980) has argued, a major challenge for fu-

ture hunter-gatherer studies is to explain what factors condition each strategic option.

It is clear that an extremely wide range of mobility strategies was practiced in the protohistoric Great Basin (Thomas, 1981b, 1983a). Some Great Basin groups were predominantly foragers, following a mapping-on strategy during much of the year: high residential mobility and low reliance on stored foods create basically two kinds of sites (base camps and procurement locations). Other protohistoric Great Basin groups were nearly classic collectors, employing a strategy that minimized residential mobility while maximizing logistic deployment of specialized task groups. For much of the year such groups successfully moved key resources to a single area of consumption—the valley village.

Some protohistoric Basin groups maintained a decided mixture of both strategies by following a fusion-fission settlement mode. During part of the year, such groups employed a largely logistic strategy, living in nearly sedentary base camps located near extensive caches of stored resources. Special-purpose groups moved out of these base camps, transporting collected resources back to the base camps. During other seasons, these larger associations commonly split up into smaller, more mobile residential groups that followed a decidedly mapping-on strategy (frequently moving base camps to new areas of procurement). This adaptive strategy adjusted throughout the year to accommodate the changing resource mosaic.

It is particularly significant that these rather different solutions to problems of residential and logistic mobility occurred at the same time, within a 100 km. radius. That is, within a single "culture area" there was an extremely wide range of mobility patterning by three groups sharing the same basic language, culture, and technology. Those interested in the anthropology of hunter-gatherers should face the challenge of explaining such variability, rather than merely explaining it away (Thomas, 1983a, 1983b).

THE PROBLEM OF THE DESERT LAKE ECOTYPE

Researchers have only begun to identify and attempt to explain the various mobility strategies that operated in the protohistoric and prehistoric Great Basin. But even at this relatively primitive stage of the inquiry, it is clear that certain key mobility characteristics can be perceived in the archaeological record—provided that sufficient bridging argumentation can be developed to link the behavioral and archaeological contexts.

Archaeologists have to-date experienced some success at delimiting mobility patterns in the prehistoric archaeological record, but one landscape—the desert lake biome—has so far eluded satisfactory explanation. Although much has been written about the western lacustrine lifeway, there is at present little agreement regarding that adaptation or how that lifeway should be scaled along a forager–collector continuum. Our work at Hidden Cave sheds some light in this direction, but it is unrealistic to expect excavations at any single site to solve the vagaries of prehistoric marshside existence.

We can, for heuristic purposes, identify polar positions regarding the lakeside adaptation. One posture, termed the *limnosedentary hypothesis,* suggests that the ecological potential of desert lakes and marshes is such that adaptations involve minimal residential mobility; some investigators argue that near-sedentism is the result. The antithesis, which we term the *limnomobile hypothesis,* questions the overall ecological viability of the desert lake biome, suggesting that a more mobile settlement pattern is required to exploit the desert lake resource base. These positions are developed briefly in the remainder of this chapter. The next chapter will, in turn, consider how these alternatives can be tested on independent data sets.

THE LIMNOSEDENTARY HYPOTHESIS

Although the term limnosedentary can be attributed to Robert Heizer (1967, p. 7), the concept is much older; see Janetski (1983) for an excellent historical review of this mode of thinking.

In his analysis of Klamath Lake and Modoc material culture, Barrett (1910, pp. 259–260) spoke of a "very specialized tule culture . . . [they] must be placed in a class by themselves, at least as regards their material culture . . . and their characteristic foods." Ac-

tually, Barrett's often quoted comment was primarily a technological remark, with very little dietary significance. Spier's (1930) later ethnographic work among the Klamath has also served as analogy to many of those discussing the lakeside lifeway.

Citing Barrett's (1910) comments on the Klamath, Jennings and Norbeck (1955, p. 3) emphasized the importance of the lacustrine lifeway in their definition of the Desert Culture. They believed that those people living around the prehistoric Great Basin marshes, particularly in the Humboldt Basin area, were probably considerably more sedentary than groups elsewhere in the Basin because of the "richer resources of the lakes and their shores" (see also Jennings, 1957; Meighan, 1959; Rozaire, 1963; Warren, 1964; Wilke, 1978).

The limnosedentary argument was well articulated by Robert Heizer and his students in their work on ecological patterning in the Humboldt Sink area. Heizer and Napton (1970), in perhaps the most encompassing form, proposed the existence of a distinctive, lacustrine lifeway characterized by the focal exploitation of marsh resources, which led to a sedentary, or nearly sedentary occupation of the lakeshore/marsh environment (Napton, 1969, 1970; Baumhoff and Heizer, 1965, p. 703; Heizer, 1967; Cowan, 1967).

Especially important to the limnosedentary argument was evidence from coprolite analysis, particularly the samples from Lovelock Cave: About 90 percent of the foods known to have been consumed by the occupants of the cave was obtained from the lacustrine resources of the Humboldt Sink. Seeds of aquatic and wetlands grasses (*Panicum, Elymus*) formed the bulk of the diet of the Lovelock population. Wildfowl, especially ducks and mudhens, were important dietary elements. Small fish (esp. *Gila bicolor*) comprised another very important marsh food (Napton and Heizer, 1970, pp. 107–109).

Lacustrine resources are viewed as having "made possible" a relatively stable existence. Napton and Heizer (1970, p. 107) went so far as to argue that "it is obvious that the 'lacustrine biome' was far more productive of foods useful to man than was the vaunted Pinyon-Juniper zone of the upland or 'range' part of the Great Basin."

Napton (1969, pp. 58–59) generated a trait list designed to characterize the protohistoric and prehistoric lacustrine subsistence pattern in the Great Basin:

1. semi-sedentary occupation of lakeside villages
2. brush and tule thatched houses and house pits
3. intensive use of lacustrine food resources
4. boats, rafts, or "balsas" made of wrapped tule culms
5. waterfowl decoys made of skins mounted on prepared tule bodies
6. seasonal harvest of food items, e.g., communal mudhen drives using boats and nets
7. preparation of seed by parching on mats; cat-tail seed harvest, preparation of seeds by exposure to flame
8. intermittent occupation of lakeside caves; caches and inhumations in caves
9. extensive use of aquatic plants in manufacture of artifacts
10. use of specialized artifacts for efficient exploitation of lacustrine resources

David Madsen has recently argued that the limnosedentary exploitation of marsh resources has flourished in the eastern Great Basin for millennia (Madsen, 1979, 1982; Madsen and Berry, 1975; Madsen and Lindsay, 1977): "The Great Basin is characterized by rich riverine and lacustrine ecosystems, which form oases between areas of much more limited resources .... In some areas such ecosystems were sufficiently sizeable and productive to support large, stable populations throughout the year" (Madsen, 1982, p. 207). For other discussions of the limnosedentary lifeway in the Great Basin, see Aikens (1978), Nielson (1978), Clark (1978), Wilke (1978), Madsen (1979), Fowler (1982b), Hattori (1982), Janetski (1983), and Thomas (1983c).

The Limnomobile Hypothesis

Limnosedentary arguments are commonly framed in typically normative terms, assuming that the evidence found at one site (or set of sites) can readily be used to generalize about the remainder of the pattern. It is clear, however, that mere utilization of any resource suite at a single site, or series of sites, tells us

relatively little about either the overall dietary or settlement pattern (Thomas, 1973; Janetski, 1983). Establishing that piñon nuts were eaten at a single locality provides virtually no insight as to the rest of the seasonal and annual round. Similarly, although marsh resources were obviously exploited at a number of sites in the Humboldt and Carson sinks, the duration and significance of this "limnosedentary" aspect is wholly unknown: "limnosedentism" might well have lasted for only a few weeks or months at a time, and such episodes could have been separated by years, decades, or even centuries.

Those advocating the potential of marshlands emphasize the high degree of primary productivity in the lacustrine biome (Napton, 1969, p. 59; Madsen, 1979, p. 716; Madsen and Lindsay, 1977, p. 88). But this position has been recently challenged by a number of investigators, especially Kelly (1980b, n.d.b.), Jones (1981), Simms (1982), Janetski (1983), and Binford (1983, pp. 200–210). Kelly (1980b, n.d.b.) in particular has argued that measures of primary productivity are misleading because much of that productivity results from phytoplanktonic photosynthesis and hence is not available to human consumers.

Most advocates of limnosedentism emphasize the allegedly high quality sources of nutrition in the marshland, but recent experiments by Jones (1981) and Simms (1982) suggest that common marsh resources rank significantly lower than either piñon or ricegrass. Although these experiments are preliminary, it seems that regardless of the abundance of marsh resources—especially cat-tail seeds and pollen, bulrush, wokas, waterfowl, and most species of available fish—the excessive costs of procurement, processing, and storage renders them a less than satisfactory staple (esp. Kelly, 1980b, n.d.b.).

There is also the question of long-term stability of marsh resources. Several investigators have commented on the transitory nature of marshes and other wetlands (esp. Weide, 1976; Kelly, 1980b, n.d.b.; Janetski, 1983). As Wheat (1967, p. 3) has noted: "In the Great Basin the marshes . . . were intermittent affairs, always at the mercy of dry cycles and shifting dunes and channels. In half a dozen years a marsh could change into a dust bowl." Specifically with reference to the Carson Sink, Kelly and Hattori (chap. 3, this volume) demonstrate how the varied drainage patterns change over even relatively short intervals; resulting marshlands come and go in response to a number of independent factors.

Binford criticized the limnosedentary argument on more general grounds: ". . . it has been proposed that in the Great Basin of North America there existed a Garden of Eden along various internal drainages, where big marshes produce vast numbers of edible cattails. I don't know how many tons of cat-tails there were supposed to be within a two-hour radius of the site in question; but if you want to eat cat-tails all your life, then perhaps there is a Garden of Eden there. At any rate, it was argued—quite seriously—that this resource was the basis of sedentism and village life in the region [Madsen, 1979]" (Binford, 1983, p. 201).

Kelly (1983a) suggests that the prehistoric western Great Basin marshlands lacked the ecological potential to serve as primary resource bases. Such areas may, instead, have served as back-up resource zones, to be exploited mainly as a survival response to failure of the primary terrestrial resources. This suggestion quite obviously has implications for the archaeology of areas such as the Carson Sink.

These differing interpretations bring us back to the question that began this chapter—"Why bother digging Hidden Cave again???" We think that this site and the surrounding Carson Sink area provide an excellent laboratory in which to examine the nature of the prehistoric lacustrine adaptation. Granted, this site had been excavated twice previously, but we think that the renewed excavations asked questions not previously asked and employed techniques not previously employed. Yet these questions and techniques could not be indiscriminately applied, and the next chapter sets out how the renewed excavations at Hidden Cave were undertaken.

CHAPTER 2. THREE MODES OF INQUIRY INTO THE LACUSTRINE LIFEWAY

DAVID HURST THOMAS

The preceding chapter emphasized the importance of the forager-collector continuum as a focal concept. Although many protohistoric and prehistoric Great Basin groups can readily be scaled according to their residential mobility (Thomas, 1981b, 1983a), little agreement exists as to the relative mobility of the lacustrine groups. Both the limnosedentary and limnomobile hypotheses enjoy a certain intuitive (if not empirical) credibility, and a consensus is currently lacking. It is possible at this point, however, to isolate some fruitful directions of inquiry into the nature of the lacustrine lifeway. This chapter discusses three complementary research options.

FIRST AVENUE OF INQUIRY: MODELING LACUSTRINE RESOURCE STRUCTURES AND STRATEGIES

It is sometimes useful to begin with an examination of the relatively "known" and work toward the relatively "unknown." In this case, the ethnographic picture is incomplete, but it does provide a point of departure. Lacustrine resource structure involves several factors: nature of the standing biomass, spatial and temporal incongruities within that resource base, degree of predictability of various resource suites, plus the relative costs of procurement, processing, transport, and potential for storage. Preliminary studies (Kelly, 1980b, 1983b; Jones, 1981; O'Connell, Jones, and Simms, 1982; Simms, 1982) suggest that marshland resources rank relatively low when compared to commonly exploited terrestrial resources. But these data are, at present, only preliminary, badly in need of supplementary study before they can provide a basis for archaeological inquiry (see also Janetski, 1983).

Until more comprehensive mid-range theory is available regarding the structure of the lacustrine biome, we can only explore the known behavioral strategies available to exploit the lacustrine resource base. Similar strategic models have been constructed for groups living elsewhere in the Great Basin (Thomas, 1981b, 1983a), but model building is severely crippled by the spotty nature of the ethnographic record. Key ethnographies provide only general sketches of "typical years" for the protohistoric Northern Paiute groups living in the Carson and Humboldt sinks (e.g., Simpson, 1876; Hopkins, 1883; Lowie, 1924; Stewart, 1939, 1941; Park, 1938; DeQuille, 1963; Wheat, 1959, 1967; Heizer, 1960, 1970a, 1970b; Shimkin and Reid, 1970; Steward and Wheeler-Voeglin, 1974). As Catherine Fowler (1977, 1982a, 1982b; see also Fowler and Bath, 1981), Thomas (1979, 1983c), Madsen (1982), and Janetski (1983) have noted, the lacustrine lifeway has been slighted by ethnographers, especially in the influential writings of Julian Steward. This "bias in the Basin" is reflected in the relative sketchiness of our knowledge of the lakeside exploitative pattern.

What Was the Toedökadö Exploitative Strategy?

Despite the lack of ecological and ethnographic clarity, it is possible to draw together some preliminary notion of the strategy by which the Toedökadö Northern Paiute of the Carson Sink exploited their environment during the protohistoric period. This strategy is clearly only a single possibility for lacustrine patterning; the protohistoric Toedökadö strategy in no way provides a firm analogy from which to interpret the archaeological record.

The Toedökadö ("tule [or rush] eaters") band of Northern Paiute lived in the Stillwater area of central Nevada during protohistoric times (fig. 1). Stewart assigned a territory of about 17,400 sq. km. to this group and estimated the population to be about 800 individuals during pre-contact times (1939, p. 141). But of more interest than absolute figures are relative estimates made of their "territory" (more properly, the annual range).

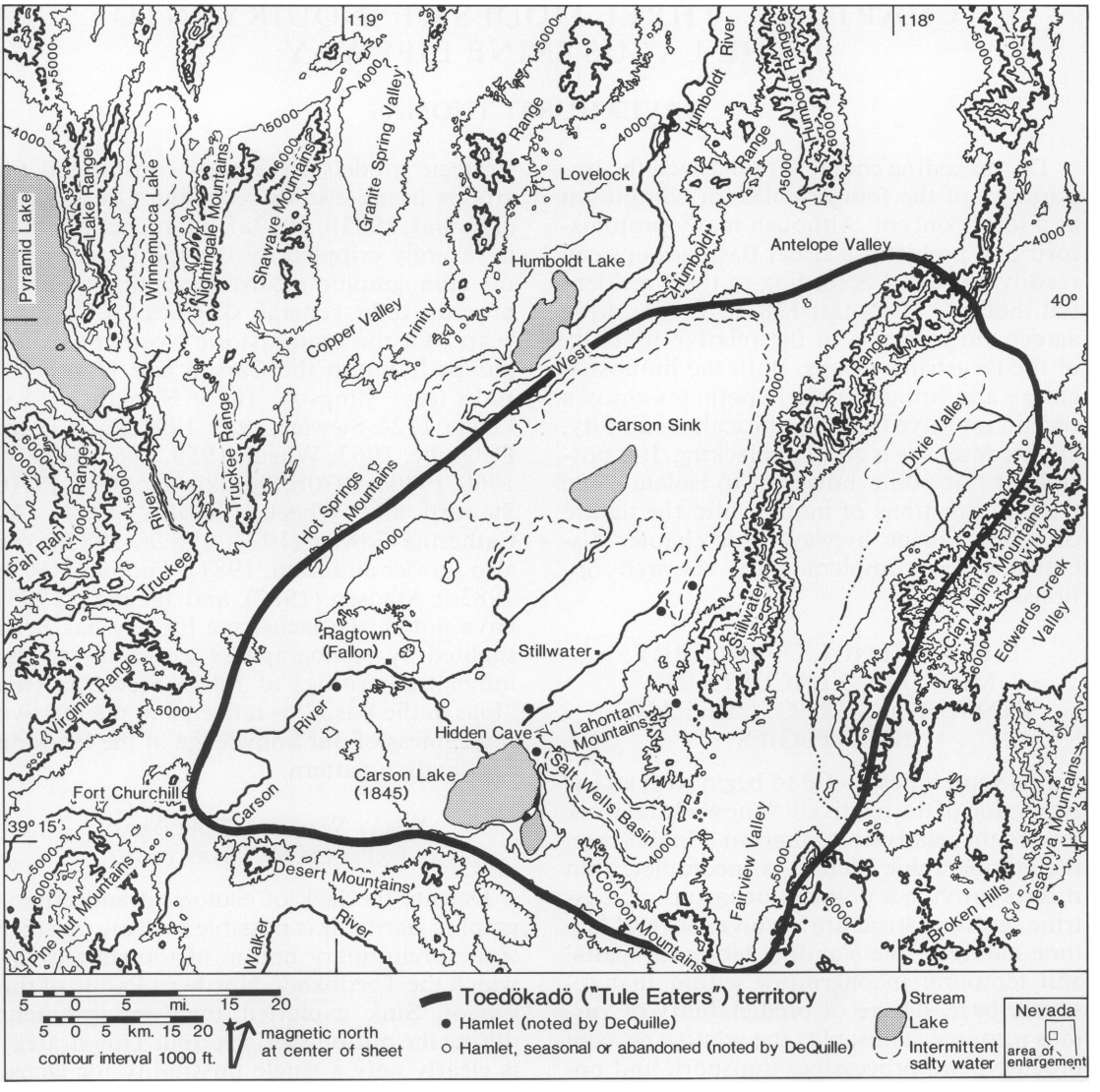

FIG. 1. Territorial map of the Toedökadö Northern Paiute (after Stewart, 1939; Shimkin and Reid, 1970).

Figure 1 shows that the Toedökadö annual range stretched from Fort Churchill on the Carson River well to the east into the Clan Alpine Range, nearly 130 km. away. Other estimates show the eastern margin of Toedökadö territory even further to the east, bordering the Reese River Valley (Stewart, 1939, map 1; 1966, map 8; Johnson, 1975).

Toedökadö winter villages were established either in the uplands near pine nut caches or, probably more frequently, in lowland marshy areas (Loud and Harrington, 1929, p. 159; Lowie, 1924, pp. 202–203). According to Wheat (1967, p. 15), deciding where to locate the winter residence was based largely on the nature of the fall piñon harvest. In exceptional piñon years, base camps were established in the mountains; in ordinary and poor harvest years, residential bases were transplanted from the woodlands to lakeside villages (see also Stewart, 1941, p. 374).

DeQuille (1963, pp. 30–31) noted that most

of the lacustrine villages were located on sandy high ground, somewhat removed from the Carson River and Lake; these locations provided potable water, some protection from mosquitos, as well as abundant marsh resources for use as food, fuel, and raw materials for a wide assortment of material culture.

But regardless where winter residence was established, the large base camps were commonly broken up in the spring, so that smaller groups could conduct a variety of procurement activities: collect early roots and greens, hunt small game, sometimes conduct communal antelope and jack rabbit hunts, fish in nearby streams and lakes, drive migratory waterfowl, and collect seeds and berries. Most procurement activities could have occurred either in the lowland marshes or in the surrounding desert scrub areas of the Carson Sink. Procurement such as this is best done by smaller groups following a forager-like pattern of high residential mobility (see esp. DeQuille, 1963, pp. 30–31, 141; Wheat, 1967, pp. 9–10). By late spring, most of the seed-bearing crops had matured and the harvested seeds could either be consumed immediately or stored for future use (DeQuille, 1963, p. 53). Although many lacustrine and scrubland root and seed crops were available from spring through fall, spring collection was particularly critical because winter stores were often exhausted by this time; in some years, the entire range of famine food was consumed during the spring and winter months.

Fishing was important to the Toedökadö and structured the overall annual round. Some fish could be procured in the Carson Sink during the late winter and early spring. But the most important fishing occurred in May, when the Toedökadö joined several other groups to exploit the spring spawning run in the Truckee River/Pyramid Lake or Walker River/Walker Lake area (Wheat, 1967, p. 10; Speth, 1969; Fowler and Bath, 1981). The Carson River spawning run was of only minimal importance (Snyder, 1917); note that each of these major spawning areas was well outside the nuclear Carson Sink. In good years, the fish were dried and often cached for winter use (Stewart, 1941, p. 376; Wheat, 1967, pp. 8–9; Speth, 1969; Fowler and Bath, 1981). Transport costs from the area of procurement (wherever the spring spawning run occurred) to the Toedökadö homeland undoubtedly conditioned the location of the winter base camp.

Summer months were generally spent in smaller groups foraging throughout the desert scrub and marshland environments, harvesting a wide variety of seeds and berries, hunting and/or driving ducks, hunting both large and small game, and collecting cat-tail pollen. While camped not far from Hidden Cave in early June, Simpson (1876, p. 85) noted that "A number of Pi-utes, some two dozen, live near our camp, and I notice they have piles of fish lying about drying, principally chubs and mullet. They catch them with a seine. Their habitation consists of flimsy sheds, made of rushes, which screen them from the sun and wind . . . . The decoy-ducks they use on the lake to attract the live ducks are perfect in form and fabric, and I have obtained a couple for the Smithsonian Institution."

Simpson (1876, p. 104) also noted a good Indian trail heading east from the Carson Sink; this trail was sufficiently well-used to permit pack animals ("but it would require considerable work to make it so for wagons"). Following this trail to the east, Simpson (1876, p. 106) makes a most interesting journal entry on June 29: "There are several families of Pi-Utes at this Middle Gate, collecting grass-seed, which they separate from the husks by first rubbing the heads lightly under stones and then winnow, by throwing it up in the wind. Afterward they convert it into flour by rubbing it by the hand between stones. I notice they use a variety of seeds in making flour. *These Indians have come from Carson Lake . . .*" [emphasis added]. Simpson's note is of interest not only because it documents a dispersed foraging group collecting seeds in early summer, but also because this group had traveled a minimum of 75 km. from their base camp near Carson Lake.

This rather high degree of logistic mobility, incidentally, took the Toedökadö well beyond their so-called "territorial boundaries," as defined by Stewart (1939) and Shimkin and Reid (1970); see also figure 1.

DeQuille (1963, pp. 2–36, 71) made a similar observation upon encountering a task group returning to the base camp in the Car-

son Sink after hunting wood rats in the mountains to the east: "They had left the Cold Spring [Clan Alpine] mountains at sundown, and had been traveling all night across the desert. They carried small water bottles . . ., and were loaded with a species of mountain rat, smoked and dried, packed in oblong hampers made of twisted ropes of grass." This seems to have been a procurement group operating on a foraging basis; logistic procurement probably occurred as well.

Although this account is unavoidably sketchy, some impressions emerge regarding both the structure of the marshland resource in the Carson Sink area, and the adaptive strategy by which those resources were exploited.

The Toedökadö Were Probably Not Pure Collectors

Pursuing a strictly collecting strategy in the Desert West environment requires a resource base that is sufficiently abundant, nutritious, closely spaced, and predictable to allow for considerable year-to-year redundancy (Thomas, 1981b, 1983a; see also Kelly, 1983b). Particularly important is the positioning of the winter residential base camp, which, because of generally low winter productivity in this area, depends rather heavily on stored food caches.

The protohistoric Owens Valley Paiute, for instance, pursued a predominantly collecting strategy by balancing annual piñon abundance against a host of storable valley floor resources; Janetski (1983) makes a similar case for the Western Ute of Utah Valley. Residential mobility was thus conditioned only in part by the specific abundance of any single resource in any given year (Thomas, 1983a). Base camps were established in the woodlands only in years of exceptional piñon abundance, when the excessive transport costs outweighed the costs of establishing the winter residence in the mountains. In most years, the piñon crops were transported to the valley villages, where additional storable resources (and relatively permanent dwellings) were available.

This strategy could not work for the Toedökadö. The structure of their resource base contained too many temporal and especially spatial incongruities. Temporal conflicts—limited seasonal availability of key resources—could be offset to some extent by a storage strategy, and the Toedökadö stored large quantities of resources: marsh seeds, pollen and rhizomes, fish, waterfowl, small and large game, and pine nuts. This temporal diversity was probably beneficial in the long run due to occasional resource failure—failure of the local piñon crop, inadequate spring spawning run, temporal marshland desiccation could often be offset by resources cached in other seasons. Storage strategies are to be expected in areas like the Carson Sink, provided that key resources do not fail year after year. Long-term resource depletion would, of course, negate the effectiveness of caching as a leveling device.

Nevertheless the problems of spatial incongruity in Toedökadö territory probably rendered the collecting strategy ineffective. Because there was no local spring spawning run, Carson Sink groups were required to travel to the Truckee/Pyramid or Walker River areas, a distance of at least 55 km. and as much as 90 km. Even in years of exceptional abundance of fish, high transport costs probably kept the Toedökadö from stockpiling significant quantities of fish as winter stores.

Similar problems plagued the fall piñon harvest. At least two prime pine nutting areas fell within Toedökadö "territory": the Stillwater Range, only 24 to 32 km. away from Carson Lake proper, and the Clan Alpine Range about 65 (airline) km. away. According to Stewart (1939), the Toedökadö also collected pine nuts in the Desatoya Range, 80 km. to the east, and even the Shoshone Range, a full 95 km. away.

Ecological diversity within protohistoric Toedökadö Northern Paiute "territory" buffered them against the failure of individual resource patches. But unfortunately, these diverse habitats were rather far flung, commonly involving distances on the order of 80–95 km. Thus while the multiple backup areas no doubt provided a measure of long-term stability to the Toedökadö adaptive strategy, year-to-year spatial incongruities imposed very high transport costs between areas.

If, for instance, the Toedökadö harvested

pine nuts in the Stillwater Range, it might be quite feasible for them to transport the nut crop down to the marshland villages (where, presumably, additional spring and summer resource caches had been established). But if the nearest satisfactory pine nut patch was in the Clan Alpine Range—still well within their "territory"—the costs of bringing the nut caches back to the Carson Sink (a distance of at least 50 km.) would readily be excessive. It is also quite possible that crops were transported partway between base camp and procurement area, a strategy designed to decrease transport costs within the commonly exploited logistic range.

Groups such as the Toedökadö commonly faced the decision of which to transport, resources or people. Each major resource patch—spring fish runs, spring/fall lacustrine harvests, fall/winter pine nuts—occurred in widely separated areas. These are, with the possible exception of fish, extremely high bulk crops, exacting expensive transport costs to a single, all-season base camp. Although large quantities of high-bulk resources were undoubtedly transported from time-to-time, rarely could they be transported in sufficient quantity to offset the spatial incongruity of the landscape.

Unless a single resource could be gathered in abundance with sufficient regularity and at acceptable costs of extraction and processing, there was little chance (or necessity) for such a group to become "sedentary." Hence, it is spatial incongruity that probably precluded a well-developed, year-round collector strategy.

The Toedökadö Were Probably Not Pure Foragers

Because of the high residential mobility involved in a foraging lifeway, caching and food storage occur only minimally (Binford, 1980). Yet we know from the various Carson Sink ethnographic and ethnohistoric sources that the aboriginal groups engaged in extensive caching of storable resources: riparian, desert scrub, marsh, and riverine seeds (Wheat, 1967; DeQuille, 1963, p. 141; Stewart, 1941, p. 376; Lowie, 1924, p. 202), pine nuts (Loud and Harrington, 1929, p. 158; Heizer, 1950; Wheat, 1967; Stewart, 1941, p. 374), berries (Stewart, 1941, p. 374), honey dew "sugar" (Heizer, 1945), rabbits (Wheat, 1967, p. 14), birds such as mudhens (Scott, 1966, pp. 41–42; see also Heizer, 1970a, p. 235), fish (Stewart, 1941, p. 376; Wheat, 1967, pp. 8–9; Speth, 1969; Fowler and Bath, 1981), fish eggs (Stewart, 1941, p. 376).

Although we lack a comprehensive overview of the variability within the Toedökadö settlement strategy, there are simply too many well documented instances of food caching and storage for this group to have followed a purely foraging strategy.

Given these considerations, it is my impression that the Toedökadö probably employed a mix between foraging and collecting, in most years following a fission-fusion pattern (as defined by Thomas, 1983a, pp. 30–32). During most winters they probably maintained a relatively stable residential base, in either marshland or upland settings, depending on the local availability of key fall resources, the quantity of foodstuffs cached during the summer, and the transport costs involved. Although we do not now understand the long-term resource structuring, the inherent instability of the marshland setting almost certainly required a flexible and annually variable approach to overwintering.

These relatively sedentary winter residences were probably abandoned in the spring of most years, as smaller fission groups followed a largely forager strategy: frequent residential movements to collect early roots and greens, hunt small game, fish sporadically in local rivers and lakes, drive mudhen and ducks, collect seeds and berries, and so forth. It is likely that the spring/summer settlement pattern involved mostly base camps and procurement localities. At least during the protohistoric period, logistic mobility—in the form of special-purpose task groups—was probably minimal during the spring and summer.

We lack hard data regarding how various Northern Paiute groups conducted such spring encampments, but in any case, even in good years these large-scale nucleated settlements lasted no longer than a month or so (Wheat, 1967, p. 10).

Small fusion encampments probably lasted through the summer and into the fall, when pine nuts and *Scirpus* seeds ripened once

again. It is likely that all such groups were well versed in the condition of various piñon patches; key information such as this was undoubtedly shared at major gatherings like spring fishing camps.

Fall/winter encampments involved considerably more residential permanence than the summer and spring portion of the seasonal round. One measure of this predictability and residential stability is the tendency of both the Toedökadö and the Kamödokadö (of the Humboldt Sink) to maintain proprietary rights to the piñon areas. Although evidence is sketchy, there is a tendency among many protohistoric Great Basin groups to develop territoriality and ownership in concert with residential stability (Dyson-Hudson and Smith, 1978; Eggan, 1980; Thomas 1981b, 1983a; Fowler, 1982b). Resource territoriality in the Great Basin ranges from extreme among primarily collecting groups to minimal among groups following a forager strategy. Groups following a fusion-fission pattern tended to exercise ownership only on those resources sufficiently predictable for establishment of year-to-year residential permanence.

Loud (Loud and Harrington, 1929, p. 159) notes that piñon productivity was so important to protohistoric groups living in the Carson and Humboldt sinks that these people held "proprietary rights" to specific piñon tracts. Winnemucca, for instance, claimed the pine nuts along the "Weasel Trail," a ridge located near the northern part of the Stillwater Range (Loud and Harrington, 1929, pp. 159–160, pl. 68). Presumably these proprietary rights operated similarly to those in other limited areas of the Great Basin, where the degree of habitual use directly conditioned the degree of direct ownership and exclusivity (Steward, 1938, p. 106). Fowler (1982b) has recently suggested that the "food-named" territories in this area functioned to define resource-use rights, and also to assist in monitoring resource conditions in distant areas.

In contrast to the practice among groups following a more purely logistic strategy, there is no evidence of a true territorial system in either the Carson or Humboldt sinks.

The quasi-territorial system among the protohistoric Toedökadö suggests two things: (1) that piñon productivity was sufficiently important in the overall resource structure to warrant a semi-exclusionary policy toward the piñon-juniper woodland, and (2) that residential mobility was sufficiently high to vitiate any need to protect a single winter residence area as true "territory." This suggests further that in the long run, the Toedökadö could count on returning annually to their home range. But that they were in no sense "sedentary," since there were several options for the location of the winter residence.

This account outlining the exploitative potential of the Carson Sink remains both preliminary and tentative because we still lack critical details about resource structure and exploitative strategy during protohistoric times. It is probably also necessary to emphasize again that this is not an ethnographic analogy for the interpretation of the archaeological record of the Carson Sink (see also Thomas, 1983a, chap. 2). One can never assume that any given landscape could be exploited in only one way—the nature of that exploitation is subject to vagaries of a changing resource base and regional demographic pattern. This is why additional avenues of inquiry must be pursued when seeking to document the past subsistence patterning in this area.

A SECOND AVENUE OF INQUIRY: THE REGIONAL ARCHAEOLOGICAL SURVEY

The regional approach to archaeology began in the immediate post-World War II era, and settlement archaeology was maturing during the 1950s (e.g., Willey, 1953, 1956; Meggers, 1956; see also Thomas, 1979; Willey and Sabloff, 1980, pp. 146–148). Since then, major regional efforts have been conducted throughout both the Old and New worlds (e.g., Chang, 1968). Although a few archaeologists doggedly retain a single-site, normative perspective, archaeology in general has accepted the regional approach to issues of human ecology and adaptation.

The advent of regional archaeology has led to the development of specific methodological tools for conducting archaeology at a macro-level, especially statistically based sampling designs (e.g., Binford, 1964; Muel-

ler, 1974, 1975; Flannery, 1976). The archaeology of the Great Basin has, to some extent, occupied a vanguard position in the formulation of regional research designs. We now have systematic regional data from a number of Great Basin localities, including the Reese River Valley (Thomas, 1971, 1973), Owens Valley (Bettinger, 1975, 1976), the Monitor Valley (Thomas, 1983a, 1983b, in press), Big Smoky Valley (Kelly, n.d.a.; Pendleton, 1979), Pine Valley (Hatoff, 1974), the Steens Mountain area of Oregon (Aikens, Grayson, and Mehringer, 1979), the field data from throughout the Great Basin as a result of surveys conducted for the MX missile system (esp. Holmer, 1981), plus various ongoing projects in Grass Valley (Elston, personal commun.), Mineral County (M. Hall, personal commun.), and the Wassuk Range (David Rhode, personal commun.).

But curiously, systematic survey data are badly wanting for the lacustrine biome in the western Great Basin (a major exception is the data currently being analyzed from the Steens Mountain area of Oregon); the best available data for most areas resulted from opportunistic, haphazard, unsystematic sampling. Although lacustrine settings have received a major research effort, too many archaeologists still restrict their attention to spectacular, artifact-rich caves and large open sites. It is true, of course, that much of this investigation took place in the formative days of archaeological technique, prior to the advent of regional archaeology. But even in recent years, few investigators seem willing to invest the research effort necessary to survey the surrounding lacustrine settings in an intensive, systematic manner (see Bettinger, 1978a). Without supporting, systematically collected survey data, excavations at the high-information cave sites stand high and dry, lacking the regional framework necessary to monitor the ecological network in which these isolated sites once operated.

In part to remedy this situation, and in part to clarify the nature of the lacustrine lifeway, Robert L. Kelly (sponsored by the American Museum of Natural History) has designed and implemented a large-scale regional random sample of the Carson Sink/Stillwater Range (Kelly, 1980b; 1983a, p. 6; Kelly, Ingbar, and Graham, 1982). This survey has now been completed, and the data are being analyzed. Although coordinated with the Hidden Cave excavations, Kelly's survey proceeded independently; no results are available from the survey at present, but the following sketch will briefly explain the nature and objectives of the survey effort.

Kelly's Carson Sink/Stillwater survey was initiated in 1980 specifically to attack the problem of lacustrine subsistence patterning. The survey fieldwork was conducted in an area of about 1600 sq. km., encompassing both the Carson Sink and the Stillwater Range to the east. The objective of the 1980 fieldwork was to obtain a 1 percent randomly selected sample from lowland and mountain areas. A second field season (1981) was spent on more intensive investigation of key areas defined in the 1980 survey. A weighted, proportional sampling design was employed: the Carson Sink was sampled with 16 transects, each 100 m. wide, with an aggregate length of 257 km. The mountains were sampled with 57 quadrants, 500 sq. m. in size. In all, 161 archaeological sites were recorded in 1980–1981.

The Carson/Stillwater Archaeological Project promises to provide a badly needed regional perspective to our excavations at Hidden Cave. A great deal can be learned from high-information sites such as Hidden Cave, but such studies still deal only with the single case; these sites are in no way "average" or "typical" of anything. Many of the pressing aspects of the limnosedentary/limnomobile issue must await completion of Kelly's analysis of patterning in the Carson Sink/Stillwater area.

A THIRD AVENUE OF INQUIRY: ENCOUNTERING THE HIGH-INFORMATION SITE

Most archaeologists, in the Great Basin and elsewhere, recognize that the extensive, regional surveys must be coupled with intensive excavations of relatively high-information sites. Flannery (1976), O'Connell (1975), Madsen (1981), Bettinger (1981), and Thomas (1979, 1983a, 1983b), among many others, have emphasized the importance of employing a diversified archaeological research strategy. The Reese River research, for instance,

began as a three-season extensive regional random sample (Thomas, 1969a, 1971, 1973). But when the survey was completed, it was clearly necessary to supplement and enhance the findings from surface archaeology with data from stratified excavations at key sites such as Gatecliff Shelter (Thomas, 1983b).

Similarly, Bettinger's extensive survey of the Owens Valley was coupled with intensive excavations at important stratified sites initially located in the surface survey (Bettinger, 1981). The same is true of the recent research of Aikens, Grayson, and Mehringer (1979) in the Steens Mountain area.

In each case, appropriate high-information sites were needed to clarify issues of cultural and paleoenvironmental chronology, as well as to recover sufficient *in situ* micro- and macro-fossils for reconstruction of the fine-grained details of subsistence and settlement structuring.

In order to recognize the importance of an integrated archaeological strategy, it is critical to couple extensive survey efforts with intensive excavations whenever possible. The regional survey of the Carson Sink/Stillwater area was mentioned above; the trick—in terms of archaeological methodology—is to link this survey with excavations at one or more high-information lacustrine sites.

Lovelock Cave, a very high-information lacustrine site, was the first major archaeological excavation in the Great Basin. Unfortunately, primary investigations at Lovelock Cave occurred when archaeological techniques were rudimentary, and information loss was high. As Heizer and Napton (1970, p. 1) have lamented: "from the point of view of procedure, the initial explorations [at Lovelock Cave] were the antithesis of even the relatively unsophisticated archaeological methods practiced at the beginning of the present century."

Despite the massive artifact inventory ultimately recovered, the ecological and adaptive picture represented by the deposits of Lovelock Cave remains depressingly vague and subject to considerable speculation and controversy, even today (Napton, 1969; Heizer and Napton, 1970, pp. 39–44; Weide, 1974, p. 77; Clark, 1978, pp. 388–395; Kelly, 1980b).

Lovelock Cave is merely the best known of the high-information lacustrine sites that were once available for study. And, like Lovelock Cave, most of the best such sites were excavated—or outright pothunted—relatively early in the game and are unavailable for contemporary interdisciplinary investigation: Humboldt Cave (Heizer and Krieger, 1956), Ocala Cave (Loud and Harrington, 1929), Leonard Rockshelter (Heizer, 1951), Kramer Cave (Hattori, 1982), other Falcon Hills caves (Shutler, 1968), Thea Heye Cave (Follett, 1977), the various caves on the eastern shore of Lake Winnemucca (Orr, 1956, 1974; see also Hattori, 1982), and many others. Even when conducted scientifically, these excavations occurred before archaeological method and theory were sufficiently developed to answer questions now being posed regarding ecology and lifeway.

The unfortunate combination of relatively crude archaeological technique and outright looting has exacted a grim toll from our database of high-information lacustrine sites. Although "new" sites will occasionally be found, the truth is that contemporary lacustrine research must generally settle for the second-rate site.

Hidden Cave as a High-Information Site

This is why we were excited about the prospect of renewing excavations at Hidden Cave. We had been monitoring the residual deposits in Hidden Cave for a dozen years before starting our excavations there. This site not only retained major exposures of intact Pleistocene and Holocene sediments, but Hidden Cave was one of the primary sites taken as "typical" of the limnosedentary hypothesis (e.g., Napton, 1969). From the initial planning stages, we hoped to assemble an interdisciplinary team to study the paleoenvironmental and anthropological significance of the remaining deposits in Hidden Cave.

Analysis of extant museum collections has become an increasingly important and respectable avenue of anthropological inquiry (see e.g., Cantwell, Griffin, and Rothschild, 1981), especially when combined with additional investigations using up-to-date field techniques. Hidden Cave was attractive in

this regard because of the availability of two large and relatively unstudied museum collections from that site. Artifacts, field notes, photographs, and stratigraphic drawings from the Wheelers's 1940 excavations had been carefully stored and preserved at the Nevada State Museum, and the materials from the 1951 University of California (Berkeley) fieldwork were well curated at the Lowie Museum of Anthropology. From the outset, we wanted to renalayze both collections, and curators at both institutions generously granted us permission to do so.

The Research Bias at Hidden Cave

Strongly suspecting from the outset that Hidden Cave had been used as a prehistoric cache, we hoped to employ the cache setting as a window through which to monitor prehistoric decision-making processes. As is often the case, the reality of such inquiry was considerably more complex than we had initially anticipated.

Several investigators have previously discussed the role of caching in the Great Basin: "Many famous sites seem to have been more heavily used as cache storage spots (for example, Lovelock) rather than as dwelling places. As a result, Danger [Cave—a habitation site] has a wider variety of utilitarian objects, whereas the cache sites contain perhaps more 'valued' materials" (Jennings, 1968, p. 139; see also Jennings, 1964, p. 161).

Others stressed the distinctive function of the so-called cache cave, paticularly those known to ring the marshland margins of the Lahontan drainage (Loud and Harrington, 1929, p. 914; Heizer and Krieger, 1956, p. 11; Baumhoff, 1958; Heizer and Napton, 1970, pp. 42–43; Hester, 1973, p. 93, 1974; Clark, 1978, p. 386; Kelly, 1980b; Hattori, 1982, p. 2; Roust and Grosscup, n.d.).

Although a few investigators thought Hidden Cave to be a habitation site (Napton, 1969, p. 48; 1971b, pp. 12–13; Morrison, 1964, pp. 105–106), most archaeologists classified Hidden Cave as another of the lacustrine cache loci.

Determining site function is, of course, but a step along a lengthy trail. As emphasized above, our excavations at Hidden Cave are complemented by the extensive regional survey of the Carson Sink/Stillwater area, but the cave deposits *per se* are also useful in examining the prehistoric ecology of the area. Although no single site is "typical" of the overall settlement patterning, Hidden Cave is a reasonably high-information site from which to monitor selected aspects of the prehistoric seasonal round.

Site functional issues necessarily involve definitional criteria (Binford, 1977, pp. 2–4)—but defining site function does not involve hypothesis-testing as such. This brings us back, once again, to the critical importance of the operational definition in archaeology (Thomas, 1970, 1974, 1983b). Meaningful identification of site types, artifact functions, temporal ranges, and so forth provide a necessary first step in using archaeological data for theory building. Too often, there is a tendency to launch into elaborate arguments about archaeological theory without the slightest grounding in adequate definitional and empirical criteria (see esp. Flannery, 1982 for a look at the hazards of archaeology-sans-fieldwork).

The Archaeological Visibility of Storage Facilities

Given this background, the operational issue revolved about the recognition of storage strategies and caching features in the archaeological record. Heizer and Napton (1970, pp. 43–44) considered this issue with regard to the distinctive deposits of Lovelock Cave:

> . . . The enormous mass of artifacts from Lovelock Cave, probably amounting to more than 20,000 specimens, is an impressive collection. However, in examining the cave midden, we are equally impressed with what is *not* present. Absent, or nearly so, are the ash lenses that are almost invariably found in large rockshelters and caves, absent also are large amounts of flint debitage, discarded bones of. . . fauna, and many other kinds of debris that were usually produced in the course of daily living in . . . occupation sites . . . . In short, there are enough anomalies in the Lovelock Cave occupational debris to suggest that part of the daily human activity that usually occurred in this type of Great Basin occupation site probably took place at some other location—most probably the lakeshore villages.

Written nearly 15 years ago, this statement

articulates rather well with the modern thrust of hunter-gatherer studies. In more modern parlance, the archaeological visibility of a cache cave depends on two factors: (1) the presence of stored tools and/or resources, and (2) the absence of maintenance/habitation evidence.

The intact cache has a high degree of archaeological visibility; its positioning and contents are directly conditioned by the role it played in the settlement strategy that created it. Unfortunately, we knew from previous investigations that most of the cache pits at Hidden Cave were empty, significantly diminishing the archaeological visibility of the storage strategy.

To cope with this difficulty, we have found it necessary to examine the cache pit in some detail. In this chapter, we consider the nature of *cache contents,* particularly with reference to the strategies behind creation of such features. Elsewhere (chap. 21, this volume), Ingbar furthers this discussion by considering the *morphology* of cache pit features.

Assuming that the problems of archaeological visibility can be appropriately addressed, it would seem that caches might provide relevant signatures betraying certain characteristics of the systems that produced them.

Elsewhere, I have considered in some detail the nature and role of caching loci in the protohistoric Great Basin (Thomas, 1983a, pp. 81–82). Powell (in Fowler and Fowler, 1971, p. 49) provides an excellent account of how, why, and when caches were constructed by the Southern Paiute and Ute, and the variety of caching spots during protohistoric times is truly impressive (see also Steward, 1933, p. 252; 1941, p. 281; Harris, 1940, p. 41; Fowler and Fowler, 1971, p. 48). In the following discussion, we will examine the nature of variability in these known cases of caching behavior.

The Resource Cache

Caches come in a great variety of sizes, shapes, and, functions. The *resource* cache stores either seasonally available foodstuffs or staged raw materials destined for subsequent artifact manufacture. These two cache types differ in a number of important aspects.

A wide variety of food resources were cached during protohistoric times in the Great Basin: piñon nuts, roots, seeds, berries, cured meat, various insect larvae, dried rabbits and fish, processed seeds, salt, lizards, cut grain, acorns, plus an assortment of seasonally available leaves, roots, herbs, seeds, and berries used for medicinal purposes (Lowie, 1924, pp. 198, 202; Steward, 1933, p. 252; 1941, p. 281; Harris, 1940, p. 41; Train, Henrichs, and Archer, 1941; Shutler, 1956; DeQuille, 1963; Fowler and Fowler, 1971, p. 48).

Several archaeological food caches have been discovered in the Great Basin. Shutler (1956) reports on a historic period cache in Monitor Valley that contained eight bushels of piñon nuts. Pit 9 at Lovelock Cave was a frequently reused "pot-shaped" pit, containing 126 small dried fish "overlooked doubtless in the darkness of the cave by the last user of the pit" (Loud and Harrington, 1929, p. 11). Cache 6 at Humboldt Cave contained 100 pieces of dried fish, many of them practically whole (Heizer and Krieger, 1956, p. 93). Several dried chubs were wrapped in moss and grass before they were cached in Stick Cave (Orr, 1952, p. 12). A grasshopper cache was found in Crypt Cave (Orr, 1952, fig. 8).

The *food cache* is a concrete attempt to conquer temporal incongruity in a seasonally variable ecosystem (Binford, 1980, p. 12; Thomas, 1983a, p. 82). This strategy allows more equitable temporal phasing of key resources by storage of seasonally available comestibles—generally conducted as an episode of intensive harvesting or collecting, followed by a period of bulk storage, commonly in a dried or frozen state. Food caches usually contain only a single kind of seasonally available resource and are generally constructed near the locus of procurement.

Like the food cache, the *raw materials cache* often has a temporal component, since some resources for fabrication are available only seasonally: *Apocynum* for cordage is collected only in the early summer, when the stalks are new and covered with reddish brown outer fibers (Wheat, 1967, p. 55). Willow for various perishable constructions is collected only after the leaves drop in the fall, and before buds appear in the spring (Kelly, 1932, p. 120; Steward, 1933, p. 270; Wheat, 1967, p. 92).

Raw material caches can also overcome

spatial variability within a habitat. "Areas where the [*Apocynum*] plants grew tallest and developed the fewest branches were well known to the [Northern Paiute]" (Wheat, 1967, pp. 55–56). Prime willow stands were also known to all, and the disappearance of such stands posed major problems for historic period basket makers (see references in Thomas, 1983a, p. 68).

Stone suitable for flintknapping is usually restricted to a few key quarry localities. Except in years of extremely high snowfall, stone availability is usually constant throughout the year, but spatially quite variable. Caches of high quality lithics can reflect an attempt to amass a variety of raw materials in a single place. Pavesic (1966b), for instance, describes a lithic raw materials cache buried near Sterling, Idaho. In this case, nine projectile point blanks—made of a distinctive obsidian welded tuff—were buried about 30 km. from the quarry source. Several similar caches have been reported from western Nevada (Richard Hanes, personal commun.).

The Tool Cache

Binford (1979, p. 256) makes the useful distinction between *active* and *passive* artifacts. Gear is considered to be "active" when it is currently and regularly being utilized in the on-going, behavioral adaptive system; such gear is commonly discarded in or near the locus of habitation.

An artifact slips into "passive" status when it is temporally (and temporarily) "out of synch" with techno-environmental reality. A wide range of gear can potentially fall into this passive state: milling stones, rabbit nets, bird nets, deadfall parts, fishing equipment, digging sticks, snares, specialized traps, ritual items, trade items, cached salt, unworked obsidian, rabbit skin blankets, balls of tobacco, baskets, and buckskin (Steward, 1933, pp. 257–258; 1934). Some such gear is useful only seasonally, only in times of famine, only in a certain habitat, or under very special social conditions (such as times of maximum aggregation). Critical technological items commonly pass between active and passive status, depending on the conditions at hand.

The tool cache is thus a repository for passive artifacts, a place where curated items are kept until they are upgraded into more relevant, active status.

The Personal Gear Cache: Many caches contain critical items of survival gear that were either carried on logistic forays, or were strategically stored in such logistic zones in anticipation of future needs. Such personal gear caches are, in a real sense, the material, cultural expressions of concern. Binford's (1979, p. 262) Nunamiut informants described three such anticipatory sentiments: (1) what must I do on a given logistic trek; (2) how might I feel in terms of hunger and warmth; (3) what mishaps could befall me?

"Personal property" among the protohistoric Shoshonean-speakers was generally limited to clothing, ornaments, implements, weapons, and tools (Cappannari, 1960, p. 139). The "elemental principle of property" was simple: "Objects belonged to persons who expended work on them and used them . . . . Willow groves could be used by anyone, but baskets made of willows belonged to their makers" (Steward, 1938, p. 253).

Caches of personal tools contain heavily curated, gender-specific assemblages of "essential" tools that have temporarily fallen into a passive state: general utility and fabricating items; fire making equipment, weapons, spare parts (sinew, needles, extra patches). Because such survival items were manufactured, maintained, curated, and stored by an individual, the degree of functional redundancy is low. The typical cache of personal gear manifests an extremely high degree of diversity (that is, a relatively low ratio of artifacts to artifact types).

By its nature, personal gear is still serviceable and carefully maintained: "One *never* went into the field with personal gear that was not in good condition and relatively new; informants agreed that personal gear was inspected before going into the field so that worn items or items in need of repair were either repaired first or replaced before leaving for the field" (Binford, 1979, p. 263).

The archaeological record of the Great Basin contains a number of personal gear caches. One vivid example is *Cache 22* at Humboldt Cave (Heizer and Krieger, 1956, p. 98). This so-called "fisherman's cache" contained eight composite bone and wood fishhooks with attached lines, five containers (three intestine skin pouches, a swan or goose skin pouch,

and a hide envelopelike pouch), plus an assortment of general utility repair parts (a strip of bird skin, a strip of *Juncus* wrap, and a bundle of cane, some with heads still affixed).

The fishhooks are unusually large, averaging 93 mm. in length ($S = 36$ mm.; range: 77–175 mm.). Because these huge hooks could be used only to procure fish larger than about 50–75 cm. in length, they were almost certainly intended to catch Lahontan cutthroat trout, *Salmo clarki.* The Cache 22 fishhooks are similar in size and configuration to the lake trout hooks described by Willard Park and collected by Samuel Barrett (Fowler and Bath, 1981, pp. 183–184, fig. 10). Today, lake trout are restricted to Pyramid Lake and the Truckee River; *Salmo clarki* probably disappeared from the Carson and Humboldt sinks well before the utilization of either Humboldt or Lovelock Cave (see chap. 11, this volume).

The facts of fish biology betray the strategy behind Cache 22 at Humboldt Cave. Most importantly, these fishhooks would be totally ineffective for procuring the smaller, local fish species endemic to the Humboldt/Carson sinks during the Middle and Late Holocene—*Gila bicolor* (tui chub), *Catostomus tahoensis* (Tahoe sucker), and *Richardsonius egregius* (Lahontan redside). Because the fishhooks would only work on large lake species, the fishermen must have traveled at least 50 km. to the west, probably during a spawning run.

Humboldt Cave is situated on the extreme western reach of the Humboldt Range (Heizer and Krieger, 1956, map 1). As one travels west, Humboldt Cave is the westernmost cache cave in the Humboldt Sink; conversely, fishermen returning from one of the western spawning runs would pass directly by Humboldt Cave, a most convenient place to lighten one's load.

This cache contains an ecologically (and probably seasonally) specific toolkit, items of personal gear deliberately cached in anticipation of future fishing forays to the west, probably in spring or late winter. The implements existed in a "passive" state because they were useless in the immediate context of the Humboldt Sink.

A similar strategy is evident at Eastgate Cave, where Elsasser and Prince (1961, p. 142) recovered a bundle of 40 hinged-stick snares neatly stacked inside a pit 15 cm. in diameter. These uniformly sized snares were used to procure small rodents such as wood rats, ground squirrels, or chipmunks. These animals could be trapped only during the warmer months, since they are active (and hence available as prey) only from late winter (February) through fall (September or October [Hall, 1946; see also Grayson and Thomas, 1983]).

Eastgate Cave, roughly 40 km. east of the Carson Sink, is situated at the major pass through the Desatoya Range. In a real sense, this pass is a natural gateway separating the lacustrine biome of the Carson/Humboldt sinks from the pinõn-laden uplands of the central Great Basin.

The snare cache in Eastgate Cave was probably created by a logistic group leaving the piñon slopes on their way to the lacustral lowlands to the west. The snares are both seasonally and geographically specific pieces of personal gear—procurement items stored in "passive" state during the colder months of rodent inactivity.

A rather similar cache of seasonally specific snare parts—Promontory pegs tied in a neat grass bundle—was found in southwestern Idaho (Swanson, Powers, and Bryan, 1964, fig. 17a). Similar caches of seasonal gear are described by Schellbach (1927), Pavesic (1966a), Osborne and Riddell (1978), Janetski (1979), and Echlin, Wilke, and Dawson (1981).

Pit 12 at Lovelock Cave is another well-known cache of specialized personal gear. Cleverly secreted beneath a false bottom created by three large pieces of a twined "pack basket" was a bundle wrapped with rush matting. Inside was a spectacular cache of 11 duck decoys and two bundles of snares with attached trigger pins (Promontory pegs). The pit also contained an assortment of spare parts destined for decoy repair (or perhaps fabrication of new decoys): a rush bag filled with feathers, a bundle of feathers wrapped in a piece of matting, and a bunch of feathers bound with cordage.

Pit 12 at Lovelock Cave was probably an overwinter cache. Such snares and decoys would become "passive" sometime in the fall when rodents began winter hibernation and waterfowl migrated toward winter feeding

grounds far to the south. This procurement gear returned to "active duty" again in February or March, when relevant prey became locally plentiful once again.

All of these personal gear caches were created as a response to seasonal specificity; but tool kits can also be rendered "passive" by extreme *functional specificity.* Ambro (1970), found an example of this buried in the west alcove of Lovelock Cave. It is a prehistoric basket-maker's work kit consisting of an outer cover of Canada goose skin wrapped about a folded fox skin pouch and containing personal fabricating gear: a chert flake (general utility tool), two bone awls (fabricating items), one bone awl blank (probably acquired as an embedded strategy). The kit also contained a bundle of prepared willow splints (almost certainly collected between late fall and early spring). Note that this function-specific gear cache combines staged raw materials with the fabricators necessary for their conversion into finished artifacts.

Hester (1974) describes another functionally specific cache, a marmot (?) skin bag found at Wa-197, a deep shaft cave at the southern end of Winnemucca Lake.[1] *Pouch II* contained four general utility tools (one hafted and three unhafted bifaces), a large quantity of weapons (67 finished projectile points), an unusual decorated bone artifact (perhaps a sweat scraper), one fabricating tool (a flaking tool), and a quantity of non-local projectile point preforms. Once again, non-local staged raw materials were stored with the tools necessary to fabricate finished items.

Personal gear caches can likewise contain more generalized assemblages, placed in temporary storage to lighten the immediate load and to establish a material culture buffer against future needs. The other cache at Wa-197 (*Pouch I*) is a single generalized tool stash: a marmot (?) skin bag containing several general utility tools (six hafted bifaces, two unhafted bifaces, and two wooden knife handles that probably matched the two unhafted knives), and a composite cordage/quill artifact (perhaps an item of clothing [Hester, 1974]). The fawn's head pouch found at Cowboy Cave, Utah appears to be another generalized, load lightening accumulation of personal gear, consisting of fiber pads, hematite stones, a bone awl, a seed necklace, and a stone ball (Hull, 1980).

THE INSURANCE CACHE: It is also possible to create small stores of low-cost items that provide a rather informal hedge against unknown perils of an uncertain environment. Speaking specifically of the Nunamiut case, Binford (1979, p. 257) notes that

> Insurance gear is cached throughout the region, not in terms of specifically anticipated seasonal needs, but in terms of what might generally be needed at the location at some time in the future .... Insurance gear is generally distributed throughout the region: as site furniture at locations not in use . . . as discrete caches at stream crossings, in well-known caves and rock crevices, in caches adjacent to known archaeological sites, or in deliberately constructed rock cairn caching facilities .... [Insurance gear is] gathered, produced or "drafted into use" for purposes of carrying out a specific activity (Binford, 1979, pp. 257, 264).

Generally expedient in nature, insurance gear can be extracted from available raw materials, or scavenged as lost or discarded gear at abandoned sites. These *ad hoc* items may display little investment in tool production—they are basically hedges against unusual field circumstances, often in rarely visited areas.

Caches of insurance gear occur throughout the Great Basin, but they are rarely interpreted as such. Feature 2 at Eastgate Cave, for example, is a side opening twined bag containing a great diversity of general utility items: a complete bobcat kitten skin, an assortment of wing and tail feathers of red-tailed hawk, two lumps of pine pitch, three scraps of previously sewn hide, a scrap of beaver fur with hair still attached, a scrap of extremely tough and twisted rawhide, a grass bundle tied with sagebrush bark, a small bundle of human (?) hair tied with sagebrush bark, several pieces of soft hide tied together with *Apocynum* cordage (a moccasin toe?), a twisted piece of rawhide (probably an upper fragment of the same moccasin), and a fragment of

[1] Because human bones were scattered throughout the looted deposit of Wa-197, it is possible that the two skin pouches were burial-associated. It is, however, much more likely that the pouches were deliberate caches of personal fabrication gear.

worked greasewood stick, perhaps the distal end of a broken digging stick (Elsasser and Prince, 1961, pp. 141–142).

This cache was interpreted by the excavators "with considerable confidence" as a "shaman's bundle" or "medicine bag": "Surely most of the items contained in this bundle are bizarre in terms of the necessities of everyday living, and almost certainly represent the prized possessions of some special ceremonial practitioner within the aborginal band or group" (Elsasser and Prince, 1961, p. 142).

Although this may be true, it is more likely that this is an assortment of "spare parts," left as insurance gear. Feature 2 at Eastgate Cave seems to graphically reflect the third concern of Binford's Nunamiut informant: "what may happen to me in terms of mishaps."

Humboldt Cave contained dozens of similar caches, most of which were unopened prior to archaeological excavation (Heizer and Krieger, 1956, Appendix I; see also Ingbar, chap. 21, this volume). Although some pits (such as Cache 22 discussed above) contained seasonal and function-specific tool kits, many others held highly idiosyncratic assortments of insurance gear.

Cache 13 at Humboldt Cave was interpreted by the excavators as another "shaman's cache" (Heizer and Krieger, 1956, p. 11). A great diversity of seemingly anomalous items was found in this grass-lined pit: a fragmentary twined rush mat, a folded birdskin robe, several small bunches of duck feathers tied with *Juncus,* a fawnskin pouch (in which there were four spatulate bone objects, a smaller rabbitskin pouch [inside was some caked vegetal material, a mineral flake, and a fossilized mollusk shell], a scrotum pouch containing pitch, a soft skin pouch containing red ocher, a small skin bundle bound with cordage, two acorns, and a nondescript stone), a goose (?) skin pouch (containing a stuffed weasel [?] skin and four individual skin bundles wrapped with sinew or cordage, one piece of which had an attached bone fishhook), a bird bone tube, and a bundle of hawk feathers bound with a rush culm.

It is difficult for the twentieth-century mind to imagine all the uses to which such diverse items could be put. But the twenty-fourth-century mind will have equal difficulty deciphering the functions for items contained in the "ditty bags" of today's backpackers; quite likely, the most obscure items will be labeled ceremonial. I think it extremely likely that Cache 13 at Humboldt Cave was another spare parts cache: an assortment of curated raw materials, recycled scraps, and miscellaneous substances stashed as insurance gear in the remote cave at the extreme end of the Humboldt Range. The cached birdskin robe might suggest that these materials were stored as an overwinter cache.

Cache 1 at the same site contained a rather similar assemblage from the protohistoric period: several general utility items (a length of *Apocynum* cordage, a chert blade, and five strips of patching cloth), two weapons (a fish line with several bone hooks [suitable for local species], and a steel arrowpoint), clothing (two pairs of trousers), and four containers (three burlap sacks and one canvas ore sack). This feature also held a bundle of eagle feathers (perhaps ceremonial, but more likely raw materials to be fabricated into weapons or decoration).

Cache 1 reflects several strategic concerns. There is the load-lightening factor common to many tool caches; some items are too bulky to justify transport. And yet, this assortment was considered sufficiently important to warrant deliberate caching instead of discard. Such scuttling behavior implies a rather high degree of tethered mobility. Yet, had the residential base been nearby, low cost artifacts and artifact parts would have been discarded or stored there. Had people not intended to return to this area, there would have been no pretense at saving items for future retrieval.

Cache 2 at Humboldt Cave likewise reflects an insurance strategy, containing a wide variety of spare parts, several probably scavenged from domestic contexts elsewhere: an unidentified stone object, several *Apocynum* string fragments, six wicker basketry fragments, one coiled basket fragment, one willow wickerwork fragment, two tule mat fragments, a sandal fragment, and a bundle of bound feathers. One fabricating tool (a bone awl) and one piece of desiccated fish remains were also found in Cache 2.

Cache 10 at this site, seemingly another generalized cache of situational items, may

have been a potentially life-saving hedge in a rarely visited hinterland: three hafted stone knives, two hafted spear or knife blades, three chert arrowpoints, and one wooden bunt point. Repair items were left as well: a mass of pitch with tule strands, a buckskin wrapping (tied with string), and a length of *Apocynum* cordage.

A similar picture emerges from Pit 4 at Lovelock Cave (Loud and Harrington, 1929, p. 10), a repeatedly used pit or "cist," lined with worn-out rush matting and basket fragments. This cache contained a small breechcloth or apron made of shredded bark. Inside were the byproducts or spare parts for duck decoy manufacture: 198 bunches of small feathers, each bound together with cordage, some downy feathers, and a duck bill.

Numerous other examples could be cited, but in general, the situational cache can be expected to contain an assemblage characterized by general utility, high diversity, and low cost; many individual items will be broken or fragmentary artifacts ("spare parts"), probably scavenged from residential contexts.

The Communal Cache

So far, we have only considered storage strategies appropriate to personal property, "gear." Conserving corporate property involves somewhat different considerations. So-called *site furniture* consists of relatively bulky, site-specific items that were left on-site—these artifacts simply "went with the place" (Binford, 1978b, p. 339): domestic equipment (processing and cooking items), specialized harvesting equipment (such as piñon hooks and milling items), bulky general utility tools (hammerstones, massive scrapers), tent weights, various containers. Such items were commonly old, worn-out implements—often old items "recycled out" from a residence. Wheat (1967, p. 36) notes, for instance, that manos and metates were not transported between base camp and areas of piñon procurement; rather, such processing implements "were placed in the crotches of juniper trees or were neatly stacked and left in camp to be used the following year."

Steward (1938, pp. 253–254) terms such items "general equipment": "All this conforms to the work-use-ownership principle . . . often many families cooperated in the construction of a deer or antelope corral . . . jointly prepared and used dance grounds and fish weirs. But once abandoned, anyone was at liberty to use these things in the future." Because site-specific, corporate artifacts were so considered, there was little need to conceal items of site furniture; only after Euro-American contact did these people feel compelled to hide prized communal property (Wheat, 1967, p. 36).

The Afterlife Cache

Grave goods pose a special problem for defining the nature and visibility of deliberately discarded artifacts in archaeological assemblages. To illustrate the difficulty, consider the grave furniture associated with the Ross infant burial, found not far from Hidden Cave (see Appendix C, this volume): one general utility tool (a chert flake), weapons (five projectile points), abundant domestic equipment (nearly 800 ornaments and three spatulate bone objects of unknown function), and one fabricating tool (an artiodactyl splinter bone awl). The Ross burial grave goods provide an exceptionally clear-cut, behaviorally associated assemblage of known function—these items were destined to accompany a recently deceased young person into the afterlife.

Rather similar artifact diversity is evident in the other known grave assemblages from the Hidden Cave/Grimes Point area. During the 1940 field season at Hidden Cave, the Wheelers also excavated a number of burials in the Eetza Mountain area (Wheeler and Wheeler, 1969; see also chap. 4 and Appendix B, this volume). At Spirit Cave, one cremation was buried inside a closely twined outer bag and an open twined inner bag; a small, unshaped metate covered the grave pit. Cremation 2 was likewise encased within an open twined bag. The "lower burial" at Spirit Cave was found in a sagebrush lined pit, also containing several domestic items: a large, finely twined mat, a fur blanket, a pair of leather moccasins, and a fiber loin cloth. The "intrusive burial" at this site was also found with a large, twined mat.

At nearby Fish Cave, the Wheelers exca-

vated remains of an elderly female buried with the following artifacts: a few general utility or repair items (a small basketry fragment, fur strings, and a leather patch), several domestic artifacts (a fur blanket, a shallow coiled basket, an apron of leather strips, and a shell disc bead) plus a piece of harvesting equipment (a digging stick).

Most grave goods consist, of course, of complete, functional, utilitarian artifacts. The burials at Lovelock Cave, for instance, were accompanied by a fantastic array of clothing and procurement artifacts: strings of *Olivella* shell beads, a number of coiled baskets, woven bags, bird and rabbit skin blankets, buckskin clothing, a headband, prayer plumes, harvesting sickles, moccasins, bighorn sheep pendants, and an atlatl foreshaft with hafted stone point (Loud and Harrington, 1929, pp. 14–18). Several individuals were wrapped in fine fishing nets.

But one should not get the impression that grave goods are exclusively intact, serviceable artifacts. Three of the five projectile points in the Ross burial assemblage, for instance, were so badly fractured that they were disfunctional. The so-called shaman burial at Pyramid Lake likewise had an extremely large amount of broken artifacts included as deliberate grave goods: (a badly fractured Elko Eared projectile point, a broken slate pendant, three bone pendants, three broken bone awls, and several shell bead and ornament fragments. The excavators had carefully examined these artifacts, concluding in nearly all cases that the fractures occurred prior to interment (Tuohy and Stein, 1969). Similarly, Pit 29 at Lovelock Cave contained a burnt adult skeleton in flexed position: "at the right side of the head was a knife blade of flinty stone, and on the left side a large knife blade of obsidian, minus the point" (Loud and Harrington, 1929, p. 15). Broken artifacts also accompanied the burials at Rose Spring (Lanning, 1963, p. 263).

Note the frequency with which broken artifacts were included as deliberate grave goods. These items were all apparently broken as part of their conventional use-lives; none were "killed" as part of the funerary ritual.

We know, beyond doubt, that the above assemblages are "burial furniture." This certainty derives from firm contextual evidence—the artifacts were found in primary association with human remains inside deliberate grave pits.

Unfortunately, prehistoric burial sites in the Great Basin are rarely found under such ideal conditions. Grave pits are commonly disturbed by erosion, subsequent excavations, or scavenging carnivores. The human bones in Lovelock Cave, for instance, were scattered haphazardly throughout the deposits, and strings of shell beads were found contained within coyote scats, almost certainly swallowed while feeding on a recently interred human corpse (Loud and Harrington, 1929, pp. 6, 17; see also Ingbar, chap. 21, this volume).

Such disturbances destroy the mortuary *contexts,* leaving one with only grave pit *contents.* And unfortunately, given the nature of the assemblages discussed above, it becomes a difficult matter to separate grave goods from tool caches of anticipatory personal gear.

Some burial caches are deliberately intended to assist the deceased in the afterlife (Lowie, 1924, pp. 279–282; Fowler and Fowler, 1971, pp. 215, 248). In other cases, items were buried because, as one Western Shoshone informant put it "to leave them around would cause unhappiness to his relatives" (Steward, 1941, p. 257; see also Kelly, 1964, p. 102). Regardless, burial caches reflect the deliberate placement of key items into "storage," for subsequent use by somebody.

In other words, the reality of disturbance factors in the archaeological record requires that grave furniture be viewed as a specialized kind of anticipatory cache—an afterlife cache, if you will.

The Implications of Storage Behavior on the Archaeological Visibility of Caches

Several general points emerge regarding the archaeological visibility of storage strategies. It is important to keep these considerations in mind as we encounter the empirical archaeological record at Hidden Cave.

All caches place passive items into deep storage, anticipating activation at some fu-

ture time. But specific caches can reflect radically variant storage strategies that are differentially manifest in the archaeological record.

Resource caches contain either seasonally available foodstuffs or raw materials destined for subsequent artifact manufacture. Food caches buffer the effects of temporal incongruity in a seasonally variable ecosystem by creating a more equitable temporal phasing of key comestibles. Food stores are constructed after an episode of intensive harvesting or collecting, and such caches typically contain only one kind of food item. To minimize transport costs, such features are generally located near the locus of procurement (particularly in the case of high bulk foodstuffs).

But the act of storage can create difficulties of spatial incongruity. In a logistic system, relatively small numbers of people can procure resources for a relatively large number of consumers, requiring a high bulk storehouse. Caches provide the means for storing bulk, but in turn create a transportation problem (since bulky resources must still be made available to the rest of the consumers). At times, the bulk of a cached resource may be sufficient to warrant repositioning of the residential base. In other cases, storage facilities are created as temporary holding areas, anticipating future transport of that resource to the residential base.

The raw material cache commonly manifests a temporal concern as well, "laying down" seasonally available resources for subsequent fabrication. But more commonly, the raw material cache brings spatially variable, transportable resources into more readily accessible storage areas. Non-food resources are commonly collected in very specific habitat types, then cached elsewhere for later use. Raw material caches—especially those of low bulk resources—are usually constructed a great distance from the zone of procurement. Such low bulk items are also commonly processed in preliminary fashion ("staged") prior to storage, and such caches very often contain appropriate fabricating tools as well.

The tool cache *per se* is a repository where passive items are curated until they are upgraded into more relevant, active status. Such gear caches exist along a sliding scale of strategic decision-making, a continuum of *anticipatory-situational concerns* (after Binford, 1979, p. 261).

At one extreme is the seasonally and/or functionally specific cache of personal gear, temporally put away in anticipation of known, specific needs. Personal tool caches contain characteristic assemblages of passive tools that are usually high cost, heavily curated, well-maintained, ready to use, and gender-specific. Because this gear usually belongs to a single individual, the ratio of types to individual artifacts is relatively high. Personal gear caches are often created as a response to seasonal specificity; but tool kits can also be rendered passive by extreme *functional specificity*. Anticipatory caches contain more generalized assemblages, placed into temporary storage to lighten the immediate load and to establish a material culture buffer against future needs.

More situational concerns are reflected in *insurance gear caches,* commonly placed in strategic localities throughout the extended range. One takes out material culture insurance not so much to anticipate specific seasonal needs, but rather to protect against the more general hazards of the unknowable future. Insurance gear usually consists of generalized, often broken, low cost, *ad hoc* artifacts and resources. The relative diversity (artifacts per artifact type) can be quite high, particularly in the case of seasonally available "spare parts."

A situational strategy is also reflected in the distribution of communally owned items, particularly relatively bulky, site-specific corporate property. Such items are not so much "cached" as they are simply left behind in residential or logistic contexts, available on-site to all who would subsequently exploit the area.

Grave goods can be viewed as a specialized kind of anticipatory cache of personal gear; in this case, one is anticipating the hazards of the afterlife. Most grave goods are intact, serviceable items of daily life. But a survey of controlled mortuary contexts shows that broken, highly curated artifacts are also commonly included as deliberate grave goods. So long as the grave contexts remain intact, one

can easily define the mortuary assemblages. But when post-depositional factors destroy the mortuary *contexts,* leaving one with only grave pit *contents,* it becomes a difficult matter indeed to separate grave goods from tool caches of anticipatory personal gear. Unless grave goods are found in direct association with human bones, we lack a clear-cut signature to allow separation of grave goods from caches of anticipatory personal gear.

This, in fact, is the most important point that emerges from a consideration of archaeological visibility in storage strategies. Cache assemblages contain a subset of the artifacts, ecofacts, and unmodified resources that cycle through the behavioral system. So long as caches remain intact, one can employ the concrete criteria of diversity, condition, and functional specificity to readily distinguish the strategies behind their construction.

But there are no characteristic, individual, artifact-level signatures to distinguish the contents of a cache from the rest of the behavioral assemblage. This is because the passive status that defines potentially storable items in the first place is transitory. Today's passive artifacts are tomorrow's active tool kit. This situational pose depends on external systemic factors of cultural geography and ecology—not on observable characteristics of artifact morphology.

Cache contents can range from the exquisitely fashioned implement of technological virtuosity to a ragtag collection of apparent junk, from a homogeneous assemblage of seasonally specific anticipatory gear to a generalized tool kit of seemingly unrelated artifacts. In other words, it is context rather than content that charges a given subset of material culture with meaning for storage strategies. This critical mid-range theoretical constraint heavily conditions the framework in which we approach the apparently cache-oriented archaeological record of Hidden Cave.

CHAPTER 3. PRESENT ENVIRONMENT AND HISTORY

ROBERT L. KELLY[1] AND EUGENE HATTORI[2]

Before considering the archaeology of Hidden Cave, it is necessary to examine the modern setting of the cave. The Carson Desert has undergone significant historic changes affecting water supply to the Lahontan Basin and associated vegetation. In the following sections, we discuss the modern environment and examine relevant historical literature to determine how this setting has changed over the last 150 years.

TOPOGRAPHY

Hidden Cave overlooks the Carson Desert, a large intermontane basin containing the Carson Sink and the South Carson Lake (fig. 2).

This lowland basin is bounded to the north by the West Humboldt Range which separates the Carson and Humboldt sinks. The eastern margin is formed by the Stillwater Range; and the western margin consists of the Hot Springs Mountains, Trinity Range, and Dead Camel Mountains. The Desert Mountains, White Throne Mountains, and Cocoon Mountains create the southern margin of the Carson Sink (McLane, 1978). The regional geology has been discussed by Russell (1885), Morrison (1964), Bonham (1965), Willden and Speed (1974), and Johnson (1977); see also Davis (this volume).

The Carson Desert consists of extensive dune fields, alkali flats, and slightly alkaline marshes in the west central part of Nevada, about 100 km. east of Reno. It is over 112 km. along its north-south axis and between 25 and 60 km. from east to west and encompasses nearly 2800 sq. km. The elevation, 1180 m. (3871 ft.), marks one of the lower points in the west central Great Basin. It contains the drainage basin or sink of the Carson River and, in the past, occasionally received Humboldt River water as well. The Humboldt Sink lies north of the West Humboldt Range and is separated from the Carson Sink by a narrow gravel embankment, the Humboldt Bar, which has a sill elevation of about 1201 m. (3940 ft.). A cleft in the embankment, however, allowed passage of water through the Lower Humboldt Slough to the Carson Sink when Humboldt Lake exceeded a surface elevation of 1189 m. (3900 ft.) (Russell, 1885). This channel, now called the Lower Humboldt Drain, has been dredged in historic times to prevent submergence of the Southern Pacific Railroad tracks at 1195 m. (3920 ft.).

The northern half of the Carson Sink is dominated by an extensive alkali flat with little more than 1 or 2 m. topographic variation over its entire extent. Providing the only topographic relief to this monotonous scene is Lone Rock, a small volcanic cone located in the northeast corner of the sink. Large north-northeast to south-southwest trending longitudinal dunes rim the eastern edge of the alkali flat at the base of the Stillwater Range bajada. These dunes are built by intensive sand storms that occur almost daily on the alkali flat during the summer. A large shallow body of water over 30 km. in diameter, the "North Carson Lake" or "Lower Carson Lake," frequently occupied the western half of the alkali flat.

The alkali flat is separated from the southern half of the sink by a thin band of unstabilized sand dunes which form an east-west line across the middle of the sink. These dunes are, for the most part, unvegetated; most are transverse dunes interspersed with a few small barchan dunes. The southern half of the sink is covered by east-west trending psammogenic dunes, some of which are more than 10 m. high.

HYDROLOGY

The Carson Desert presently receives most of its water from the Carson and Truckee river drainages. This situation, however, is a relatively recent event dating from the 1905

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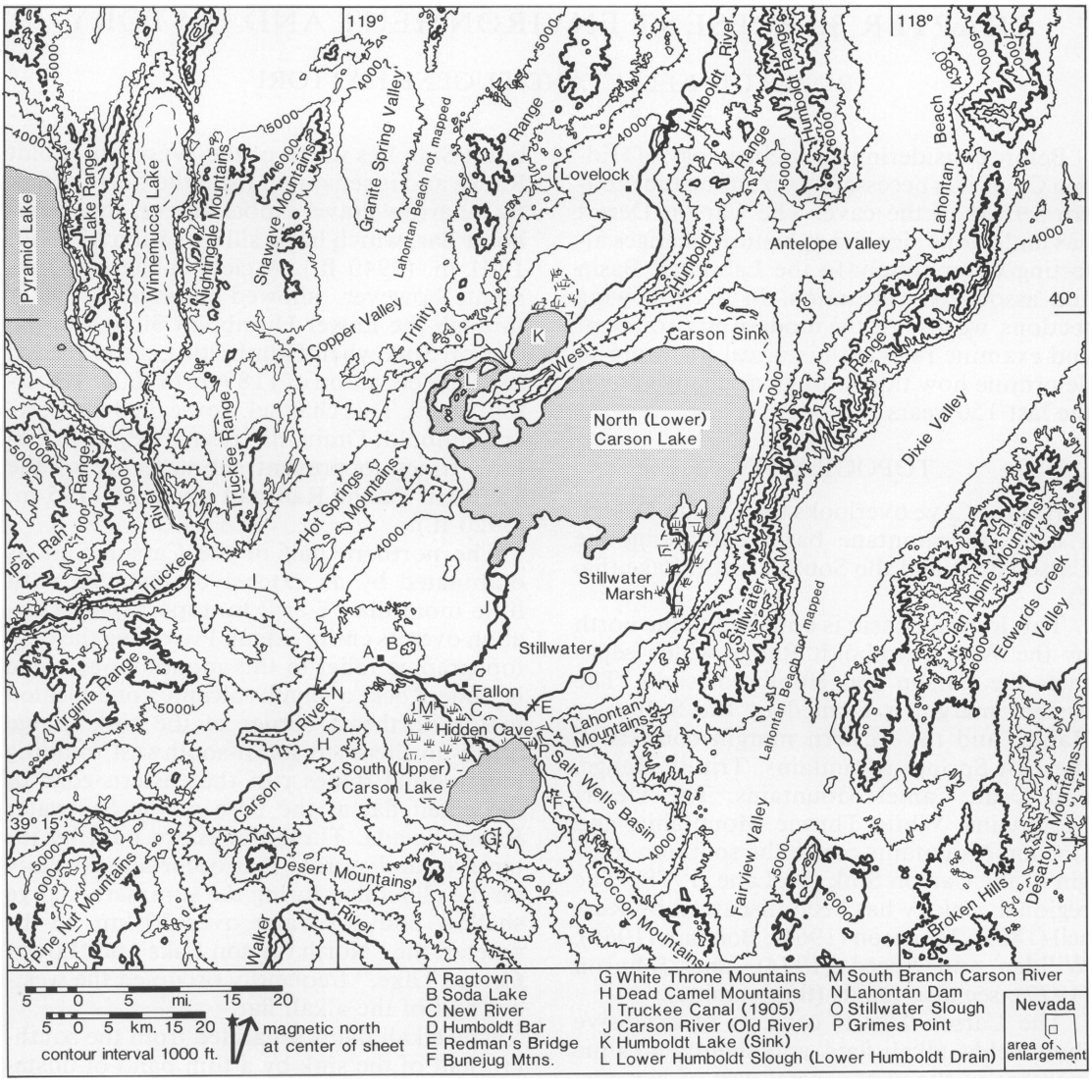

FIG. 2. Map of Carson Desert and surrounding area. Waterways and lake levels are based on 1881–1883 observations by I. C. Russell (modified from Russell, 1885, plate VII).

completion of the Truckee Canal and the diversion of approximately 180,000 acre-feet of the Truckee's flow annually (Glancy and Katzer, 1975). The massive engineering feat responsible for this (The Newlands Reclamation Project) increased the total inflow into the Lahontan Valley by approximately 40 percent while also causing the desiccation of Winnemucca Lake and a massive drop in the elevation of Pyramid Lake. Any attempt to compare modern environmental conditions with prehistoric environments must consider the increased available water, elevation of the water table, and other modifications to the drainages and flow regimes.

The Carson River derives most of its water from the melting of the Sierra Nevada snowpack between March and July (Glancy and Katzer, 1975). The principal hydrological source areas are located in Nevada and Cal-

ifornia, to the east and south of Lake Tahoe and the Truckee River drainage system. The precipitation falls primarily in the Sierra as a result of a rainshadow effect, with the Carson Desert receiving only about 12.6 cm. annual precipitation; evaporation there is estimated at 188.0 cm. per year (Houghton, 1969; Morrison, 1964).

The Carson River empties into the relatively flat, sediment filled basin of the Carson Desert immediately north of the Dead Camel Mountains. Historically, prior to 1862, the river flowed to the east until it reached a point near the modern town of Fallon (fig. 2). From there it flowed in a southeasterly direction emptying into the large deltaic marsh of Carson Lake (South or Upper Carson Lake; see Russell, 1885). About 6.4 km. west of present-day Fallon, an abandoned, former river channel ran northward into the Carson Sink (North or Lower Carson Lake). Water also reached North Carson Lake via the Stillwater Slough running north from the South Carson Lake and from there through a deltaic marsh near the settlement of Stillwater.

In January 1862, the Carson River overflowed its banks causing significant damage to the upstream settlements of Empire and Dayton (Glancy and Katzer, 1975). Downstream, in the Carson Desert, the flood waters resulted in the reopening of the north running channel, named Old River, into North Carson Lake. Then in the spring of 1867 another flood opened an easterly running river channel (New River or New Slough) which flowed into the Stillwater Slough (Russell, 1885; Glancy and Katzer, 1975). The various natural waterways have since been greatly modified and diverted but still exist as the Carson River, emptying into the Carson Sink, the South Branch of the Carson River, emptying into Carson Lake (South Carson Lake), and the New River Extension Drain, emptying into New (Stillwater) Slough and Winsett Drain about 4.5 km. northwest of the Lahontan Mountains.

Shifting drainage patterns, however, were probably the rule in the past and the traces of numerous abandoned river channels meander through the pastures and fields surrounding Fallon. Furthermore, shells of freshwater mussels and snails—organisms which today live only along canals and other watercourses—are found everywhere on the valley floor indicating that at one time or another all parts of the valley floor held water for some length of time (though not necessarily simultaneously).

The multiple waterways flowing into the various drainage basins provided differing amounts of water to the North and South Carson lakes. This was reflected historically in the direction of water flow through the Stillwater Slough joining these two water bodies. The usual flow direction of the Stillwater Slough is north from South (Upper) Carson Lake to North (Lower) Carson Lake, but a southerly flow is also reported (Russell, 1885; Wheeler, 1877). The reversal of the Stillwater Slough flow may have contributed to the notion that the mythical Buenaventura River, the river thought to connect the Great Basin with the Pacific Ocean, flowed south part of the year and north the rest of the time.

The Carson Sink has usually been without a lake in recent years. The waters from the Carson and Humboldt rivers which formerly fed it are now extensively used for irrigating agricultural lands in the Carson Valley, Dayton Valley, Churchill Valley, Lahontan Valley, Upper and Lower Humboldt River valleys, as well as for municipal purposes for the various urban centers along the drainages. Because of exceptionally high precipitation and runoff in the Carson, Truckee, and Humboldt drainages in the winter of 1982–1983, however, the Carson Sink (North Carson Lake) held water through the summer of 1983. Many of the former waterways mentioned in this chapter were rejuvenated during this wet interval.

Average annual temperature at Fallon is about 11°C., with monthly ranges of −1°C. for January to 22°C. for July. During the summer, temperatures can often hover at 37°C. in the daytime, with ground temperatures in excess of 55°C. not uncommon. As in most deserts, there are extremely large differences between diurnal maximum and nocturnal minimum temperatures. Frosts occur from early fall through late spring. The Stillwater Range has been known to be covered with snow into the month of June, and although snow often reaches the valley floor, it never

remains for very long. Bracketed by the first and last frosts, the growing season lasts about 125 days.

VEGETATION

The vegetation presently surrounding much of the Carson Desert, including the Hidden Cave area, is encompassed within the Little Greasewood-Shadscale Association (Billings, 1945, Appendix 3-1). The dominant species in the area are little greasewood (*Sarcobatus baileyi*), four-winged saltbrush (*Atriplex canescens*), and budsage (*Artemisia spinescens*). Little greasewood is by far the most frequent native species, comprising over 50 percent of the vegetation. Shadscale comprises about 30 percent, with lesser amounts of budsage, winterfat (*Ceratoides lanata*), wolfberry (*Lycium cooperi*), and several herbs such as Indian ricegrass (*Oryzopsis hymenoides*). Farther south, near Carson Lake and the Salt Wells Basin east of Carson Lake, the more stabilized dunes and slightly less alkaline soils have allowed the formation of the Dalea Association (Billings, 1945). In this region, the vegetation is comprised of dalea (*Dalea polydenia*), shadscale (*Atriplex confertifolia*), horsebrush (*Tetradymia glabrata* and *T. spinosa*), rabbitbrush (*Chrysothamnus nauseosus*), and several perennials such as Indian ricegrass, annuals such as Russian thistle (*Salsola kali*) and cheat grass (*Bromus tectorum*), the last two are historic exotics. Other dominant exotics found in the valley include tamarisk and Russian olive.

Throughout the southern sink, small alkali encrusted playas support lesser amounts of greasewood and greater percentages of pickleweed (*Allenrolfea occidentalis*) and tamarisk. More stabilized sand dunes near the Carson River support a Dalea Association. Cottonwoods (*Populus fremontii*) border the various active water channels in the valley.

A common complaint of a number of the explorers and emigrants passing through the southern Carson Sink was the lack of firewood. While encamped at the outlet of South Carson Lake in 1859, Simpson (1876, p. 85) wrote that "our only fuel is dry rush." Two years after Simpson's visit to the Carson Sink, Dan DeQuille (a.k.a. William Wright) also complained that there was no wood to burn—only grass (DeQuille, 1963, p. 33; see also Burton, 1963). The area north of South Carson Lake—at least up to Redman's Bridge (3.8 km. northwest of Hidden Cave)—apparently was an extensive wet meadowland: "We were now traveling across a level piece of meadow land covered with excellent grass, and passed another small [Paiute] village lying to our right, on the margin of the meadow .... We started up several large flocks of snipe and curlew near some ponds in the meadows . . ." (DeQuille, 1963, p. 32). Farther north, however, the slough was probably more deeply entrenched and the vegetation was similar to that found in the area today: "There is no grass along this stream [the Stillwater Slough]. The barren, sandy plain comes quite down to the abrupt banks, and the only vegetable-life visible is in the scattering clumps of sage-brush and greasewood" (DeQuille, 1963, pp. 36–37).

The Big Greasewood Association occurs along the edge of the Carson Sink between the sagebrush dominated alluvial fans bordering the Stillwater and Hot Springs ranges, and dune fields in the Carson Desert (Billings, 1945). Here the soil is composed of sand, a saline clay, or loam, and retains more moisture closer to the surface than the soil of the alluvial fans. Stretches of the Big Greasewood Association are limited to a few species, and its regional distribution is sparse. Big greasewood (*Sarcobatus vermiculatus*) dominates the association with lesser amounts of shadscale and saltgrass (*Distichlis stricta*).

A comparison of the modern vegetation and the descriptions provided by contemporary narratives and maps of the Carson Desert indicate that substantial environmental change has occurred because of Euro-American occupation of the sink. First, there was a marked decrease in the amount of meadowlands immediately north of the South Carson Lake and an increase in the arboreal vegetation on the valley floor. Another change, closely related to the first, was a decrease in the extent of wetland habitats due to the combined effects of an increased use of the incoming water supply for irrigation and the concentration of that water into more permanent channels and reservoirs. The details of these changes are more fully discussed in the following section.

The Stillwater Mountains support piñon-juniper woodlands with denser stands in the northern half of the range. This is, in part, due to the higher elevation and rainfall for the northern end of the range. Still, because the range is so narrow, there are no watersheds sufficiently large to support year-round streams.

HISTORIC SETTLEMENT AND CHANGE

Early Euro-American occupation of the Desert began in 1854 at Ragtown (located several miles west of Fallon) where emigrants found relief after crossing the Forty Mile Desert between the Humboldt Sink and the Carson River (Remy, 1861; Angel, 1881). The principal emigrant trail running through the area, the Carson River Route (Mormon Trail), ran along the western border of the sink, so there are few references to eastern and southern borders of the Carson Desert. While hundreds of emigrants passed over this trail—including some of the West's most notable characters such as Samuel Clemens and Horace Greeley (1964)—few commented on the desert except to bemoan the agony of pushing wagons through the waterless dune field of the sink.

The area surrounding Carson Lake was not extensively settled until after 1859, when Captain James H. Simpson (1876) established a wagon route between Salt Lake City and Carson City which crossed through the central portion of the Carson Sink. In 1862, Elam Redman was authorized to build a toll bridge across the Stillwater Slough, north of Carson Lake (about 2.5 km. northwest of Grimes Point; and in the same year the town of Stillwater was first settled by J. C. Scott 17 km. northeast of Redman's Bridge (Angel, 1881; DeBraga, 1964). During the 1860s, several ranchers founded the settlement of St. Clair on the south branch of the Carson River. The town of Fallon was not established until after the turn of the century and initiation of the Newlands Reclamation Project.

The initial settlers in the region were ranchers and farmers who supplied vegetables and beef to the Comstock mining towns. They set about reclaiming the valley floor by draining marshes, damming the river flow, and irrigating the drier areas. Thus, these first occupants of the valley immediately altered the local environment. For example, the Nevada Territorial Legislature passed an act in December 1862 authorizing J. Jacobson, J. Bowan, and associates to "improve" the Carson River from Dayton to the Humboldt Slough by, "cutting canals, etc., and rendering such route practicable for rafts and vessels" (Angel, 1881, p. 361). In 1866 a diversion gate was constructed at the trifurcation of the Carson River near present-day Fallon to channel the majority of the flow to the South Branch (Townley, 1977).

Upstream uses of the water and the watershed influenced the quantity and quality of the Carson River water: chemical wastes and tailings (solid waste) from the Carson River mills processing Comstock Lode ores; increased runoff, upstream flooding, and siltation from the logging operations in the Sierra; and diversion of upstream water for agricultural and urban use (Russell, 1885; Wheeler, 1877).

While DeQuille (1963) noted the presence of small, scattered clumps of willow along the Stillwater Slough in 1861, substantial tree growth was probably found only along the more permanent channel of the Carson River west of present-day Fallon (Simpson, 1876; Kern, 1876). With the inception of irrigation on the valley floor and the maintenance of more permanent watercourses, trees quickly took hold, so that by 1903 there was a fairly dense stand of trees on the eastern side of the desert around the town of Stillwater. Today many species of trees are present on the valley floor, but cottonwood and willow are still among the dominant species.

The present water situation on the valley floor is quite different from that of the recent past. The Carson River is dammed by the Lahontan Dam and Reservoir, and also receives runoff from the Truckee River via the Truckee Canal system (Townley, 1977). Since the dam's completion in 1914 almost all the water entering the valley has been controlled and channeled. Nearly 316,000 acre-feet of it is allocated for irrigation, and the remaining 90,000 acre-feet are reserved for the Stillwater Marsh and the Stillwater Wildlife Management Area (Houghton, 1976). Of course, since most of this water is used for irrigation,

it does not form the extensive marshes and lakes it once did. In some areas, however, the extra water has raised the water table. For example, the once extensive soda works of the 1870s–1880s at Soda Lakes (Ragtown Ponds) are now submerged (Russell, 1885).

A large number of interdunal marshes and sloughs, rich in marsh plants and water birds, are also supported by the increased groundwater elevation and above ground flow occurring throughout the desert. Though their water supply is increased because of the Newlands Reclamation Project, such rich microenvironments may have also formed prehistorically during intervals of increased effective moisture. The shallow interdunal basins between Hidden Cave and the Stillwater Slough may have been an ideal site for localized marshes during times of increased water flow or overflow of the slough or South Carson Lake. Occupation of the Grimes Point area may have occurred during these minor episodes of increased moisture as well as the reformation of expansive "Fallon Age" lakes.

The region's vegetation also underwent change since 1861, most significantly the loss of bunch grass from the bajadas and grass from valley bottoms (Monroe, 1868; Simpson, 1876; Kern, 1876; DeQuille, 1963). The factors for this loss may have been cultural—the introduction of cattle—or they may have been climatic. In either case desert shrubs are now the dominant species along the bajadas with *Bromus,* a historic introduction, the dominant grass. In other instances grasslands expanded at the expense of desert shrubs. For example, in 1874 the Stillwater Marsh occupied much of the same area as it does today (Monroe, 1874). At that time, "grass and grease brush" formed a narrow band along its shore. By 1882, however, the marsh had decreased in area exposing "bottom land with rich luxuriant grass" (Conkling and Stewart, 1882). The grasslands bordering the "grease brush" shrublands, however, made only minor gains into that vegetation type.

The vegetation surrounding the borders of the shallow-water bodies was apparently sensitive to minor lake level fluctuations which may have affected the availability of economically important marsh plants and water birds. Because of the gradual shoreline gradient of the playas and lakes in the Carson Desert, even slight depressions or increases in the water level would be reflected by relatively large horizontal displacements of the shore line.

In 1841, the year the Bidwell-Bartleson party passed through the area, there was apparently such heavy runoff in the Humboldt River that the Stillwater Slough ran out of, rather than into, the North Carson Lake:

> Crossed mary's River [the Humboldt River] where it led from the swamp into a lake beyond; our pilot led us south on the trail of Capt. B. Crossed a plain which is covered with water the greater part of the year [the alkali flat]—then came into sand hills, among which traveling was very laborious. Saw to the W. of us a lake, presenting a sheet of water 20 or 30 miles in extent. Encamped by another swamp, in which the water was nauseous. Distance 28 miles . . . . Crossed Mary's River [the Stillwater Slough]—it was here running E. leading *from the lake* which we saw to the W. of us yesterday, into the swamp [the Stillwater Marsh] by which we staid [*sic*] last night (Bidwell, 1964, p. 32 [emphasis added]).

Edward Kern's (1876) account of South Carson Lake in late November of 1845 provides us with the earliest detailed account of lakeside biology: "For 30 or 40 yards about its [Carson Lake] edge in width is a thick growth of bulrushes. It is a very pretty sheet of water; various kinds of fowl in abundance . . . . About midway on the western side a stream enters it. Slightly timbered; probably cottonwood" (Kern, 1876, p. 479).

In June of 1859, Simpson (1876) described the flora, fauna, and Northern Paiutes associated with South Carson Lake:

> The alluvial bottom about Carson Lake is quite extensive and rich, as the luxuriant growth of rushes shows . . . . Curlew, pelican, and ducks, and other aquatic birds frequent the locality, and the lake is filled with fish. A number of Piutes, some two dozen, live near our camp, and I notice they have piles of fish lying about drying, principally chubs and mullet. They catch them with a seine . . . . The decoy-ducks they use on the lake to attract the live ducks are perfect in form and fabric . . . (Simpson, 1876, p. 85).
>
> . . . the water of Carson Lake beautifully blue; lake margined with rushes; the shores are covered with muscle-shells; pelicans and other

aquatic fowl a characteristic (Simpson, 1876, p. 86).

On his return trip from Genoa in late June, 1859, Simpson (1876, pp. 104–105) encamped for two days along the southern and eastern shores of South Carson Lake because of the "fine grass and rushes" available.

The severity of the winter of 1859–1860 is well documented in the annals of the "Rush to Washoe" and it may be reflected in Sir Richard Burton's description of South Carson Lake in mid-October of 1860, a month usually marked by depressed water levels: "[Carson Lake is] a shallow sheet of water which, in the cloudy sky and mitigated glare of the sun, looked pale and muddy. Apparently it was divided by a long narrow ruddy line, like ochre-coloured sand; a near approach showed that water on the right was separated from a Saleratus bed on the left by a thick belt of Tule rush" (Burton, 1963, p. 550).

Early in the summer of 1861, Dan DeQuille noted increased water levels, possibly seasonal, in his description of South Carson Lake's (Ee-waah Dee-Neek') vegetation: "The water on the margin is free from grass and of a reddish hue, most diagreeably suggestive of alkali; but at the distance of a few rods from shore it is more clear and pure, nourishing a most affluent growth of tule which forms a belt of near a half-a-mile in width from the shore" (DeQuille, 1963, p. 30). Farther north, along the eastern shore of the lake below Redman's Bridge on the Stillwater Slough, DeQuille noted: "We were now traveling across a level piece of meadow land covered with excellent grass, and passed another small village (Northern Paiute) lying to our right, on the margin of the meadow . . . . We started up several large flocks of snipe and curlew near some ponds in the meadows . . ." (DeQuille, 1963, p. 32).

The drainage shifts after the 1862 flood, mentioned earlier, combined with a general decrease in outflow due to upstream use for domestic consumption and agriculture caused a reduction in the size of the South Carson Lake and, consequent decrease in the marsh vegetation and the water bird and fish populations (Townley, 1977). While subsequent floods and renewed channel cutting might have rejuvenated the lake, increased irrigation and a major drought after 1870 resulted in the Carson River's ending among the dry dune fields.

Detailed, nineteenth-century descriptions of the Carson Sink are rare because it was some distance from the main emigrant roads and trails. DeQuille (1963, p. 37) provided one of the few descriptions of the "Lower Sink" Dee-Neek (the Lower Carson Lake). From this, it is evident that the Carson Sink, dominated by alkaline waters and lacking wood and grass, was an obstacle to travel (DeQuille, 1963, pp. 139–140). We get a glimpse of the northern end of the sink and its collection of rushes in DeQuille's writing of his search for a favorite young Paiute child: "She was perhaps, out wading along the margin of the Lake, amongst the bulrushes, gathering *taewoep,* or hunting for duck's eggs. I saw several black heads . . . bobbing like buoys above the *dark field of rushes* . . . . They gather the large stalks of these rushes and peeling off the rind, chew the succulent pith. We often met them in the trails with handfuls of this plant . . ." (DeQuille, 1963, p. 141 [emphasis added]). Today, this area of the sink rarely holds water and is usually a barren alkali flat, the only vegetation in the area growing along the Humboldt Slough itself.

Finally, toward the end of the nineteenth and the beginning of the twentieth centuries, the local newspapers of Churchill County lamented the lack of water in both the Humboldt and Carson sinks. On March 31, 1888, the editors of the *Churchill News* noted that the Humboldt Slough was completely dry and the Humboldt Lake and Carson Sink nearly so. On March 26, 1904, the *Churchill Standard* reported that although the Indian reservation (located south of the sink, a few miles northeast of Fallon) encompassed 10,000 acres of land, it still had no potable water supply. While some of these changes can be attributed to the drought which struck most of the western United States in the last decades of the nineteenth century, others are undoubtedly a result of an increased diversion of the water in the Carson and Humboldt rivers for farming and mining activities.

In the 1950s the officials of the Stillwater

Wildlife Management Area, with the assistance of Margaret Wheat (1967, p. 22) conducted interviews with two local American Indians to determine the changes which had occurred in the local environment since their birth in the 1880s. From these interviews it was determined that cat-tail was more extensive in the 1950s than at the turn of the century, increasing at the expense of hardstem and alkali bulrush. It was also noted that geese were more abundant in the past than in 1950, perhaps due to a post-1900 decrease in submergents over much of the marsh.

CONCLUSIONS

Many changes have occurred in both the water supply and vegetation in the Carson Desert since cultural modifications began in the 1860s. These are principally a result of Euro-American immigration and settlement of the area or upstream regions along the watershed. Changes can be related to a variety of factors including the following: the use and modification of the Carson River for irrigation, Sierra logging, Comstock milling, local introduction of exotic plants and animals, and, finally, floods and climate. Much of the water which formerly entered the Carson Sink via the Carson and Humboldt rivers is now used for irrigation upstream before reaching the Carson Desert, thus reducing their contributions. The use of Truckee River water in the Lahontan Valley/Carson Desert for irrigation, however, has shifted the distribution of water and raised the water table in some areas. In some of these areas of increased water, sloughs and other water bodies form with their associated marsh vegetation and fauna, including populations of water birds.

It is apparent that the vegetation around the Carson Desert formerly included meadows surrounding the principal water bodies and bunch grass along the edge of the mountain ranges. The introduction of livestock undoubtedly reduced the native grasses and annuals with concomitant increases in desert shrubs and exotics. The impact of these changes upon native peoples prompted a shift in their economy from hunting and gathering to wage labor (Wheat, 1967, p. 19).

What also can be learned from this survey of historic data is that the Carson Desert is very sensitive to changes in water supply and flow. The stream courses in the Carson Desert often shifted, and the lake levels were dependent upon the highly variable Sierra snowpack. Both of these factors influenced the availability and existence of economically important plants and animals. Though the mechanisms responsible for change over the last 120 years were principally cultural, similar changes surely occurred during the Holocene by way of climatic fluctuations. Increase in the abundance of marsh plant cover and associated fauna may have occurred with the localized formation of more mesic habitats similar to those seen in the Stillwater Marsh today (see chap. 10).

CHAPTER 4. PREVIOUS RESEARCH AT HIDDEN CAVE

DAVID HURST THOMAS

Because our 1979–1980 excavations at Hidden Cave constituted the third major archaeological investigation at this site, it is necessary to consider the previous research in some detail. We are particularly concerned with reconstructing the details surrounding the discovery of Hidden Cave and documenting the techniques and motivations of the scientists who subsequently worked there. We not only provide the necessary background on methods and research objectives, but also attempt to determine the condition of Hidden Cave before it was extensively disturbed through both scientific excavation and outright vandalism.

DISCOVERY OF HIDDEN CAVE

The discovery—more properly, the rediscovery—of Hidden Cave occurred sometime in the 1920s (Thomas, 1980). As part of our field investigations, we attempted to contact all those knowledgeable about the history of the site. The following account has been provided by the late Mr. Dick Wisenhunt, long-term resident of Fallon, Nevada. After thorough checking, we believe that Wisenhunt's account accurately describes the discovery of Hidden Cave.

As a boy, Wisenhunt lived at a ranch located not far from Hidden Cave (approximately 1 km. west of the current Lazy B brothel). According to local legend, there had been a robbery of the stage operating between Fallon and Wonder, Nevada. When the thief was caught, he claimed to have hidden the money in one of the caves in the Grimes Point area. It was this story that brought four youths, including Wisenhunt, on horseback to explore the Grimes Point caves sometime in the mid-1920s.

While climbing among the various caves and crevices, the boys started a rock fight on one of the steep hillsides to the north of Grimes Point. The rocks were coming thick and fast, and one boy took cover behind a large rock still in place at the mouth of Hidden Cave. A small gully had eroded at the base of this boulder (fig. 3), and nearby was a small crevice about 50 cm. long leading into the side of the mountain. Although all wanted to explore inside, they were afraid to crawl in "because of the wildcats." Instead, they placed rocks over the hole, waiting six months or so before returning.

When Wisenhunt first entered the cave—probably in 1926 or 1927—the opening was so small that he believed nobody weighing more than about 140 pounds could have squirmed in; in fact, a number of jagged rocks had to be removed on his first entry. The difficulty of access convinced Wisenhunt that no one had preceded him in recent history into the cave.

After excavating a small entry shaft, the boys crawled in, but because of a bend in the small tunnel, the cave was pitch black. Their flashlights were useless not only because of the immense size of the cave, but because the walls were stained black with bat guano. They finally succeeded in lighting the cave by burning pitch on large torches. According to Wisenhunt, dozens of bats were living there at the time, and the walls were much blacker than they are today; recent excavations have covered everything with dust.

Strangely enough, these first explorers found no Indian relics (although one later reported finding a human skull nearby). At the time, they were "skeptical and afraid" to venture into the large, central portion of the cave; this area contained soft and spongy materials covered with sand, and the boys thought that rattlesnakes might be living there.

The discovery was kept secret, and Wisenhunt thinks that nobody else ventured into the site until about 1933 or so. The boys kept rocks piled up to the entrance of the cave, convinced that nobody else could have stacked the rocks up in exactly the same way. The large cave in Eetza Mountain remained their secret hideout for the next five years.

THE WORD GETS OUT

Like many sites in the area, Hidden Cave was mined for guano sometime in the mid-1930s. The first published reference to Hid-

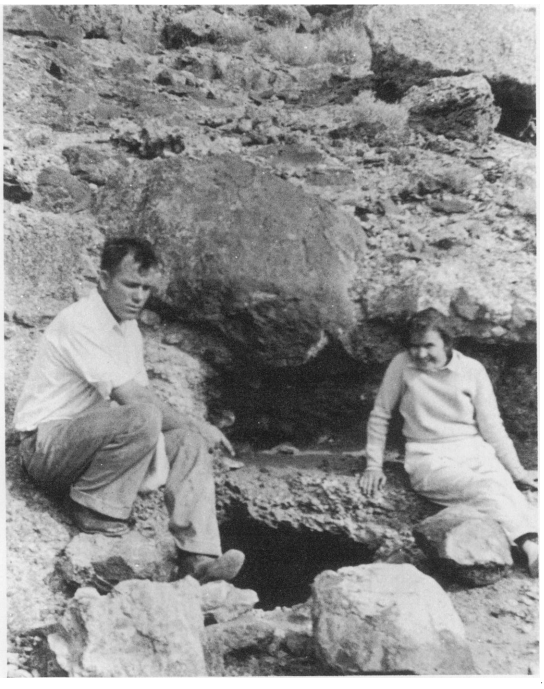

FIG. 3. Dick Wisenhunt and friend at entrance to Hidden Cave, probably in 1933. The entrance had been somewhat enlarged by this time (courtesy the late Dick Wisenhunt).

den Cave appears in the *Fallon Standard* (July 1, 1936) and discusses the guano mining operation conducted by a Mr. McRiley (also spelled McReilly):

> McRiley comes from Peru where he was in the employ of McNatt and Company of Taverna, California, dealers in guano and chemical fertilizers. He has recently completed a shipment of four tons of guano testing high in nitrogen and potassium which was taken from a cavern sixteen miles southeast of Fallon . . . . This cave is 200 feet long, 80 feet wide and 20 feet high and showed no evidence, it was said, that it had been entered before McRiley last made his entrance after widening the small inlet, a few inches across. Only small bones were found in this cave and no old Indian writings.

Mrs. Margaret Wheat (formerly Mrs. Margaret Hatton) entered the Hidden Cave picture at this point. Sometime in the mid-1930s McRiley brought in a guano sample to be mailed at the Fallon post office. Unable to address the package himself, he asked the postmaster to help him and, in the course of conversation, commented that his digging would go much quicker "if it weren't for all that Indian junk." Mrs. Wheat first heard of the cave from the postmaster.

McRiley accompanied Mrs. Wheat on her first visit to the site (Margaret Wheat, personal commun.). To enter the cave, Mrs. Wheat was forced to squirm through a very narrow opening, clogged at the time with greasewood stickers, stones, and dust. Crawling on her elbows, she was unable to bring her knees up inside the low and narrow entrance. McRiley indicated that he intended to stop mining there because the guano deposit was simply not profitable enough to justify the work. Mrs. Wheat kept the cave a secret by rolling rocks into the cave opening.

It is fortunate that McRiley ceased his guano mining in Hidden Cave, because several other of the Grimes Point caves were virtually destroyed by guano removal. According to Morrison (1964, p. 116), "the largest caves [in the Grimes Point area] are said to have yielded a hundred cubic yards or more of guano apiece, which was used locally for high-grade fertilizer. The guano mining unfortunately destroyed most of the superb archaeological record that the caves formerly held."

Speaking of the same problem, Grosscup (n.d.) later noted that "unfortunately occupational debris [in such caves] is usually so thick that getting bat guano separated from it becomes a very tedious and unprofitable chore and guano claims are often abandoned. Then local collectors may take over and finish ruining the site . . . ."

Four artifacts, probably recovered in these early guano mining activities, are curated in the National Museum of Natural History, Smithsonian Institution. The catalogue entry for numbers 377992–377994 reads: "from Guano Cave, 16 mi. SE of Fallon (donated by Mr. C. McRiley)." Although one cannot be positive, it seems quite likely that "Guano Cave" refers to Hidden Cave; the location is certainly appropriate.

Artifact 377992 is probably a child's sandal, sewn from four pieces of leather with cordage straps. The second catalog number (377993) is assigned to two tule bags. The third item is a fragment of coiled basketry.

These items are described in the appropriate material culture section of this monograph but, because of the uncertain provenience, they are not included in the actual analysis.

INITIAL ARCHAEOLOGICAL EXPLORATIONS

According to a brief unpublished account (Wheeler, n.d.a.), in 1938 Margaret Wheat urged the Southwest Museum to investigate the archaeological possibilities of this newly discovered cave. As a direct result of her request, M. R. Harrington, Curator, and S. M. Wheeler, Laboratory Associate and Assistant Field Archaeologist, visited Fallon on July 18, 1938 to learn more from Margaret Wheat. Harrington and Wheeler were on their way to excavate Baker Cave. Wheeler's large truck proved too unwieldy to negotiate the unpaved Grimes Point road, so they joined Mrs. Wheat in her vehicle for the short ride to the cave area. It turned out that she had difficulty finding the cave, looking into one outcrop after another. After examining several promising ledges, Harrington commented, "This is certainly one very hidden cave."

Margaret Wheat (personal commun.) thinks that Hidden Cave was named by Harrington that day. Three decades later, Napton noted that "Hidden Cave" without doubt merits its name. Even today the entrance is difficult to locate.

Short of time, Harrington and Wheeler spent only an hour examining Hidden Cave, but both fully concurred that it was "a potentially valuable archaeological site and should be fully protected from vandalism" (Wheeler, n.d.a., p. 1).

Robert F. Heizer apparently also visited the Grimes Point area several times in the 1930s (Bard, Busby, and Findlay, 1981, p. 117), but it is unclear whether he actually inspected Hidden Cave. According to a notation in Wheeler's field journal, Margaret Wheat "had reported the Hidden Cave to the University of California and Robert Heizer had been sent to investigate. He turned it down for excavation as containing nothing of value or importance. He made a mistake in judgment that time" (Wheeler, n.d.c., p. 14). Despite this reference, our examination of Heizer's field notes indicates that the 1937 trans-Nevada survey party spent no time at all in the Grimes point area, although they drove through on May 17, 1937. It is possible, of course, that Heizer returned at a later date to survey the Grimes Point/Hidden Cave area.

Not long thereafter, Margaret Wheat tried again to initiate professional investigations at Hidden Cave by contacting the University of Nevada, Reno in August 1939. She was referred to Robert A. Allen, Superintendent of Nevada State Parks in Carson City. He turned the matter over to Wheeler, who had just been appointed assistant to the superintendent and archaeologist for the Nevada State Park Commission. Already familiar with Hidden Cave, Wheeler vouched once again for the scientific importance of the deposits, but funding for excavations was unavailable. Wheeler did, however, dispatch a Highway Department survey crew to map the Grimes Point area. This map, now in the Archives of the Nevada State Museum, shows the locations of 26 large caves in the area; Hidden Cave is denoted as "cave #14."

Wheeler secured limited funding the next year to explore caves in the Grimes Point area. On his preliminary survey form, Wheeler (n.d.a.) noted tersely that the expedition camp "should be placed well up on the bench. Flats nearly impassable when wet . . . area infested with rattlesnakes, rabbit hunters and others very careless with guns."

Actual fieldwork at Hidden Cave began on May 26, 1940, when S. M. and Georgia N. Wheeler set up their field camp in a Highway Department trailer and station wagon, parked on a terrace of Lake Lahontan, directly below the entrance to Hidden Cave (fig. 4). At this point, "the entrance (to Hidden Cave) was very small—just large enough to allow an average-size person to crawl through. That it had never been larger was proved when it was enlarged at the beginning of the work—a project accomplished only by blasting" (Wheeler, n.d.a., p. 2; see also fig. 5).

The Wheelers excavated and surveyed in the Grimes Point area until November 18, when cold weather forced them to close their camp. All materials recovered were catalogued by the Nevada State Park Commission (and later turned over for curation to the Nevada State Museum, Carson City). All ex-

tant artifacts, field notes, and photographs from the 1940 Wheeler excavation have been reanalyzed as part of the present project.

The Wheelers concentrated their excavations on Hidden Cave proper for the first two months. But on August 7, 1940, while escorting a group of visitors through a nearby cave, Wheeler was startled by a rattlesnake and tumbled down the hillside injuring his leg. Unable to continue his excavations at Hidden Cave because of the injury, Wheeler shifted his attention to the more accessible surface sites in the Hidden Cave/Grimes Point area.

It was during this interval that the Wheelers excavated the widely publicized burials at Spirit Cave and Fish Cave (Wheeler and Wheeler, 1969; see also Appendix B, this volume). Accompanied by the Deputy Sheriff and County Coroner, the Wheelers made quite a production of removing the Spirit Cave burials. The press coverage, extensive and often confused, left most local residents with the impression that the burials had been found in Hidden Cave proper. Actually, few human bones have ever been recovered from Hidden Cave (see chap. 13, this volume), but rumors of prehistoric burials persist until today.

Although S. M. Wheeler is generally given credit for the first excavation at Hidden Cave, the truth is that Mrs. G. N. Wheeler spent vastly more time excavating than did her husband, who became increasingly involved with public visitorship at the site.

FIG. 4. 1940 Wheeler field camp, located just below the mouth of Hidden Cave, not visible in the background (courtesy Nevada State Museum).

FIG. 5. S. M. Wheeler holding forth at door of camp trailer, showing Hidden Cave artifacts to interested visitors. Arrow/pointer apparently did not come from Hidden Cave (courtesy Margaret Wheat).

According to Wheeler (n.d.b.), the first visitors at Hidden Cave arrived shortly after the initial account of the excavations appeared in the *Fallon Eagle* on July 27, 1940. In correspondence with Robert Allen, his supervisor at the Nevada State Parks Commission, Wheeler later discussed the burden of visitors at Hidden Cave:

> Sunday, following the publication of the article in the "Eagle", we got 26 visitors, no breathing spell from 11:00 A.M. until after 9:00 P.M. We got no lunch and we had to keep one group waiting until we could take time to eat supper. This is not to make a complaint, but merely to show the popularity of the site. . . . every visitor, so far, has expressed gratification that the State is finally doing something to preserve materials of this kind.

Wheeler generated a comprehensive guest-

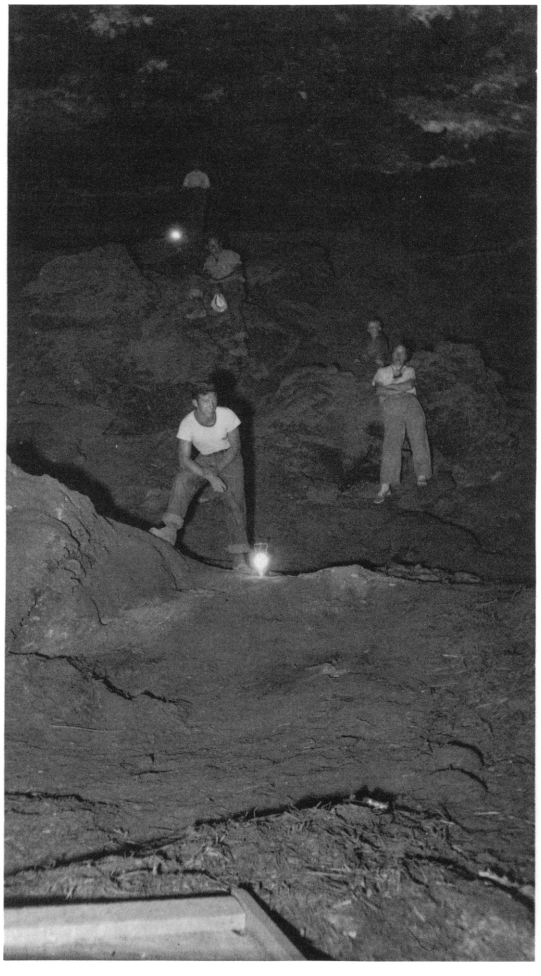

FIG. 6. Visitors to Hidden Cave posing on steep slope of Middle Cave. Corner of Wheeler's excavation unit appears in foreground (courtesy Nevada State Museum).

book, which he assiduously cross-tabulated, noting daily visitorship, hometowns, repeat visitors, and how people initially heard of the Hidden Cave excavations.

Hidden Cave was also open to the public during the Nevada State Fair held in Fallon from August 31 through September 2, 1940. The site guestbook (Wheeler, n.d.b., p. 9) indicates that 753 visitors registered for site tours in 1940; despite occasional protests, Wheeler was proud of the public interest in the archaeology of Hidden Cave: "it required a minimum of one hour be spent with each group, as many as ten groups being entertained in one day, keeping both of us busy guiding and lecturing . . . the visitors' register also showed the value of scientific work in increasing the movement of traffic in any area where such work is being conducted. Fifty-one towns and cities in ten states . . . were represented."

Public attention became so intense that Wheeler finally requested that the following item be published in the *Fallon Standard* (August 31, 1940):

PUBLIC REQUESTED NOT TO ENTER CAVE

A special request is made by S. M. Wheeler, archaeologist for the state park commission, that visitors do not enter caves during his absence.

The area has been taken over by the state park commission for exploration purposes, and the work is seriously handicapped when visitors

FIG. 7. G. N. Wheeler leaving Hidden Cave; photograph taken sometime during summer of 1940, before the entrance had been enlarged (courtesy Nevada State Museum).

> trample on the floor of the caves or handle material that has been laid out, Wheeler explained.
>
> During an absence last week and early this week Mr. and Mrs. Wheeler returned to find walls had been knocked down and that some artifacts had been moved. Restoration required several hours work, it was said, and part of the damage was irreparable.
>
> The exploring party has arranged to receive visitors after 3:30 o'clock in the afternoon, and at no other time, and only on days when Mr. and Mrs. Wheeler are present. There is too much work to be done to take care of visitors at other times, it was explained.

Elsewhere (*Fallon Standard,* September 26, 1940) the same message was reiterated:

> there is a penalty including a fine up to $1,000 and jail sentence up to six months that can be imposed upon anyone found guilty of molesting the interior of caves or Indian picture writing on exposed rocks of the area. Recently, he said, rocks carrying pictures and writing on three occasions have been broken with chisels in efforts to carry away fragments. The park commission, it was declared, is prepared to prosecute if those guilty are apprehended.

Things have changed little in the past four decades, and vandalism remains a major problem in the Grimes Point/Hidden Cave area (Appendix A; see also Hatoff, 1977; Hatoff and Thomas, 1982).

When their work at Hidden Cave was completed, the Wheelers placed an iron gate across the entrance (which had been enlarged to facilitate the removal of backdirt). The gate was designed "to protect the cave from vandalism. A later inspection showed that these 'destroyers of history' had succeeded in digging around the barrier. Fortunately, the cave deposits are such that they soon became discouraged and little actual damage was done" (Wheeler, n.d.a., p. 2). The Wheelers would, perhaps, have been interested to know that their iron gate remains intact today.

Wheeler devised another ingenious strategy to protect the Grimes Point sites. During his excavations, he pursuaded several individuals to file mining claims on the sand, gravel, and guano deposits inside Hidden Cave and other important caves in the area. A *Location Notice,* signed by eight Fallon residents and witnessed by S. M. Wheeler was filed June 1, 1940, claiming 11 caves as the "El Vera Placer Mining Claim." Then, on July 15, 1940, Wheeler filed *Proof of Location Work* certifying that:

> at least Twenty Dollars ($20.00) worth of labor, work or improvements were performed and made upon and for the development of the guano deposit duly located on June 1, 1940, as the El Vera Placer Mining Claim . . . said labor consisted of enlarging the entrance to cave #14, known as the Hidden cave . . . and the making of excavations therein to depths varying from one half (1/2) foot to two and two thirds (2 2/3) feet over an area of approximately twenty-six square yards; that such labor was performed on behalf of the above-named owners for the purpose of complying with the law and holding said claim.

A similar procedure was followed for the "Kayo Placer Mine," to protect excavations at nearby Spirit Cave (see Appendix B).

Later that summer, the so-called mine owners then "quit claimed" their deeds to Wheeler, thereby awarding legal claim of these caves to the Nevada Department of Highways. It seems ironic that mining laws turned out to be a more effective means of protecting archaeological sites than were the laws designed specifically to protect antiquities.

Wheeler never published his findings from the Hidden Cave excavations. The most complete summary appears in "Preliminary Report, Archaeological Fieldwork, June 6 to November 18, 1940" (Wheeler, n.d.b.). With the kind permission of the Nevada State Museum, we reprint the most relevant portions of this important unpublished manuscript:

> This large cave (150′ × 83′) derives its name from the small size of the opening which failed to reveal its presence to most of the numerous prospectors and hunters who passed by without learning of its existence .... complete excavation of this site was not attempted as available funds were insufficient to employ the necessary personnel. The main objective was the determination of the period represented by the deposit.
>
> The upper levels had been badly disturbed by the removal of considerable guano, but a few arrow specimens rescued from the screening of the earlier workers showed that the cave had been occupied by the Indians after the bow and arrow had come into use. However, once the

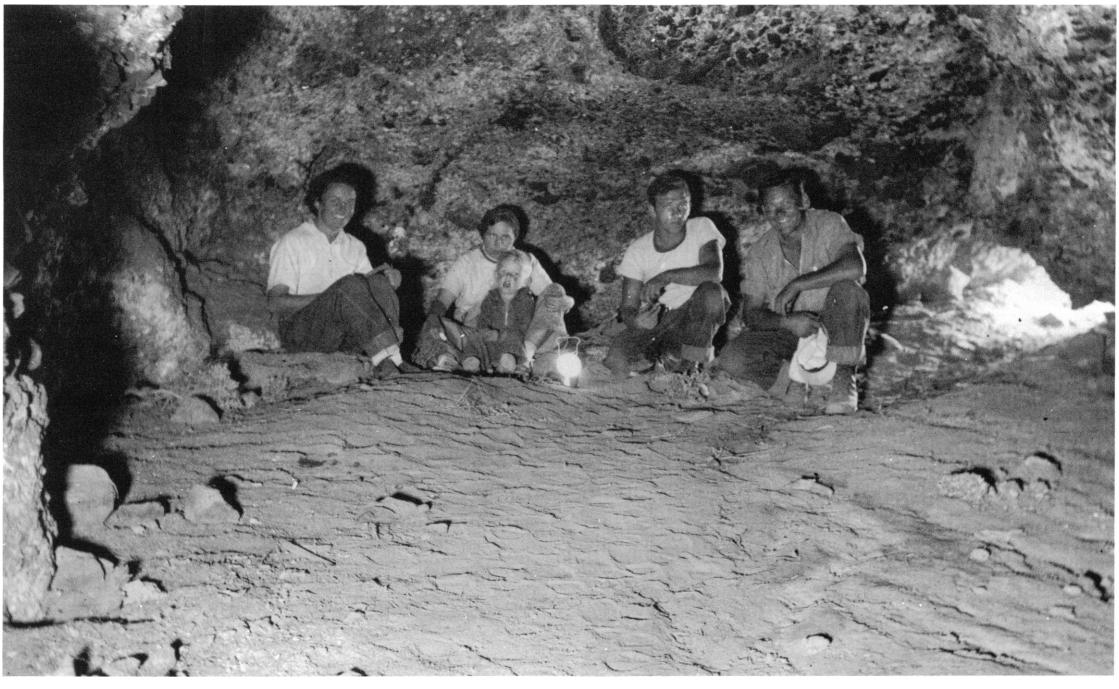

FIG. 8. Margaret Wheat (left) and visitors inside Hidden Cave. This photograph is particularly useful because it shows inside of cave entrance prior to Wheeler's extensive modifications in 1940 (courtesy Nevada State Museum).

top of the undisturbed deposit was reached, there were no more fragments of arrows, only atlatl darts and points, indicating an age of over 2,000 for the remaining levels.

The bottom of the deposit was not reached except on a ledge where the sixth stratum contained no Indian material. A Gypsum Cave type dart point found in situ in tule bedding in the fifth stratum would appear to indicate an age of 10,000 years for that level. The presence of Indians of the Gypsum Cave period, contemporaneous with the prehistoric ground sloth, was further strengthened by the uncovering of two more of these type points in other portions of the deposit. Added to this evidence was the finding of a fossilized bone which was identified by Mr. E. L. Furlong, Department of Paleontology of the California Institute of Technology, Pasadena, California. A first phalanx, also fossil, was removed from the ceiling of the cave where it was lodged in a crack. Mr. Furlong reported, "[they] are, as you anticipated, bones of a horse. It is not safe to determine the species of horse represented on just these two bones. However, there is no doubt from the state of preservation that they are fossil. In size the bones are like many of the Pleistocene E. occidentalis individuals, though I would not place them definitely in that species." Since the positions in which the bones were found could have been reached by them in more than one way it would be unwise to attempt to date the level in which the one was found on the basis of just the one find. However, taken in consideration with the Gypsum Cave artifacts, they are quite indicative. Further excavation will probably supply additional evidence, but should not be undertaken until complete excavation is possible . . . .

Over 1500 specimens were removed, treated with preservatives where necessary, packed and placed in the office of the Archaeologist in Carson City. Some of the more representative were placed in glass-covered cases and held at camp for exhibition to visitors.

We think that Wheeler's 1940 excavation at Hidden Cave remained unpublished because he planned additional work at the site.

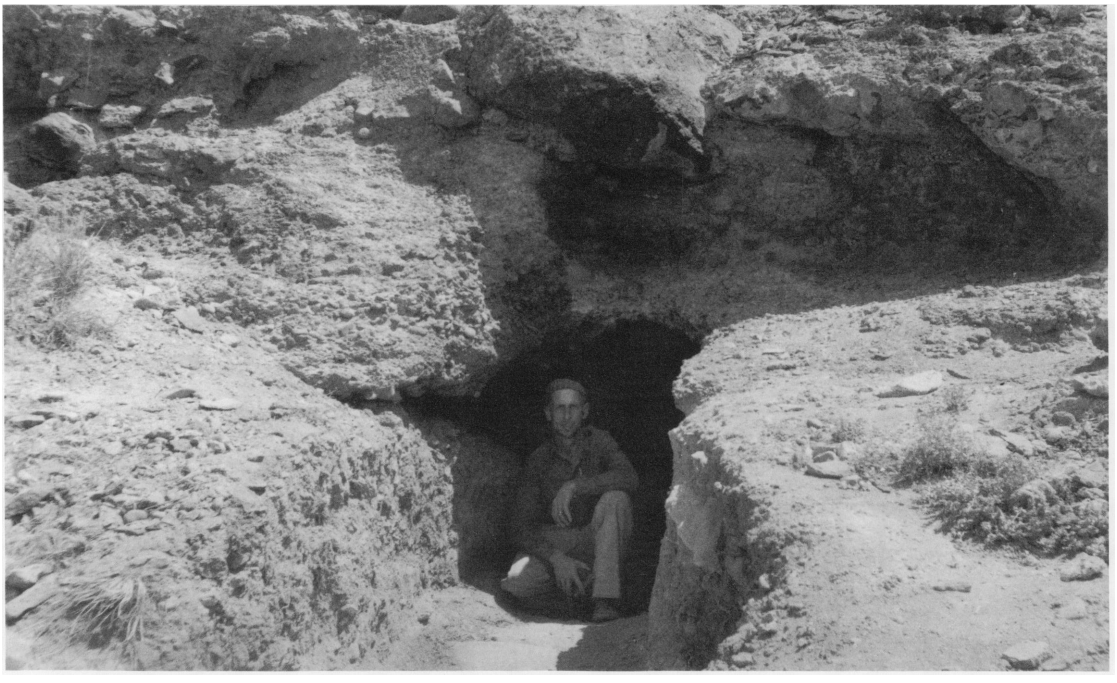

FIG. 9. S. M. Wheeler at entrance to Hidden Cave. Photograph taken in 1940, after cave mouth was enlarged to facilitate access during excavation (courtesy Nevada State Museum).

In his report of November 21, 1940, Wheeler argued that

> if the program is continued and funds made available for the purpose, a crew [will] be employed during 1941 to completely excavate Hidden Cave, Cache Cave, Hanging Rock Cave and Polished Cave. This work should be completed before new excavations are contemplated. From the work to date indications point to the possibility of securing much valuable scientific data on the area through complete excavation (Wheeler, n.d.b., pp. 10–11).

The *Fallon Standard* (Sept. 26, 1940) also considered Wheeler's future plans for Hidden Cave: "It is anticipated, Wheeler announced, that work will be resumed at the caves here next spring. This will depend on legislative appropriations for the park commission."

Despite intensive lobbying and appeals for public support, funding for 1941 Hidden Cave excavations was not forthcoming. The details are not clear, but Wheeler apparently joined the U.S. Army not long thereafter. To our knowledge, S. M. Wheeler conducted no archaeological investigations in Nevada after World War II.[1]

THE 1951 EXCAVATIONS

No further archaeological investigations were conducted at Hidden Cave until the work in 1951 by Norman L. Roust and Gordon L. Grosscup (Grosscup, 1956; Roust and Grosscup, n.d.; Morrison, 1964, pp. 134–135). Grosscup (personal commun.) has kindly provided the following account of that excavation:

> My introduction to Nevada archaeology began with Heizer's summer field class at Leonard Rockshelter, in 1950 .... The following year Roust and I received monies via the University of California ... an arrangement with the U. S. Geological Survey for financial support to work with Roger Morrison while he studied the Pleistocene and Recent geology of the Carson Basin.

[1] For a brief biographical sketch of S. M. Wheeler, see D. Fowler (1973, p. 7).

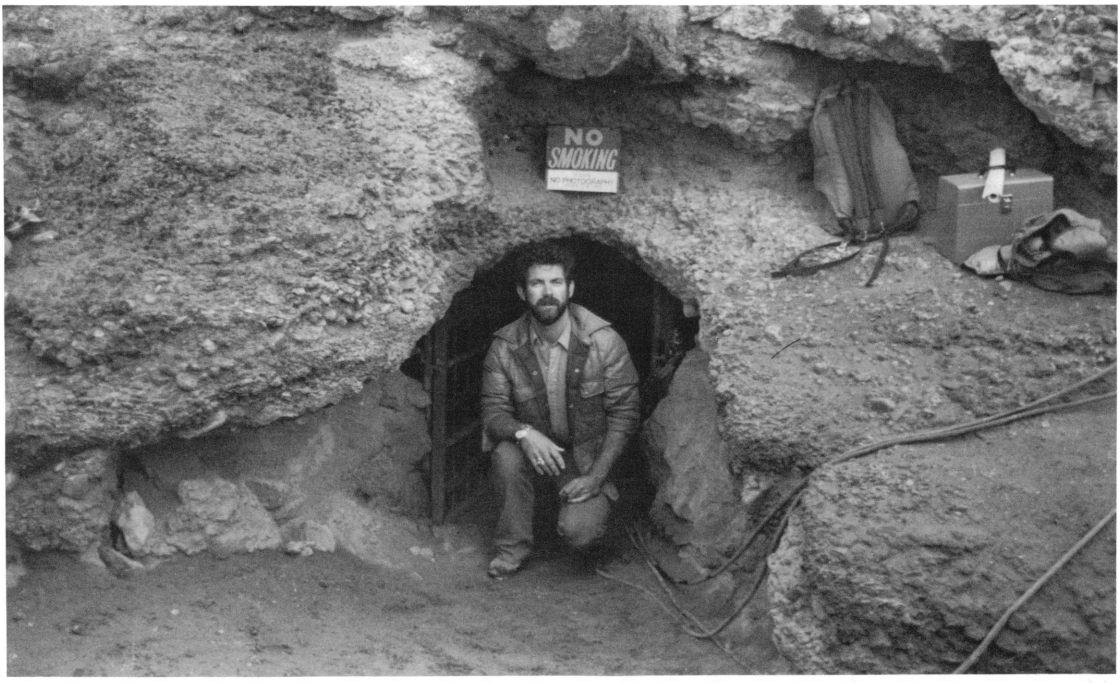

FIG. 10. D. H. Thomas at entrance to Hidden Cave, 1979.

It was felt that we could help him date some of the more recent formations . . . .

While we concentrated our [1951] work on Hidden Cave, we did site survey around the area and made extensive collections from Hathaway Beach. When we first visited Hidden Cave, the iron gate was in place. I can't remember if there was a lock and chain in place or not, but the gate was silted in and could not be opened at the time. Pothunters had burrowed in alongside of the gate anyway. We did clear the passageway into the gate for easier access, of course. As I recall there was no great disturbance of the deposits due to pothunting activity, but Wheeler's area of excavation was apparent as a depression in the center of the deposits. In laying out our excavation we attempted to skirt that depression and in general did not get into much of Wheeler's disturbed area. Our trench eventually took the form of a "4" with the leg of the 4 running back from the entrance. I assume that it is still visible and that you are familiar with it. The smaller trench in the entrance area was put in towards the end of the dig. We started out using Coleman lanterns and other crude lighting devices, but eventually acquired a generator and strung up several light bulbs . . . .

Elsewhere, Grosscup elaborated the research objectives for the 1951 excavations at Hidden Cave (Grosscup, n.d.): "one of these goals was the strictly anthropological one of learning more about the former inhabitants of the Carson Sink Basin and in extension of western Northern America. The other goal was to obtain evidence for the establishment of an absolute chronology for the fluctuations of the lakes and the recent geological deposits in the Carson Sink Basin."

The 1951 University of California/U.S. Geological Survey operations at Hidden Cave began on April 27, when Exploratory Pit "C" was excavated by Norman Roust, Gordon Grosscup, Margaret Wheat, and Roger Morrison. It was on the profile of this test pit that Morrison (1964, pp. 134–135; see also chap. 7, this volume) based his stratigraphic description of Hidden Cave (although Morrison remained in close association throughout the entire 1951 excavation).

Roust and Grosscup spent the summer of 1951 excavating at Hidden Cave. Although the results were published in only rather ab-

breviated form (Grosscup, 1956), an important preliminary report was placed on file at the University of California Archaeological Research Facility (Roust and Grosscup, n.d.).

Roust (1967) also published an analysis of coprolites recovered in the 1951 excavations (see also Ambro, 1967). Roust and Clewlow (1968) provided a preliminary description of the 1951 excavations as background to their analysis of the 39 typable projectile points recovered by Roust and Grosscup. In addition, Ambro (1966) published a meticulous description of two fish nets that he attributes to Hidden Cave. As we discuss subsequently, there are reasons to suspect that these nets did not actually come from Hidden Cave, but rather were found in one of the other caves at Grimes Point.

Orr returned to Hidden Cave in 1955 to collect radiocarbon samples (Napton and Heizer, 1970, p. 121); Orr also prepared a preliminary stratigraphic description at that time (Donald Tuohy, personal commun.). Two dates were derived from Orr's samples (Broecker and Kulp, 1957, pp. 1324–1334; Broecker and Orr, 1958; Grosscup, 1958, p. 18; Roust and Grosscup, n.d.; see also chap. 7, this volume). One sample, vegetal material from the 32 Inch Midden, dated to 3050 B.P. ± 200 (L289-BB). The other date was processed on oolitic tufa from the bottom of Hidden Cave: 15,130 B.P. ± 400 (L289-AA). These two dates provided the only radiocarbon evidence from Hidden Cave until the 1979–1980 excavations. Interestingly, these two dates are omitted from Morrison's seminal (1964) discussion of Hidden Cave stratigraphy (see also Morrison and Frye, 1965).

In 1966, Donald R. Tuohy continued archaeological fieldwork in the Hidden Cave area in his research at Hanging Rock Shelter, a small overhang initially tested by Wheeler in 1940. Tuohy was attracted to this site because of the discovery by two amateur collectors of a polychrome bird effigy in Hanging Rock Shelter. Although he did not recover additional examples of portable art, Tuohy (1969a) found and described 433 artifacts from this site.

Another field party from the University of California, Berkeley, conducted reconnaissance and field testing of several caves in the Grimes Point area during the summer of 1971 (Napton, 1971a, 1971b). Although this group wanted to dig at Hidden Cave, they were unable to do so because both their portable power units were "rendered inoperable due to magneto failure caused by operating the equipment in the dusty Grimes area caves" (Napton, 1971b, p. 9). The 1971 fieldwork was restricted to collection of midden samples and human coprolites, and observation of the strata which remained exposed from the Roust and Grosscup excavations. At the time, Napton wrote (1971b, p. 9) that "Hidden Cave is a very important site which certainly merits further excavation . . . but . . . due to technical problems, the site is probably one of the most difficult caves to excavate that I know of in the western Great Basin."

Davis included Hidden Cave as sample "JOD39" in his analysis of Quaternary tephrochronology for the Lake Lahontan area (Davis, 1978). He notes that his samples came from the University of California Archaeological Research Facility, through Mr. J. Pat Green, then of Washington State University.

No further strictly scientific studies were conducted in the Hidden Cave/Grimes Point area prior to American Museum involvement in 1979. But the innovative cultural resource program instituted in that area deserves mention (Hatoff, 1977). Beginning in the spring of 1976, the BLM has pursued an aggressive program of protection and public education at the Grimes Point Petroglyph Area. A self-guiding trail was installed through the rock art zone in an attempt to educate the public and discourage vandalism. Since that time, Hidden Cave itself has been prepared for on-site visitation (Hatoff and Thomas, 1982).

This is the background against which the American Museum of Natural History team initiated excavations at Hidden Cave in June 1979. Subsequent chapters detail the specific research and management objectives of these excavations.

CHAPTER 5. OBJECTIVES OF THE 1979–1980 EXCAVATIONS

DAVID HURST THOMAS

For decades, archaeologists and geologists have known that Hidden Cave contains a complex series of depositional units reflecting the stratigraphic record of late Pleistocene and Holocene times. A major objective of the 1979–1980 Hidden Cave excavations was to obtain from those sediments a more complete picture of the paleoenvironmental record of Hidden Cave and the Carson Sink. Several specialists were invited to participate in both the planning and execution of on-site and laboratory investigations.

The 1979–1980 excavations were also directed at specific anthropological objectives. By combining additional fieldwork with analysis of the existing museum collections, we proposed to use Hidden Cave to clarify specific issues of cultural chronology and site function and then use these findings to explore the overall regional adaptive significance.

GEOLOGICAL AND GEOMORPHOLOGICAL OBJECTIVES

The geological investigation of the Hidden Cave sediments was initiated by Roger B. Morrison, whose monograph establishing the late Quaternary sequence for the Carson Desert remains the basic stratigraphic reference for the area (Morrison, 1964; see also chap. 7, this volume). Because most of Morrison's work was conducted prior to the advent of radiocarbon dating, estimates of absolute age have been derived largely from later work (Benson, 1978; Davis, 1978).

Hidden Cave was an especially important stratigraphic section for Morrison (1964) because it included sediments from the Sehoo Formation as well as the entire Holocene in simple stratigraphic superposition. The lower sediments (Morrison's Units 11, 12, and 13) were overlain by a lens of poorly sorted gravels, slightly cemented by calcium carbonate. Hidden Cave is, in fact, the type locality of the Middle Tongue of the Indian Lakes Formation (Morrison, 1964, p. 68). Somewhat higher in the column is a tephra correlative with the Tsoyawata Bed of the Mazama member, about 7000 years old (Davis, 1978). The overlying organic debris was attributed by Morrison to episodes in which lakes existed in the Carson Sink, interbedded with layered silt correlated to the nonlake intervals. Additionally, Davis (1978) correlated another tephra layer in the upper portion of the Fallon Formation—not included in Morrison's description—with the Turupah Flat Bed from Mono-Inyo Craters; the best estimate of the age of this bed is about 1500 B.P. (Davis, 1978; chap. 7, this volume).

Because of the previous geological description of Hidden Cave—especially Morrison (1964)—the questions posed for the 1979–1980 excavations were more detailed and more precisely directed than is the case for most archaeological sites. These research objectives were concerned with the physical relations between previously described strata, as well as with the interpretation and dating of the deposits:

1. to re-examine Morrison's interpretations of the depositional environments, especially the nature of the Turupah, Indian Lakes, and Fallon formations;

2. to re-examine the relationship between the Mazama and the Tsoyawata tephras, since Davis's (1978) previous research was based on only two samples, already removed from stratigraphic contexts;

3. to expand the earlier geological framework to include new strata evident in the greatly expanded excavations;

4. to obtain a significantly large number of radiocarbon samples to allow definition of finer chronological distinctions.

Results from this investigation are discussed by Davis in chapter 7.

PALEOBOTANICAL OBJECTIVES

Although previous investigations had derived a workable geological framework for Hidden Cave, this research provided only the barest outline of the floral history of the Hid-

den Cave area. Both Morrison (1964, pp. 105–106) and Grosscup (1956, pp. 61–63) emphasized the correlation between the density of human occupation in The Hidden Cave area and the filling of the desert lakes: "Doubtless the density fluctuation was due to corresponding variations in the food supply" (Morrison, 1964, p. 105). According to Morrison's interpretation, at least five lakes existed in the Carson Sink during the past 4000 years. The first Fallon lake was interpreted as a time of sparse human occupation, as judged from the relatively few artifacts recovered in the 32 Inch Midden (Roust and Grosscup, n.d.; Grosscup, 1956, p. 61; Roust and Clewlow, 1968). Morrison correlated the loess layer (lying atop the 32 Inch Midden) with the recession of the first Fallon lake, and postulated an aboriginal withdrawal from the area. Morrison (1964, p. 105) and Grosscup (1956) thought that the aboriginal population reached an "all-time climax" during the time of the second Fallon lake, correlative with the Surface Middens inside Hidden Cave. Since approximately 85 percent of the cultural materials recovered in 1951 came from the Surface Middens, Morrison and Grosscup argued that human occupation of the area must have declined as the second lake receded and people moved toward Carson Lake to the south. Although few radiocarbon dates were available at the time, Morrison estimated that "Fallon time" lasted from about 2000 B.C. to the present, with the various lake fluctuations contained within this interval.

But previous excavations in the Carson Sink provided little paleobotanical information upon which to base such geological or cultural interpretations of prehistoric human ecology in this area. The only direct data from Hidden Cave was a suite of 85 coprolites, analyzed by Roust (1967). In general, the Hidden Cave data seemed to mirror the more comprehensive coprolite studies for sites in the nearby Humboldt Sink (Napton and Heizer, 1970, pp. 107–109). Hidden Cave was lumped into the generalized *Lacustrine Subsistence Pattern* defined for the Humboldt region "though we assume that . . . [in the Carson Sink] there could have been local specializations not present at Humboldt Lake" (Napton and Heizer, 1970, p. 108).

Beyond Roust's pioneering coprolite study, published paleobotanical data were lacking for Hidden Cave. To explore this critical topic, the current Hidden Cave project enlisted the assistance of Peter E. Wigand and Peter J. Mehringer, Jr. Their research was designed to apply modern techniques of paleobotanical and microstratigraphic analysis to one of the few remaining dry lacustrine caves.

Specifically, the 1979–1980 fieldwork attempted to accomplish the following paleobotanical objectives:

1. to prepare a pollen diagram for Hidden Cave, sampling all of Morrison's (1964) stratigraphic units, as well as additional units first recognized in the 1979–1980 excavations;

2. to extract pollen from a sample of human coprolites, deriving data to compare and contrast with results from the master pollen profile;

3. to identify a large range of plant macrofossils from the Hidden Cave strata, attempting to monitor both vegetation and also on-site human activities;

4. to conduct sediment analysis to determine grain size distribution of Hidden Cave sediments, in an attempt to reconstruct the depositional environments of these strata;

5. to attempt a reconstruction of both widescale and local vegetative change in the Hidden Cave area, with especial attention to the changing nature of effective moisture, fluctuating water tables, and lacustrine expansion and contraction in the Carson Sink area.

The results of the 1979–1980 paleobotanical investigations at Hidden Cave are presented by Wigand and Mehringer in chapter 9.

PALEONTOLOGICAL OBJECTIVES

The 1979–1980 Hidden Cave fieldwork also had specific paleontological objectives, framed primarily by Donald K. Grayson. From the beginning, Grayson thought that Hidden Cave could provide a unique opportunity to study the historic biogeography of a wide range of animals, particularly small vertebrates.

Hidden Cave is situated at about 1250 m. elevation (4100 ft.). Previous excavations had demonstrated that the deposits contained a rich array of small mammal, bird, fish, reptile, and amphibian remains. No other pa-

leontological or archaeological site in western Nevada had such a large series of well-stratified vertebrate remains, extending from late Pleistocene through Holocene times. In fact, Hidden Cave was thought potentially to provide the first stratified and well-dated Great Basin sequence of small vertebrates spanning the last 15,000 years.

Initially, Grayson hoped that the small mammals from Hidden Cave would allow further testing of J. H. Brown's model of boreal mammal biogeography in the Great Basin. Brown (1971, 1978) had argued that the distribution of boreal mammals on mountaintops within the Great Basin today cannot be accounted for merely by an equilibrium between the rates of colonization and extinction (MacArthur and Wilson, 1967). Instead, this distribution could perhaps be explained by an initial Pleistocene colonization followed by extinction of geographically intermediate populations.

Grayson (1982, 1983) has previously outlined a set of predictions that must be met by the paleontological record if this model is to be considered correct. One of these implications can be addressed directly through the analysis of the Hidden Cave mammalian fauna: *boreal mammals now isolated on Great Basin mountain tops must have been present in the lowlands in the past, since (according to the Brown hypothesis) these lowlands provided the corridor of access to the mountains during the Pleistocene.*

This specific research objective guided the 1979–1980 excavation. It was recognized at the time, of course, that the Hidden Cave excavations would produce a wide range of vertebrate remains, but no additional research objectives were framed prior to excavation (see chap. 10, this volume).

CULTURAL CHRONOLOGICAL OBJECTIVES

As we approached the archaeology of Hidden Cave in the late 1970s, it was possible to detect two rather different views of cultural chronologies for that site. The traditional view is that Hidden Cave represents a long-term, culturally diverse episode. But in our research in Monitor Valley, central Nevada, we evolved a somewhat different cultural chronology, and the differences between the two views of chronology are magnified at sites like Hidden Cave.

Roust and Clewlow (1968) provide a detailed discussion of the typology and significance of the 38 typable projectile points recovered in the 1951 excavations at Hidden Cave. This interpretation holds that the Hidden Cave occupation began during early Holocene times—as indicated by four large Humboldt points—waned during the Altithermal, then blossomed during the early Medithermal with a flurry of types that persisted until about A.D. 1300 (Heizer and Hester, 1978). This traditional interpretation of Hidden Cave is well-expressed by Napton (1971b, p. 9), who speaks of the "lengthy projectile point sequence and well stratified deposits [which] form an important reference sequence for the Grimes area."

This interpretation of the Hidden Cave sequence has been used by a number of investigators to bolster chronological arguments from throughout the Great Basin. We proposed, in the renewed excavations and analysis, to examine this chronology in detail.

SITE FUNCTIONAL OBJECTIVES

A second anthropological objective of the 1979–1980 excavations was to clarify the functional status of Hidden Cave. A number of other investigators have similarly recognized the probable storage function of lacustrine caves in the Humboldt Sink, the Pyramid/Winnemucca Lake sites, and also the caves of the Carson Sink.

But there hardly exists a consensus about the functions of lacustrine caves, and others have argued specifically that Hidden Cave was used as a habitation site (Napton, 1969, p. 48; 1971a, pp. 12–13; Morrison, 1964, pp. 105–106).

Adequate analysis of cache sites is important because of the close relationship between such sites and strategies of storage and mobility. The cache is a distinctive archaeological signature that holds key information for reconstructing the nature of past settlement and subsistence decisions. One of the major anthropological objectives of this project is to examine the presumed caching function at Hidden Cave.

REGIONAL ADAPTIVE SIGNIFICANCE

Finally, we wanted to explore the nature of prehistoric man-land relations, as encoded in the deposits of Hidden Cave. Excavations at Hidden Cave are complemented by the extensive regional survey of the Carson Sink/Stillwater area, but the cave deposits *per se* are also useful in examining the prehistoric ecology of the area.

If it turns out that Hidden Cave functioned largely as a cache spot, as some previous investigators have suggested, then this site provides a useful node from which to partially monitor the adaptive strategy of a hunting-gathering group.

Because the degree of storage is a primary discriminator between collector and forager, proper excavation and analysis of such sites should enable the archaeologist to look beyond the artifact and feature to the underlying strategy. Caches have a high degree of archaeological visibility; their positioning and contents are directly conditioned by the role they played in the settlement strategy that created them. We think that the cache is a fairly reliable signature denoting some characteristics of the system that produced it. It is thus clear that analysis of cache locations will provide important clues in the limnosedentary/limnomobile question.

Although no cache site—or any single site—can be taken as "typical" of the overall settlement patterning, cache sites are indeed high-information places in which to monitor selected aspects of the prehistoric seasonal round. At the outset, we hoped that the renewed excavations and reanalysis planned for Hidden Cave could use the cache setting as a window on a much larger data set dealing with adaptive strategy decisions.

CHAPTER 6. EXCAVATION STRATEGIES AT HIDDEN CAVE: 1940–1980

DAVID HURST THOMAS AND DEBRA PETER[1]

Hidden Cave (elev. 1251 m. [4104 ft.]; NW ¼, SW ¼, sec. 21, T. 18 N., R. 30E.) is on the north side of Eetza Mountain within the Lahontan Mountains which adjoin the Stillwater Range to the west (fig. 11). The cave, one of the so-called Bat Caves of the Grimes Point Petroglyph Area (Hatoff, 1977; figs. 11 and 12), is approximately 15 km. southwest of the town of Fallon. Sydney M. Wheeler of the Nevada Highway Commission first recorded Hidden Cave as Cave #14 and later as site 1-1B. Subsequently, this site was recorded as 26-Ch-16 (also written as NV-Ch-16) by the University of California (Berkeley) Archaeological Survey. Hidden Cave is also listed as 26Ch46 in the site files of the Nevada State Museum.

The maximum dimensions of Hidden Cave are: length approximately 45 m., width 29 m. The maximum ceiling height inside the cave—when first discovered—was about 4.5 m. above the archaeological and geological deposits (figs. 13 and 14). In cross-section, Hidden Cave can be divided into three zones, termed by Roust and Grosscup (n.d.) the "Lower," "Middle," and "Upper" caves. The Lower Cave is approximately 18 m. long, and contained approximately 95 percent of the archaeological materials. The Middle Cave slopes steeply upward, rising some 10 m. in a horizontal distance of only 13 m. No archaeological remains were found in this zone. The Upper Cave has a relatively level surface, but the ceiling is low and the area receives little ambient light. Only a few isolated artifacts were found in the upper portion of the cave.

The Hidden Cave entrance is a single small opening on the northwestern side of the cave. Since the rediscovery of this site in the 1920s, this opening has been enlarged several times. Based on the earliest available accounts (discussed in chap. 4), we estimate that at the time of discovery the entrance to Hidden Cave could have been no larger than about 50 cm. by 25 cm. The interior of the cave has a nearly constant floor temperature of about 14.5°C.

The cave exists in a matrix of Eetza age tufa-cemented conglomerate (Morrison, 1964, pp. 29, 48). Created about 21,000 B.P. by wave action from Lake Lahontan, Hidden Cave remained water-filled until about 16,000 B.P., when it was briefly exposed and rubble accumulated in it. The cave was again submerged *ca.* 15,000 and once again *ca.* 10,000 B.P. The Holocene age sediments inside the cave consist of lacustrine deposits and colluvium covered by alluvium and loess. The sediments and geological setting of Hidden Cave are discussed by Morrison (1964) and Davis (chap. 7, this volume).

EXCAVATION STRATEGY AND PROCEDURES: 1940

Although the Wheelers never prepared a final report describing their 1940 work at Hidden Cave, both the methods employed and the stratigraphy encountered can be reconstructed from their ample field notes (Wheeler, n.d.a., n.d.b., n.d.c.). On deposit at the Nevada State Museum is a complete set of artifact inventory cards, two completed cross-sections, and several photographs of the 1940 excavations inside Hidden Cave. In addition, we have consulted an undated, unpublished paper entitled "Methods of Working an Archaeological Site" (Wheeler, n.d.d.) in which Wheeler sets out his views on both the philosophy and practice of conducting archaeological fieldwork.

The Wheelers confined their excavations to the northeastern portion of the "Lower" cave (fig. 15). The major grid system was divided into lettered blocks 30 ft. on a side. Within each block, the individual 3 ft. excavation squares were numbered both east-west and north-south. Thus, in the Wheelers' nomenclature, "E/5/3" refers to the 3 ft. square located in Block E, five squares (yards)

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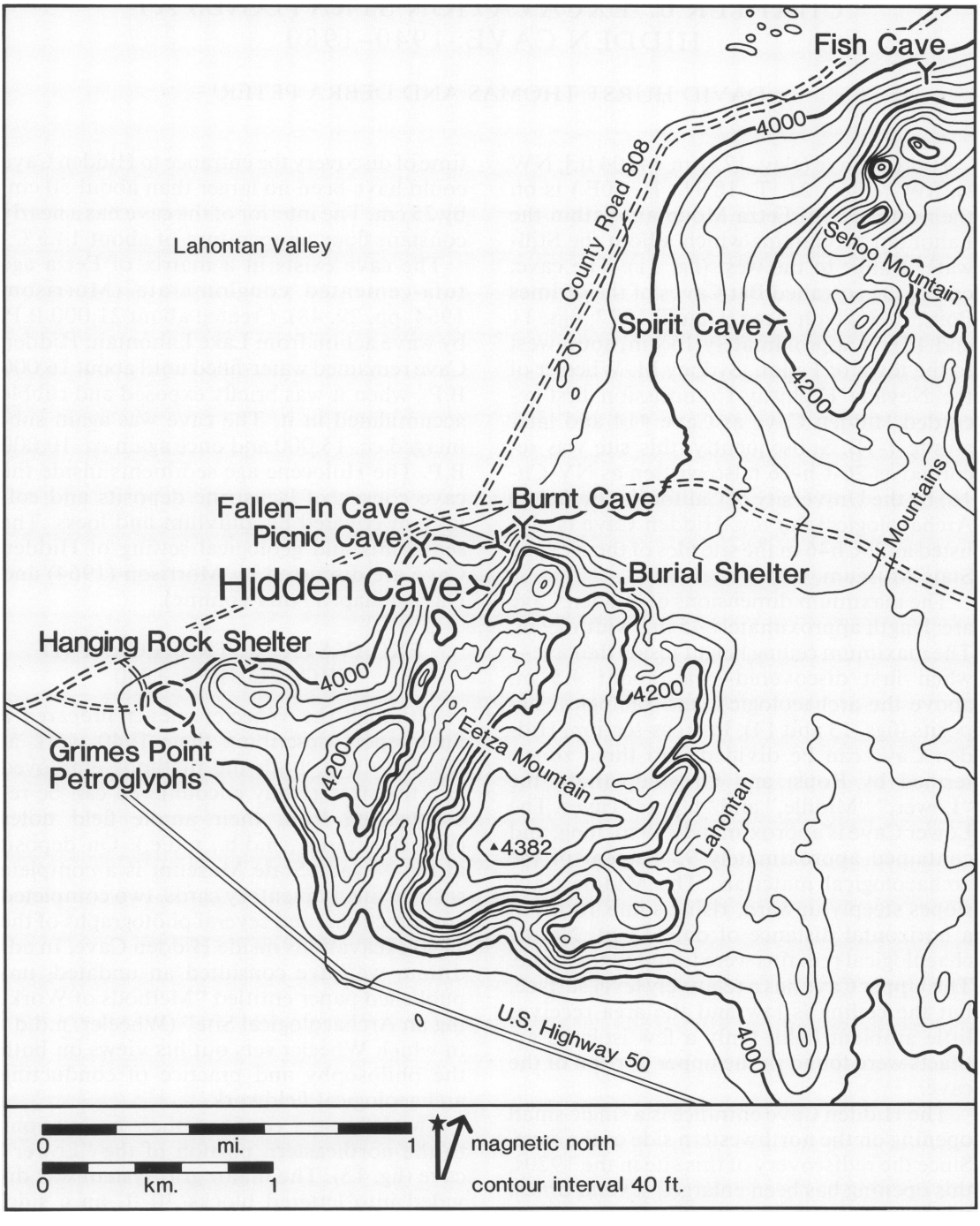

FIG. 11. Location of Hidden Cave and other key sites in Grimes Point area.

from the western margin of Block E, and three squares (yards) from the northern margin.

We estimate, based on the 1940 field maps, that the Wheelers excavated about 15 cu. m.

of Hidden Cave, primarily as a series of 3 ft. squares aligned in three parallel trenches. Dust was a major problem, and the Wheelers wore a variety of dust masks and bandanas to help them breathe inside the cave. We have no record of their lighting system, but we assume that they must have run power lines into the cave.

The specific excavation procedures seem to have followed Wheeler's general excavation strategy, apparently developed during his earlier excavation at Etna Cave (Wheeler, 1942; see also Wheeler, 1973). Elsewhere, Wheeler (n.d.d.) spelled out his approach:

> Start all trenches by cutting to the very bottom of deposit in undisturbed soil to bedrock and keep down to that level always . . . dig as much as possible from face when trenching through a deposit, rather than attacking it from the surface. This will often save objects that would be destroyed if struck blindly from above. It will also preserve the original setting of the object, which can be noted before clearing and removing anything of interest.

Judging from photographs and field notes, most of the 1940 excavation was conducted with trowel, dustpan, and brush; no shovels appear in any of the photographs. They apparently screened a good portion of the deposit.

Excavation proceeded according to natural levels, with no level being more than 6 in. thick. It is evident from their stratigraphic profile of the west side of E/8 and F/8 that they recognized six major strata inside Hidden Cave:

Stratum #1: loose guano (surface)
Stratum #2: tule, cane, guano—rotten
Stratum #3: tule, cane, grass—guano covered—well preserved
Stratum #4: tule, cane, grass, guano—matted—rotten—mouldy, some pebbles
Stratum #5: tule, cane, grass—guano covered—good condition
Stratum #6: dust, stones, few twigs, rodent channels

In a few places, Wheeler defined a "Stratum #7," consisting of a "hard clay" layer. For a detailed discussion of the 1940 stratigraphic profile, see chapter 8.

All artifacts found *in situ* were piece-plotted in three dimensions. Wheeler's "pro-

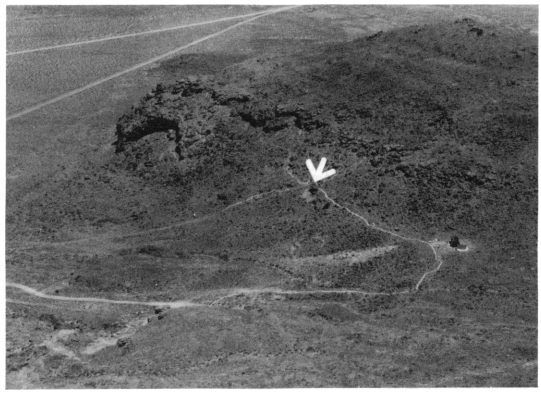

FIG. 12. Aerial photograph Hidden Cave area (courtesy James F. X. O'Connell). Arrow points to Hidden Cave entrance.

venience equation" appears on each artifact card, and provides the clues necessary to reconstruct all proveniences for the 1940 excavation. For example, an artifact might be labeled:

$$\frac{\text{E (8-11/4-7)}}{\text{(7)}}$$

This designation means that this artifact was found in Block E, 8 yards from the west and 4 yards from the north (i.e., in square E/8/4). This artifact occurred 11 in. from the west and 7 in. from the north, at a depth of 7 in. below the cave surface. Most artifacts are also plotted according to the natural strata listed above.

The Wheelers did not prepare a stratum-by-stratum analysis of the Hidden Cave materials. The closest approximation to such a synthesis appeared as a brief preface to the typed copy of the 1940 field notes (Wheeler, n.d.a.): "One thousand forty-seven specimens were collected during this partial excavation. Modern Northern Paiute material was relatively scarce and found only in a very thin layer at the bottom of the deposit. Beneath this were Basketmaker III, Basketmaker II, Pinto and Gypsum Cave artifacts. Two fossilized horse bones were found, one in a crevice in the wall of the alcove near the ceiling and the other in the Gypsum Cave level." All artifacts, catalog, field notes, photographs, and site maps are stored at the Nevada State Museum, where they were generously made available to us for duplication

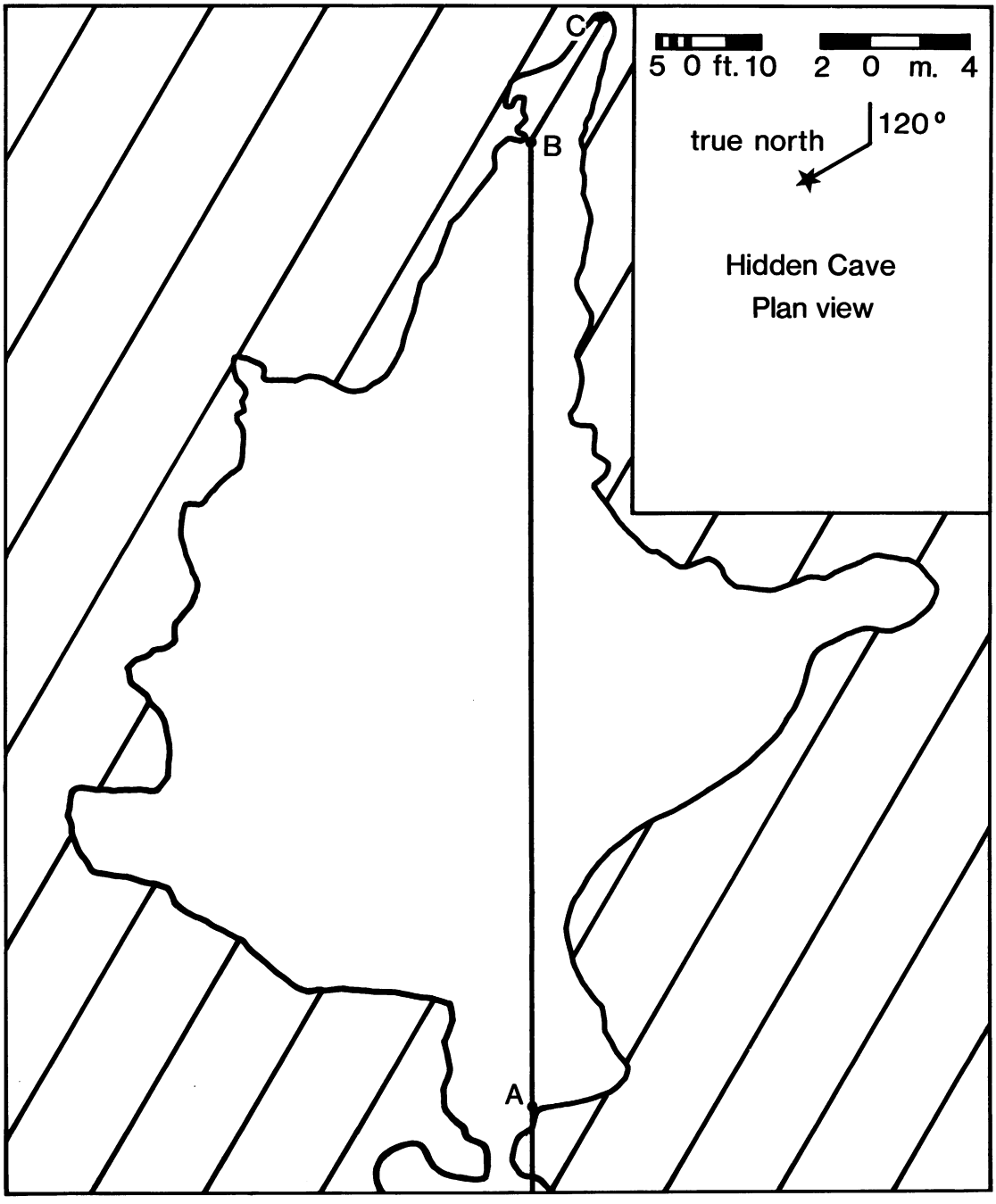

FIG. 13. Plan view of Hidden Cave. A-B-C line indicates placement of cross-section in figure 14.

and study. The major task in analyzing the 1940 collection was to correlate Wheeler's six major strata with stratigraphic units employed in the 1979–1980 excavations; the specifics of this correlation are discussed in chapter 8.

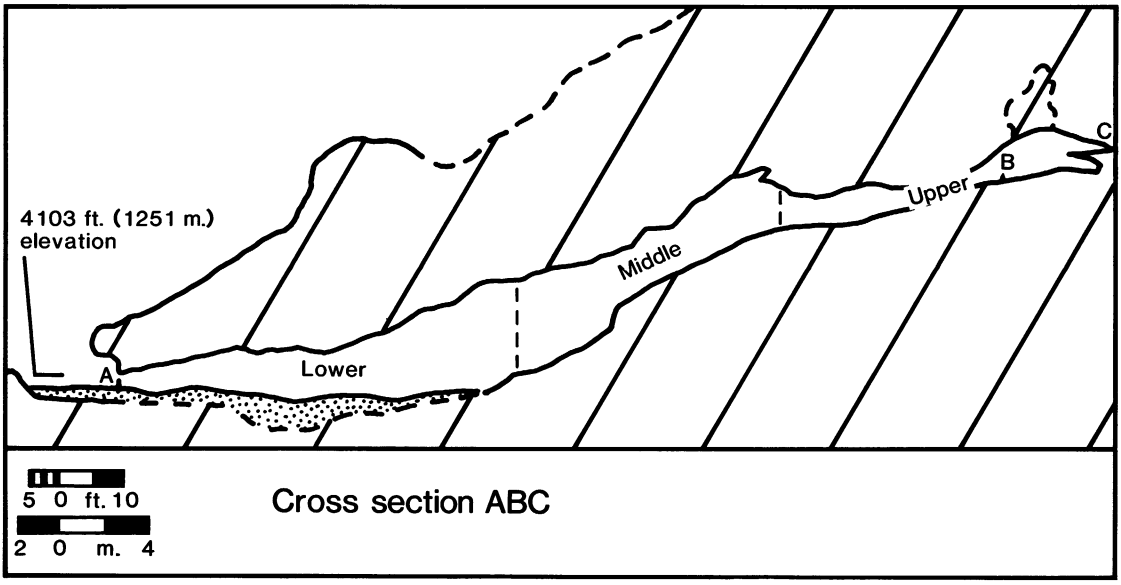

FIG. 14. Cross-section of Hidden Cave; see figure 13 for location of this section.

EXCAVATION STRATEGY AND PROCEDURES: 1951

The excavation procedures employed in 1951 have been well described in an unpublished manuscript on file at the University of California (Berkeley) Archaeological Research Facility (Roust and Grosscup, n.d.). As mentioned previously, the University of California crew subdivided Hidden Cave into "Lower," "Middle," and "Upper" portions (fig. 14). All the fieldwork in 1951 was restricted to the "Lower" part of Hidden Cave.

Datum A (also called the West Datum) was established at the cave entrance, at the level of the iron post in the gate installed by Wheeler in 1940. Another datum (termed Datum B or the East Datum) was established in what Roust and Grosscup (n.d., p. 19) termed the "bat chimney," a deep fissure in the ceiling above the "Upper" part of the cave. These two datum points were used to define the primary axis of excavation. A 5 ft. interval grid was then projected across the entire lower part of Hidden Cave. Grid squares were lettered according to north-south position and numbered by their east-west coordinates (fig. 17).

The excavators estimated that they handled the equivalent of about 60 cu. m. of Hidden Cave deposits in the 1951 excavations (Roust and Grosscup, n.d., p. 21). Their fieldwork began with a trench from the cave entrance along the primary axis toward the rear of Hidden Cave. All excavation was conducted in 6 in. levels down to the cemented gravels of the cave floor. All horizontal proveniences were recorded from the northwest grid corner, and feature locations were taken "from the surface of the pit overlying the artifacts—not from the datum plane proper." The Roust and Grosscup trenches seem to have entirely avoided the area excavated by Wheeler a decade before (figs. 18 and 19).

Little of the fill was screened (Gordon Grosscup, personal commun.); instead, the fill was examined twice inside the cave, then wheeled outside for disposal.

The extremely dusty environment and lack of adequate light plagued the University of California team. Both carbide and battery-powered lamps proved to be unsatisfactory, and an electrical generator was eventually installed. Bat guano dust posed a serious health hazard, and a succession of dust masks, air filters, and moistened cloths were tried: "none of these proved satisfactory, and until some more capable experimenters produce the answer, this problem will remain annoyingly unsolved" (Roust and Grosscup, n.d., p. 22).

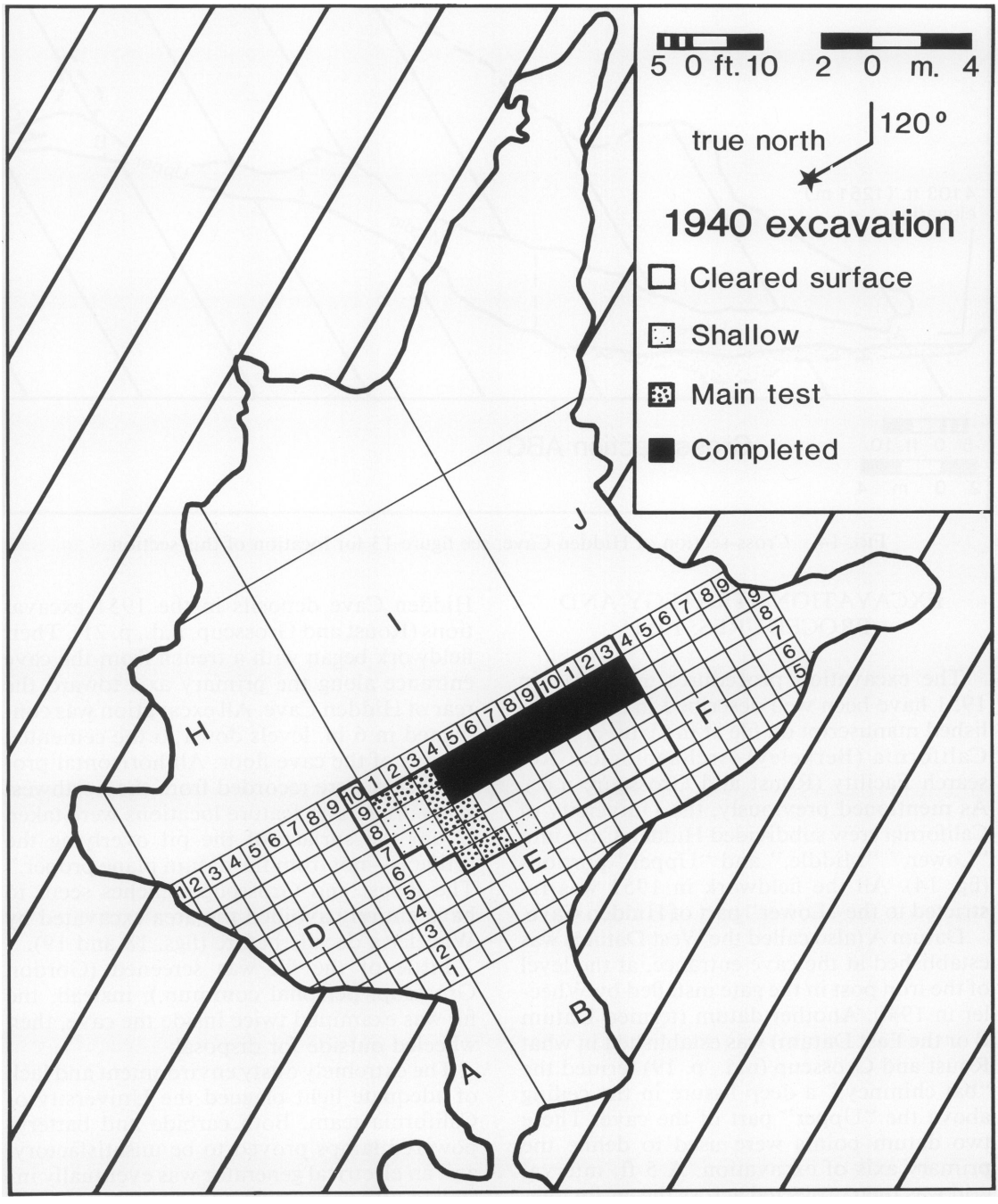

FIG. 15. Grid system established by the Wheelers in their 1940 excavations at Hidden Cave.

Through the generosity of the Lowie Museum of Anthropology, the Nevada State Museum, and Dr. Gordon Grosscup, we have been able to examine the photographs, artifacts, field notes, feature forms, and stratigraphic profiles surviving from the 1951 ex-

cavations at Hidden Cave. The Roust and Grosscup (n.d.) manuscript has proved invaluable in determining procedural details. We have, however, reanalyzed all the 1951 artifacts and ecofacts in order to standardize our descriptions across the three excavation data sets.

EXCAVATION STRATEGY AND PROCEDURES, 1979–1980

Before excavations could begin in 1979, it was necessary to remove old excavation backdirt from the front of the cave. To provide an area for screeners to work, areas for wheelbarrows to maneuver, and a place for visitors to assemble, we cleared a large staging area at the mouth of the cave. Although much of this backdirt was simply shoveled down the hill, about 2 cu. m. of fill was screened in order to provide something of a control on the recovery rates of previous excavations. As expected, these deposits contained a fair amount of bone, cordage, and organic debris, discarded during the earlier excavations. In addition, some broken artifacts—and an occasional whole specimen—were recovered from the backdirt, suggesting that the earlier lack of screening had biased, to some extent, the quantitative data from Hidden Cave. For quantitative studies, we will rely exclusively on information generated in 1979–1980, when recovery rates could be controlled and degree of loss monitored.

After this sample deposit was screened, the entire backdirt pile was covered with heavy gauge black plastic in order to separate the earlier backdirt from that generated by the 1979–1980 excavations.

With the staging area cleared, we could turn our attention to the interior of Hidden Cave proper. From the beginning, we set up an electrical generator to power a variety of lighting units inside the cave. After experimenting with a number of systems, we finally adopted a combination of fluorescent and quartz-halogen lights. Some of these (fig. 20) were installed in relatively permanent stands, while a number of the quartz-halogen units were maintained as portable units, to be used as necessary. Although considerable time was spent keeping the bank of generators operating, this lighting arrangement proved entirely satisfactory and the near-total darkness inside the cave was no longer an inhibiting factor during excavation.

FIG. 16. G. N. Wheeler excavating inside Hidden Cave in 1940 (courtesy Nevada State Museum).

Ventilation was a more serious problem. All archaeologists who had previously worked at Hidden Cave found it necessary to wear dust masks while excavating. In fact, the lack of adequate ventilation (and light) prevented a University of California (Berkeley) crew from working in Hidden Cave at all in 1971 (Napton, 1971b).

Field notes from both the Wheeler and Roust-Grosscup expeditions to Hidden Cave complained about the dust, and as these excavations had generally involved only two people working inside at a time, we anticipated that the ventilation problem would be even more extreme, given the size of the crew employed in 1979–1980.

Two major ventilation problems were anticipated from the beginning: visibility and crew safety. We were particularly concerned that the Hidden Cave deposits might contain some hazardous spore or other microorganism, so we requested Dr. Robert Myles of Reno to examine sample deposits from Hidden Cave for possible health hazards. Dr. Myles kindly agreed, and he traveled to the site to collect appropriate samples early in 1979. He reported to us that the most feared hazard—valley fever (*coccidioidomycosis*)—was absent from Hidden Cave (see Werner,

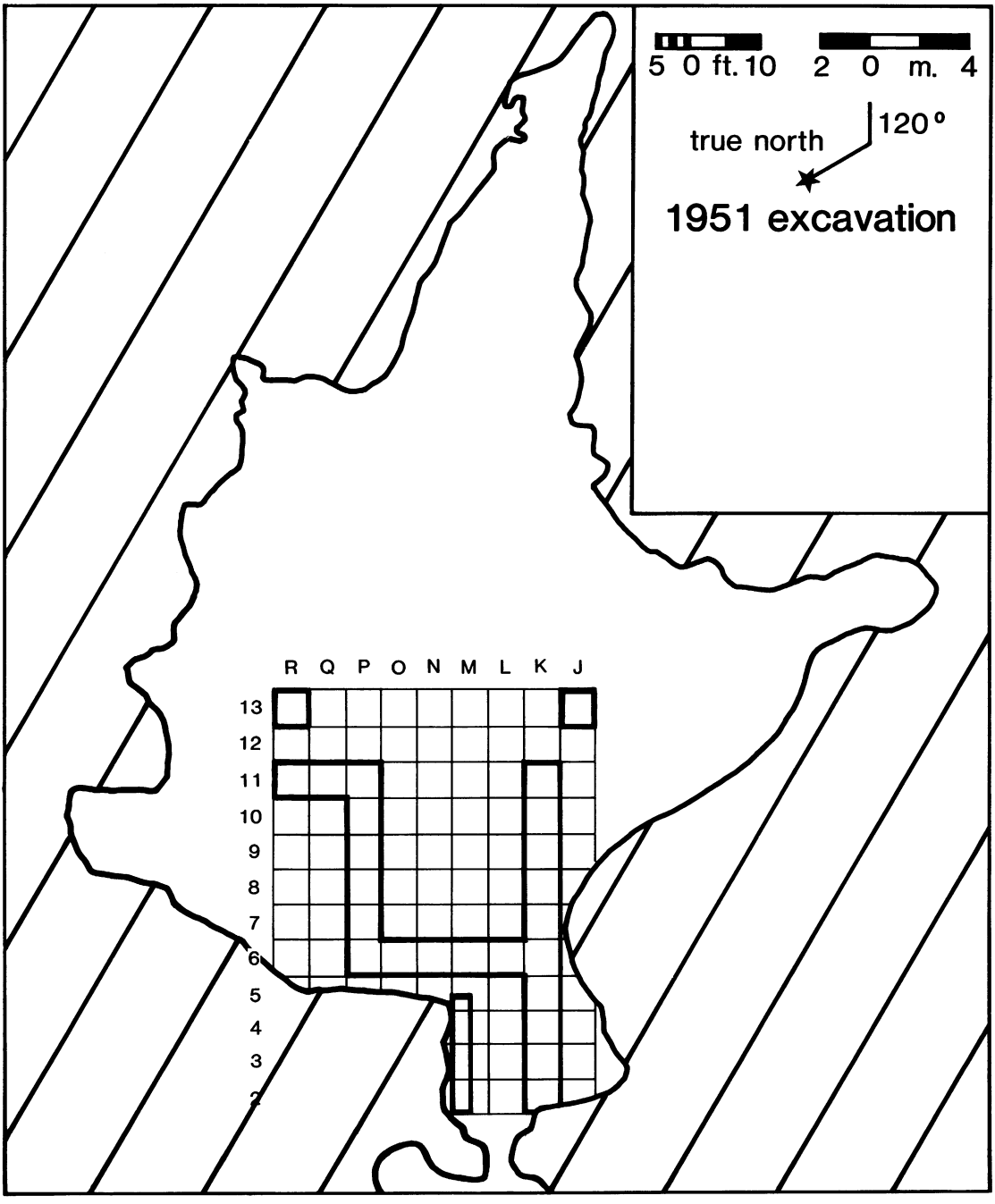

FIG. 17. Grid system employed by Norman L. Roust and Gordon L. Grosscup in their 1951 excavation of Hidden Cave.

1974, for a discussion of the problems of valley fever relative to archaeology). The greatest health hazard appeared to be the dust itself, and Dr. Myles advised us to obtain

FIG. 18. View from the back of Hidden Cave, looking toward entrance. This view was taken very early in the 1951 excavations. Note the two 5 ft. square test pits (photograph by John Black and Associates).

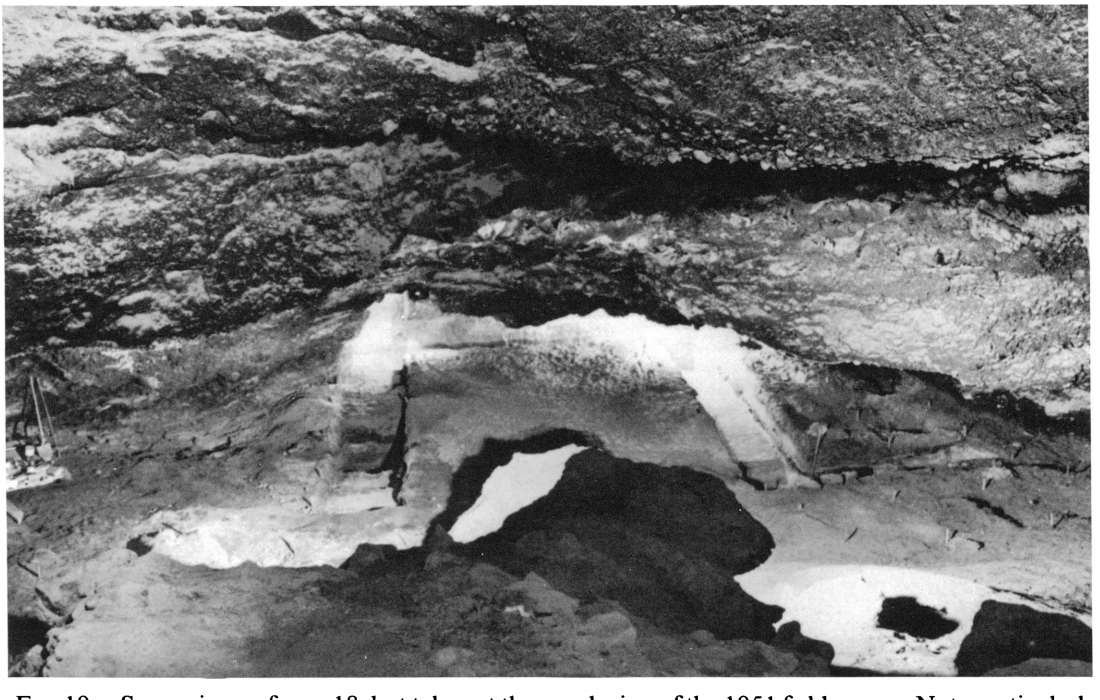

FIG. 19. Same view as figure 18, but taken at the conclusion of the 1951 field season. Note particularly completed U-shaped excavation trench (photograph by John Black and Associates).

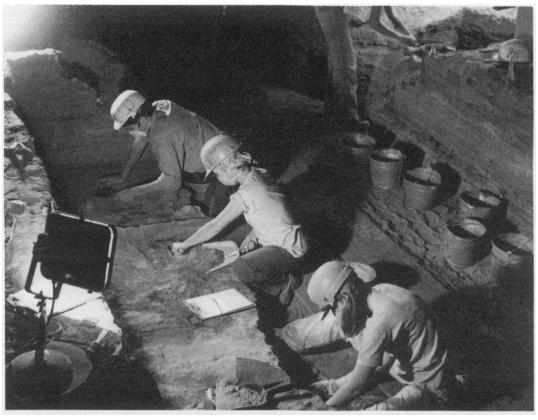

FIG. 20. General view of 1979 excavations. Note quartz-halogen lighting and use of surgical masks to minimize dust hazard.

appropriate surgical masks to guard against inhalation of dust particles. Taking his advice, we purchased a large supply of masks, and all excavators were encouraged to wear the masks when working inside the cave. As an added health precaution, Dr. Myles tested each excavator in the 1979 field program for valley fever, but no problems were encountered.

The second ventilation problem, visibility, was more difficult to overcome. The problem was simple: 30 people stir up an amazing amount of dust as they tramp about inside Hidden Cave, and once stirred, that dust hangs in suspension for hours. Something had to be done about the dust, since the excavators could not be expected to maintain proper controls if they could not see what they were doing.

We solved the dust problem in two ways. First, we installed wooden ramps along all major access routes inside the cave. Not only did these runways facilitate the movement of wheelbarrows and bucket-brigades, but—as long as they were swept clean at the end of the day's excavation—they minimized the amount of dust raised during excavation. All specialized sampling, such as that for pollen analysis, was conducted at night, well after the dust had settled.

But even ramps did not entirely solve the problem, so we installed a full-scale ventilation system inside Hidden Cave. Through the efforts of Mr. Brian Hatoff, we secured a 24 in. ventilator that would permit circulation of fresh air throughout the cave. To install the ventilator shaft, it was necessary to create a second opening into the cave, as the mouth of Hidden Cave was too small to allow for access for both the excavators and also the 24 in. blower tube. The ventilator opening was excavated in the cemented gravel matrix directly to the north of the original entrance with an electric jack hammer. All deposit removed in this operation was screened, but it was impossible for us to determine the stratigraphic relations, so the artifacts and ecofacts recovered were recorded as merely "N.C." (not correlated). This ventilator was powered by the same bank of generators used for the lighting system and proved to be entirely adequate in keeping the cave relatively dust-free during working hours. In fact, the dust was much worse for the screeners working on the lip of the cave than for those inside.

The logistics finally under control, it was possible to consider the specifics of excavation strategy and tactics. We planned to open a large, contiguous area in the relatively undisturbed portion of the cave, at the same time to create new stratigraphic profiles for mapping and sampling.

On several visits to the site prior to excavation, we observed that the Roust and Grosscup sidewalls were fairly intact, so we decided to orient our grid system to the 1951 grid (fig. 21). To do this, we selected the best-preserved of the 1951 sidewalls (the west sidewall of their trench P), and aligned our axis accordingly. But a couple of difficulties remained. For one thing, although Roust and Grosscup had excavated in 5 ft. squares, we preferred to conduct our excavations in metric units. Thus the two grid systems would only have that single sidewall in common. Secondly, Roust and Grosscup had employed the common alphanumeric method for denoting their excavation units (calling their excavation squares B11, K7, N7, and so forth). From the beginning, we had intended to reanalyze materials from the 1951 excavation, and, in order to minimize confusion of nomenclature, we decided to use a different system to name our excavation squares. Although we could have used coordinate

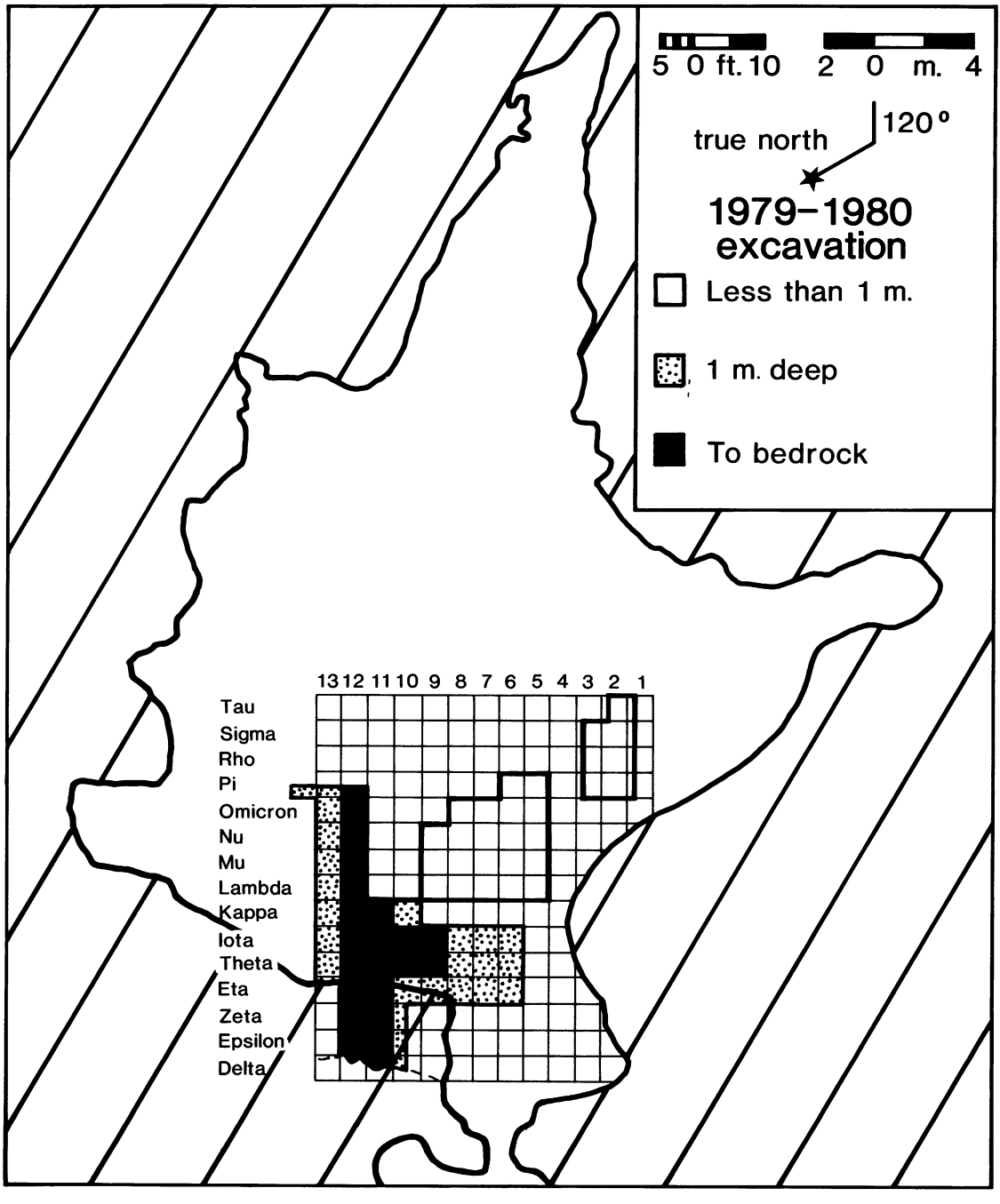

FIG. 21. Grid system employed by the American Museum of Natural History during 1979–1980 excavations at Hidden Cave.

designations (such as 100N53E), over the years we have found that excavators commonly confuse such complicated systems. The simple alphanumeric system is probably the

FIG. 22. Excavator working near rear of Hidden Cave during 1980 field season.

best, but since Roust and Grosscup had previously used numbers and letters, we decided to employ Greek letters instead.

Thus, the 1979–1980 excavation units would be designated as Kappa 8, Alpha 6, Nu 5, and so forth. As an added precaution against confusion of the two alphanumeric systems, we set our alphabetic system roughly east–west, whereas Roust and Grosscup had their letters running roughly north–south.

The master 1979–1980 datum point was established in a cement block set up in unit Sigma 6. The 1951 datum point was assigned an arbitrary elevation of 50 m., and the datum of the American Museum of Natural History was established at 60 cm. below the 1951 datum. Thus all depths in the 1979–1980 excavations were measured from an arbitrary depth of 50.60 m. All measurements were taken with a builder's level and stadia rod from this concrete datum point which was left intact after the excavation was over.

The next task was to clean out the Roust and Grosscup Trench 6 and to locate Morrison's stratigraphic section. Exposing this section was important for planning our field strategy, especially for defining the stratigraphic units of excavation. In addition, pollen samples were taken by Wigand and Mehringer from the newly exposed Morrison profile.

The actual excavation proceeded with trowel, dust pan, and brush (fig. 22); fill was placed in buckets for transport outside for screening. Excavators attempted to find all artifacts in place, and proveniences were recorded in three dimensions.

Excavation followed natural stratigraphy throughout, and all new squares were established by working off existing vertical profiles, so that the stratigraphy could be monitored from both the top and also the side. The following nomenclature was employed in the 1979–1980 excavations:

Geological unit: analytical devices determined after excavation by examination of vertical profiles; not an excavation unit.

Unit: horizontal excavation square (imposed by the master grid system).

Level: horizontal and vertical divisions within each unit. Levels comprised the actual elements of excavation, the minimum division of stratigraphy. No levels were ever deeper than 10 cm.

Stratum: analytical combination of levels into synthetic units of temporal and depositional significance.

Level forms were kept by individual excavators, and a master site notebook was kept by the site crew chiefs.

The screening area was established on a relatively level spot immediately outside the mouth of Hidden Cave. Individual sifter screens, with ⅛ in. mesh, were employed throughout the 1979–1980 excavation, and all deposit removed in stratigraphic contexts was carefully screened and sorted.

A dump sifter was also installed at the extreme southern end of the screening area. Originally constructed by Junius Bird for excavations at Gatecliff Shelter, this screening device provided a quick means of screening backdirt, slump, and other non-provenienced deposits through ½ in. mesh. All fill removed from Hidden Cave was screened by one of these methods (see also a discussion of the small-scale recovery below).

Prior to excavation of each level, soil descriptions were recorded by a crew chief who noted color (with a Munsell chart), texture, structure, consistency, and degree of disturbance (as defined in USDA, 1951). In addition, the strata and GU designations were recorded, as well as depth below datum at all four corners of each unit.

Two soil monoliths were taken by Davis to provide a permanent record of the impor-

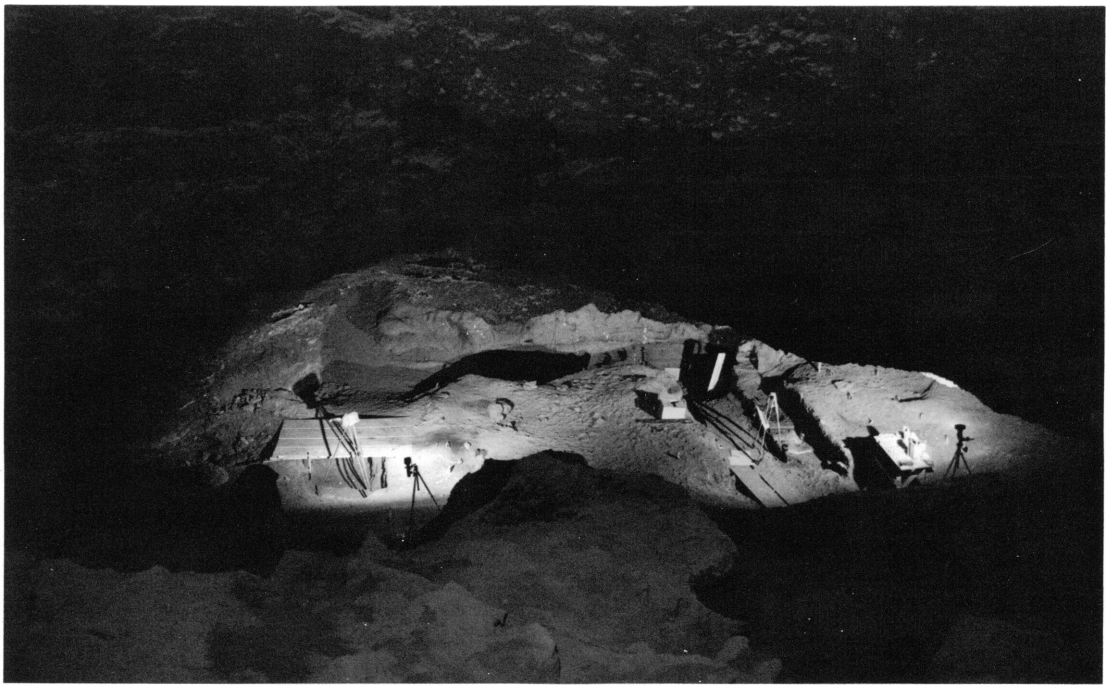

FIG. 23. Overall view of Hidden Cave excavations, taken early in 1979 season.

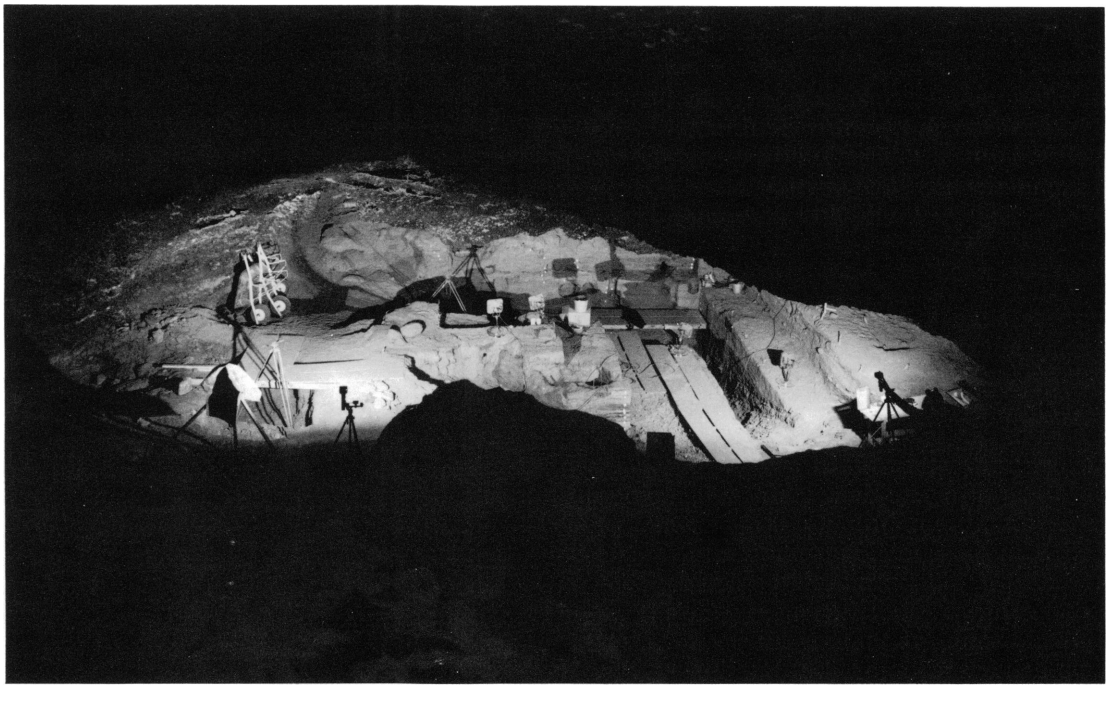

FIG. 24. Overall view of Hidden Cave excavations, taken late in 1979 season.

tant stratigraphic profiles. One monolith was located within Eta 9, to preserve the stratigraphy in Morrison's major section; the other profile in Eta 11 was placed so as to preserve the two lobes of Mazama tephra.

Stratigraphic profiles were drawn for specific sidewalls that contained features or facies contacts. Additionally, polaroid and 35 mm. photographs were taken of all sidewalls.

In the lower strata (below Stratum CV silts), soil samples were obtained for fine screening (see below). Four quarts of "constant volume samples" were taken from layers containing evidence of a bone lens or concentrations that would not last in the normal screening methods. Half of this sample was stored for future analysis, and the other half was screened with $\frac{1}{16}$ in. mesh screen.

A COMPARISON OF SMALL-SCALE RECOVERY TECHNIQUES

ERIC INGBAR[2]

A primary objective of the 1979–1980 Hidden Cave excavation was to provide adequate samples suitable for modern paleoenvironmental analysis. All provenienced fill was screened with ⅛ in. screens to maximize faunal recovery (Thomas, 1969b). But it was also desirable to determine what additional procedures would be necessary for adequate sampling of this dry deposit.

It is well known that botanical and floral remains normally escape from coarse, on-site screening operations. Although recovery of all macrobotanical and macrofaunal remains is impossible, processing of small control samples partially alleviates the bias inherent in collections made exclusively from coarse screens. Materials collected in small-scale recovery are only indications of site-wide trends and will tend to generalize the internal variability in any archaeological site. Nonetheless, inferences made possible by such collections are often of great importance and value (e.g., Struever, 1968a).

Several techniques are available for small-scale recovery of archaeological remains. In each case, the relative analytical benefits of a given technique must be weighed against the costs of applying that technique to a site. The simplest recovery technique is *dry-screening,* in which a soil sample is passed through a set of graduated geological sieves; material remaining in the sieves is then sorted by hand into whatever categories may be deemed of interest.

Dry-screening has the distinct advantage of being completely straightforward and simple. Soil can be processed at almost any location with a minimum of equipment. Unfortunately, dry-screening proceeds at glacial pace in archaeologically "rich" deposits, such as those of Hidden Cave. Dry-screening is also hard on small, fragile matter that tends to be abraded against the screens. Flower parts, leaves, small twigs, spinal processes, and poorly preserved shell tend to disintegrate because of mechanical damage during dry-screening (Peter Mehringer, personal commun.).

Flotation has been a popular method of processing soil to recover small-scale remains. The basic idea is simple: less dense materials sink at a slower rate than do more dense materials. Thus bone, shell, and plant parts settle more slowly than sand, silt, and stone. By keeping the former materials in suspension—through agitation or chemical treatment—the artifacts and ecofacts can be skimmed selectively out of solution. Two distinct portions are commonly distinguished in flotation analysis: the light fraction (that floats to the surface) and the heavy fraction (that does not float, but settles more slowly than the mineral matter). A number of devices have been designed to increase the suspension of the heavy fraction (e.g., Watson, 1976, Struever, 1968b). There is no doubt that such relatively sophisticated items can improve recovery and shorten processing time. The primary advantage of flotation is that it speeds recovery of large quantities of floating materials.

But there are problems with flotation. Large quantities of water are generally required—limiting its on-site application in arid places such as Hidden Cave—and time is required

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for the samples to dry. Charcoal and plant parts fall apart if they become waterlogged (Mehringer, personal commun.). Small materials become weighted down by soil and can sink. To get around these problems, a number of preliminary controlled runs must be done to determine the weak points of any given flotation system.

A third recovery technique is *wet-screen processing.* This technique is conducted like dry-screening, except that samples are washed through the sieve column with a gentle spray of water. This procedure is designed, in part, to minimize damage to fragile plant materials since water carries the sample through the screens rather than abrading it on the mesh. There is also a decreased chance of plant parts or charcoal rehydrating and then disintegrating since the exposure to water is shorter than in flotation.

The major drawback of wet-screening is that it requires a large number of sieve columns in which the samples can dry. An adequate supply of running water is also necessary, as is time to allow samples to dry before sorting.

To test the effectiveness of these techniques at Hidden Cave, 26 soil samples were processed by dry-screening, flotation, and a modification of standard wet-screening. The soil samples were taken as part of a routine sampling program of all unit/levels in the site. Two 1-quart milk cartons were filled from a stratigraphic column in each level. One carton was set aside for future analysis, and the other carton was processed immediately.

Each sample was split in halves or thirds (by weight) and processed by at least two recovery techniques. Material collected by the various techniques was then sorted and bagged in standard fashion, and the results were compared. The materials collected (when present) from a sample were: bone, identifiable plant parts, charcoal, fur, feathers, and micro-debitage.

This pilot study addressed three problems. The primary objective was to determine which technique was most effective (in terms of recovery) on the Hidden Cave deposits. We also tried to determine the degree of bias introduced by each processing technique. And finally we were concerned with defining which technique was most expedient.

The first question was addressed by weighing the amount of bone recovered from each partial sample. Bone weight was selected as the criterion for effectiveness because bone was present in nearly every sample, and sorters were instructed to pick up all visible bone, regardless of identifiability. Other material categories appeared only infrequently in the samples.

Degree of bias in each process was assessed by tabulating the presence/absence of all categories of material except bone. This was done to avoid misleading quantitative comparisons based upon variations created by sorter selectivity.

The time required to process and record each sample was recorded to determine the most expedient processing technique. Quantitative interpretation of this data is problematic: various sorters work at different rates, and sorters changed from day to day. Some general, if tentative, conclusions were reached, nevertheless.

The results of the study are presented in table 1. Before interpreting these data, a number of points must be made. Not all samples were split three ways because we began by comparing only the flotation and dry-screening techniques. Wet-screening was added somewhat later, at the suggestion of Peter Mehringer. After a few sample runs with all three techniques, it was clear that flotation was inferior, so only dry-screening and wet-screening were continued after that point.

The samples marked by an asterisk were collected as quarter-unit bulk samples, designed to expedite excavation in levels full of small bones. The figures for these samples are unadjusted: the samples were split into two-thirds dry-screen and one-third wet-screen fractions.

Dry-screening utilized four sieve sizes: U.S. Standard Sieve Series numbers 4 (4.75 mm.), 8 (2.38 mm.), 12 (1.88 mm.), and 16 (1.19 mm.). All samples were sorted by hand under a magnifying lens. Screeners/sorters varied from day to day.

Flotation was done in a plastic dishpan, using a kitchen colander to collect the heavy fraction of the sample and a Handi-wipe® over the colander to skim off floating matter. The collected material was dumped onto newspaper to dry. When dry, the sample was

TABLE 1
Result of Small-Scale Recovery Techniques at Hidden Cave (Weight in grams)

Sample Provenience[b]	Processing Technique[a]														
	Dry Screen					Wet Screen					Flotation				
	Bone	S	O	C	F	Bone	S	O	C	F	Bone	S	O	C	F
Iota 10, Level 5			sterile					sterile			—	—	—	—	—
Iota 12, Level 13	0.20	P	P	—	—	0.05	P	—	—	—			sterile		
Iota 12, Level 14	0.20	—	—	—	—	0.35	—	—	—	—	<0.01	—	—	—	—
Iota 12, Level 15	0.30	—	—	—	—	0.25	—	—	—	—			sterile		
Kappa 6, Level 10	0.60	P	P	—	—	—	—	—	—	—	0.80	P	P	—	—
Kappa 8, Level 6	0.30	—	P	—	—	—	—	—	—	—	0.60	—	—	—	—
Kappa 8, Level 7	0.30	—	P	—	—			sterile			—	—	—	—	—
Kappa 9, Level 6	1.90	P	P	—	—	—	—	—	—	—	0.80	P	P	—	—
Kappa 12, Level 1	none	P	P	—	—	—	—	—	—	—			sterile		
Kappa 12, Level 6			sterile			—	—	—	—	—			sterile		
Kappa 12, Level 20	0.20	P	—	—	—	0.04	—	—	—	—			sterile		
Kappa 12, Level 21	4.20	—	—	—	—	2.95	—	—	—	—			sterile		
Kappa 12, Level 22	2.90	—	—	P	—	0.90	—	—	—	—	—	—	—	—	—
Kappa 12, Level 23*	1.25	—	—	P	—	1.10	—	—	P	—	—	—	—	—	—
Kappa 12, Level 24*	3.50	—	—	—	—	1.55	—	—	—	—	—	—	—	—	—
Kappa 12, Level 25*	3.50	—	—	—	—	1.60	—	—	—	—	—	—	—	—	—
Lambda 12, Level 6	0.35	—	—	—	—	0.20	—	—	—	—			sterile		
Mu 12, Level 9			sterile			—	—	—	—	—	none	—	P	—	—
Mu 12, Level 14	<0.01	—	—	—	—			sterile					sterile		
Mu 13, Level 6	0.50	—	—	P	—	0.15	—	—	—	—	—	—	—	—	—
Mu 13, Level 7	0.70	P	—	—	—	0.58	P	—	P	—	—	—	—	—	—
Mu 13, Level 8	0.05	—	—	—	—	<0.01	—	—	—	—	—	—	—	—	—
Omicron 9, Level 6	0.12	—	—	—	—	0.10	—	—	P	—	—	—	—	—	—
Omicron 9, Level 7	0.36	—	—	—	—	0.40	—	P	—	—	—	—	—	—	—
Omicron 9, Level 8	0.90	—	—	—	—	0.60	—	—	—	—	—	—	—	—	—
Pi 9, Level 4	0.05	P	—	—	P	0.20	P	P	—	—			sterile		

[a] S = shell; O = organic (vegetative); C = charcoal; F = fur and feathers. All scored on a presence/absence basis: P = present.

[b] Samples marked by asterisk were collected as quarter-unit bulk samples (see text).

run through the dry sieve column to facilitate sorting.

Wet-screening was done with a #10 can—both ends removed to form a cylinder—covered on the bottom with fine (1.25 mm.) nylon mesh. The can was immersed a couple of centimeters below its top in a barrel of water. The sample was then poured into a coffee can, stirred very briefly to break up dry aggregates of soil, swirled a few times to drop the silt through the bottom, then dumped onto newspaper to dry.

This rather crude technique was devised because only one sieve column was available, and that was required for dry-screening. It would have been necessary to wait for each wet-screen sample to dry before processing the next one. Since around 15 samples arrived in the lab each day, this would have been unacceptably slow. The nylon mesh is almost exactly the size of a #16 sieve, and there is no reason to believe materials would be lost through the bottom of the wet-screen cylinder: the same particle sizes should be retained by both screens. After drying, the materials were sorted through the dry-sieve column, as described above.

Table 1 indicates that the weight of bone recovered by each technique varied widely within the same sample. The reasons for this are not clear, especially with regard to the difference in recovery between dry-screening and wet-screening. Since the same mesh size was used in both, the recovery should be

equal. Flotation was expected to produce better results than dry-screening, because the material would be fairly concentrated and easy to sort out. This too was not the case.

Flotation turned out to be the least effective and least reliable method of recovery. Only four out of 14 samples produced any bone at all. Excluding Levels 9 and 14 from square Mu12 (which were essentially sterile), flotation produced bone in only one-third of the samples run. In the four cases where bone was recovered, two samples produced more bone in flotation than in dry screening, and two produced less bone in flotation than in dry-screening. Significantly, the two samples in which flotation was more successful than dry-screening (Kappa 6, Level 10 and Kappa 8, Level 6) are both from the 32 Inch Midden (GU 36).

We figured that flotation would do a better job on this type of deposit than dry-screening, and this was true. Kappa 6 (Level 10) had 57 percent of the total recovered bone in the float, and Kappa 8 (Level 6) had 66 percent of the total recovered bone in the float.

Kappa 9 (Level 6), also from the 32 Inch Midden, was contrary to this trend. In this sample only 42 percent of the total recovered bone weight came from the float. Iota 12 (Level 14), from the striated silts, also had less bone recovery through flotation—less than 5 percent of the total bone recovery came from the float.

The flotation results are equivocal. Compared to dry-screening, flotation seems sometimes to work slightly better than dry recovery, but only to a small extent. Yet in other cases, flotation is much less effective than dry-screening: 10 out of 12 samples (83%) produced less bone than dry-screening.

The quantity of other material collected in flotation is also somewhat less than for dry-screening. Charcoal appears to be systematically selected out, perhaps but not certainly due to disintegration in water. Shell and organic fractions are recovered in roughly the same proportions by both techniques.

These are very poor results. The recent claims that have been made for flotation led us to expect more efficient recovery. There were, admittedly, a number of weak points in the way we applied flotation to the Hidden Cave material. First of all, the flotation system itself may have biased the results; kitchen colanders and Handi-wipes® are hardly ideal laboratory paraphernalia. Material can sometimes slip through in uncontrolled fashion, especially in the heavy fraction. Although LeBlanc advocated the simplicity of this method, he did not run controls to see how well the system actually functioned (Minnis and LeBlanc, 1976).

Another problem in our flotation set-up might be in recovery of the heavy fraction, since bone could be weighted down with silt on the bottom of the pan instead of remaining in suspension. This is also a potential equipment problem that could be evaluated experimentally.

A further source of bias is the processing of the dry flotation collection. All screeners were able to go through the samples much more rapidly after it had been floated, but the screeners changed for one portion of an individual sample to another. Thus observed differences may be due to variations in the selectivity of individual sorters. This may well be the case in the four samples in which bone was present in the float sample.

One more possibility, as yet untested, is that the nature of the deposit may dictate the success of recovery. For rich organic deposits, full of very small floating materials such as seeds, the percentage of loss in flotation may be quite small. In less rich deposits, flotation may remove a significantly greater percentage of the materials present in the soil than the actual collection made by dry-sorting. Since the proportional loss differs under the two conditions, relatively rich deposits could be over-represented and relatively poor or sparse deposits could be systematically under-represented.

Flotation appears even less effective when compared with wet-screening. In the comparative samples, flotation recovered no bone at all (despite the similarity of the two techniques). This is why flotation was abandoned as a processing technique, particularly since wet-screened materials take no longer to sort than flotation processed materials.

Flotation thus turned out to be less effective than dry-screening or wet-screening; it was the least desirable method of recovery at Hidden Cave.

In contrast, wet-screening is a relatively

TABLE 2
Percentage of Total Bone Weight Recovered by Dry-Screening and by Wet-Screening
(Sterile samples omitted.)

Sample Provenience	Dry Screen Sample Weight	Wet Screen Sample Weight
	Percent	Percent
Iota 12, Level 13	80	20
Iota 12, Level 14	36	64
Iota 12, Level 15	56	44
Kappa 8, Level 7	100	0
Kappa 12, Level 20	83	17
Kappa 12, Level 21	59	41
Kappa 12, Level 22	76	24
Kappa 12, Level 23[a]	69	31
Kappa 12, Level 24[a]	82	18
Kappa 12, Level 25[a]	81	19
Lambda 12, Level 6	64	36
Mu 13, Level 6	77	23
Mu 13, Level 7	55	45
Mu 13, Level 8	(80)[b]	(20)[b]
Omicron 9, Level 6	55	45
Omicron 9, Level 7	47	53
Omicron 9, Level 8	60	40
Pi 9, Level 4	20	80

[a] Figures adjusted from ⅔ wet, ⅓ dry screening ratio to reflect ½ wet, ½ dry.

[b] Approximation—wet recovered material too small to weigh.

good technique, although still less effective than dry-screening. Wet-screening produced more bone than dry-screening in only three out of 18 runs (17%); sterile layers and samples with bone weights in significant figures are omitted from the following discussion.

If we acknowledge the somewhat spotty consistency of the data and reduce the variables to interval level measurements of 0.05 gram categories, then a number of samples are actually equal. This 0.05 gram buffer zone would seem to allow for both screener variability and vagaries of measuring very small amounts of bone on a triple-beam balance. In this perspective, Iota 12 (Level 15), Mu 13 (Level 8), Omicron 9 (Level 6) and Omicron 9 (Level 7) contain essentially equivalent amounts of bone in the recovery by the two processes.

If one adds in the two samples in which recovery was better than in dry-screening, the percentage of samples in which wet-screening was better than, or equal to, dry-screening is inflated to 33 percent. Although wet-screening is still not as effective as dry-screening, the 33 percent differential probably represents more accurately the failure of the wet-screening technique.

Another way to view this difference is to examine the contribution of each technique to total bone weight per sample (table 2). Table 2 cannot be used without table 1, however, because the percentage breakdowns tend to mask some very small differences in absolute bone weight recovered by the two techniques. This adds to the above six "equivalent or better than" dry-screen samples an additional wet-screen sample which was fairly close to its dry-screen counterpart, Mu 13 (Level 7). The total percent of samples in which wet screen recovery was the same or greater than that in dry-screening is then raised to 39 percent.

Since recovery of shell, charcoal, and organic matter appears to be about equal in both sets of data, one might conclude that recovery for both screening techniques is fairly consistent. But comparing presence/absence categories between the two techniques is misleading since dry-screen samples often yield charcoal, whereas their wet-screen counterparts do not. Although these results might suggest systematic destruction of charcoal, a more likely possibility, given the small absolute amounts involved, would seem to be variability among various screeners.

Keep in mind that wet-screening is considerably faster than dry screening, and that wet-screen sorting goes much more quickly because the fine dirt particles have been removed. Most screeners can sort through a wet-screened sample in half the time it takes to sort the counterpart dry-screened sample.

If the problems in wet-screening recovery rates could be isolated and hence avoided—bringing wet-screen recovery rates up to those of dry-screening—wet-screening would be the most practical technique of processing soil samples.

In summary, the study has demonstrated very different recovery rates in the three techniques of processing Hidden Cave soil samples. Dry-screening is the most effective method of recovery; wet-screening is some-

what less effective, and flotation runs a distant third. But these results are not conclusive because too many processing variables are left uncontrolled: screener selectivity, quick-and-dirty techniques of wet-screening and flotation, plus the possible destruction of materials due to the techniques themselves.

We suggest that more satisfactory field equipment and more thorough training of sorters would be important prerequisites which would facilitate future studies of differential recovery rates. Problems of differential destruction should also be examined, as should absolute rates of recovery. There is also some indication in these data—especially for flotation—that different types of deposits should be processed in different fashions. But this level of resolution can be contemplated only after the problems in recovery rates are understood. Given all these difficulties, we conclude that dry-screening is the most effective and reliable method for the Hidden Cave deposits.

CHAPTER 7. SEDIMENTS AND GEOLOGICAL SETTING OF HIDDEN CAVE

JONATHAN O. DAVIS[1]

Geological investigation of Hidden Cave began with Roger Morrison's investigation of the site.[2] Morrison (1964) described the late Quaternary stratigraphy of the Fallon area in a monograph which remains the basic stratigraphic reference for the area. This sequence, defined in the 1964 monograph and amplified in other works (for instance, Morrison and Frye, 1965) is summarized in table 3. Morrison's major work in the Fallon area was before the advent of radiocarbon dating, so that the estimates of absolute age in the discussion which follow are derived from later work (Benson, 1978; Davis, 1978).

PREVIOUS RESEARCH

The Fallon Area

The Fallon Formation is the most recent sediment, and is still being deposited. Morrison recognized evidence that shallow lakes had existed during the late Holocene (last 4000 years) at least five times, but that none of these lakes had risen above 1203 m. The sand dunes in the Fallon area, and much of the cultural sediment in Hidden Cave, are of the Fallon Formation. Very weak soil profiles, such as the L-Drain Soil, formed during intervals of low water. Volcanic ash in dunes and alluvium of the Fallon Formation is from Mono Craters (Davis, 1978).

The Toyeh Soil formed during the period from about 5100 to 4200 B.P. (Davis, 1983); it is so weakly horizonated as to be difficult to identify, but typically exhibits carbonate accumulation and sometimes has a faint B horizon. The Toyeh Soil cannot be identified within Hidden Cave because the cave protects its sediments from the weathering environment which creates soil profiles.

The Turupah Formation accumulated from *ca.* 7000 until 5100 B.P.; it comprises sand and alluvium deposited during a period of generally low water in the basin. In Hidden Cave, volcanic ash layers in the base of the Turupah Formation are from the Mt. Mazama eruption, about 7000 B.P. (Davis, 1978).

The Sehoo Formation was deposited by the waters of Lake Lahontan, and the Indian Lakes Formation represents coeval sediment deposited above the lake. Morrison recognized several members of the Sehoo and Indian lakes; however, his interpretation of the events which led to their deposition has been changed by the results of Benson (1978) and Davis (1978), so that the summary which follows does not closely follow Morrison.

During early Sehoo time (prior to about 21,000 B.P.) little is known of Lake Lahontan; dates reported by Valastro, Davis, and Varela (1978) and tephrostratigraphic relations (Davis, 1978) show that the lake lay below 1260 m. until about 21,000 B.P., but that considerable water existed by at least 35,000 B.P. The bulk of the clay described by Morrison as the Lower Member of the Sehoo Formation was deposited in a lake which lay below 1260 m. Lake Lahontan then rose to about 1300 m., but receded to perhaps 1220 m. at about 15,000 B.P., and then rose to 1335 m. at about 13,000 B.P. Lahontan then fell rapidly, although the details of this recession are not clear, and the lake may have oscillated up and down several times. A very late Pleistocene stand occurred at about 1220 m., creating Morrison's Upper Sehoo shoreline, but by 7000 B.P., when the Mazama ash fell, Lahontan was essentially dry. This interpretation of Sehoo time differs from that of Morrison because it portrays the Lower Member of the Sehoo Formation as deposited in a fairly shallow lake, whereas Morrison thought the Lower Member was depos-

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[2] Editor's Note: An extraordinary set of regrettable circumstances prevented Davis from participating in manuscript revision and finalization. Consequently, Davis has reviewed neither galley proofs nor final artwork. This chapter is an unrevised draft prepared by the author in 1981. We caution the reader to keep the preliminary nature of these findings in mind.

TABLE 3
Late Quaternary Stratigraphic Units of Fallon, Nevada Area

Formation	Member		Lithology, Environment
Fallon	Upper		Sand dunes, alluvium, shallow lacustrine sediment, 3 lake episodes with intervening desiccation.
Fallon	Lower		Sand dunes, shallow lacustrine sediment, tufa, 2 lake episodes with maximum shore elevation at 1203 m.
Toyeh Soil			Carbonate accumulation, sometimes faint reddish color; desiccation of basin.
Turupah			Eolian sand, loess, minor alluvium; desiccation of basin.
(Holocene)			
(Pleistocene)			
Sehoo	Upper		Lacustrine sediment up to 1220 m.
Indian Lakes	Upper		Subaerial sediment from recession of Lake Lahontan.
Sehoo	Dendritic		Lacustrine sediment, tufa, up to 1300 m.
Indian Lakes	Middle		Subaerial sediment from lake recession.
Sehoo	Lower		Lacustrine sediment, tufa, up to 1332 m.
Indian Lakes	Lower	(Wisconsin)	Subaerial sediment above Churchill Soil.
Churchill Soil		(Sangamon)	Carbonate accumulation, reddish color, clay skins, B horizon 50 cm., thick; desiccation of basin and weathering.
Wyemaha		(Sangamon)	Sand dunes, alluvium, deposited during dry episode.
Eetza/S Bar S		(Illinoisan)	Eetza is lacustrine sediment, S Bar S is subaerial, analogous to Sehoo and Indian Lakes. During first major high stand of Lake Lahontan.
		(Illinoisan)	
Cocoon Soil		(Yarmouthian)	B horizon at 3 m. thick; desiccation and weathering of basin.
Paiute			Alluvium, subaerial.

ited when the lake stood at 1335 m. However, Morrison's stratigraphic units at Hidden Cave remain valid descriptive devices, regardless of their interpretation.

The Churchill Soil and the Wyemaha Formation are the results of an interpluvial period which probably correlates with the Sangamon Interglacial of the midwest; Lake Lahontan was essentially dry for at least several thousand years, and weathering occurred. The Eetza and S Bar S Formations were deposited by the first high stand of Lake Lahontan and are, respectively, the lacustrine and subaerial deposits of that time. Eetza deposits are thicker than the Sehoo, and Eetza shoreline features are larger and more pronounced, so that Eetza time is thought to have been longer and stormier than Sehoo time. Beneath the Eetza and S Bar S Formations is the Cocoon Soil which has formed by weathering of the Paiute Formation. The Paiute Formation and Cocoon Soil are the products of an interpluvial period, perhaps correlative with the Yarmouth Interglacial of the midwest.

Hidden Cave

Table 4 reproduces Morrison's (1964) description of the sediments of Hidden Cave. Hidden Cave was an especially important stratigraphic section for Morrison because it included sediments of the Sehoo/Indian lakes and the entire Holocene in simple stratigraphic superposition. Morrison recognized that the cave had been excavated out of Eetza age tufa-cemented conglomerate by waves of the Sehoo Lake as it rose at the beginning of Sehoo time, and that the sediments in the cave represented deposits of Lake Lahontan, colluvium, and later alluvium and loess.

The earliest sediment described by Mor-

TABLE 4
Morrison's Measured Section at Hidden Cave[a]

SECTION 39

Floor of Hidden Cave, on north side of Eetza Mountain, SW¼ sec. 21, T. 18 N. R. 30 E. Stratigraphic section exposed in west wall of pit N6 dug in 1951 by California University and U.S. Geol. Survey archaeologic field party (Grosscup, 1956). Top of section, altitude 4103 feet.

	Thickness (feet)	Depth (feet)
Fallon formation:		
Upper member equivalent:		
1. Silt, some very fine and fine sand; light-gray. Eolian; sparse pebble-size angular fragments of red basalt and tufa, probably roof fragments; well-bedded, beds thin and parallel; somewhat coherent, tends to form soft blocky fragments; thickness somewhat variable, due to deposition over irregular surface sloping slightly toward interior of cave; top surface originally was almost level	0.7	0.7
Second lake unit equivalent:		
2. "Top midden." Rat and bat guano, with abundant *Typhetum* (cattail) leaves, some clam shells, a few feathers, and Lovelock (cultural) Phase, of Heizer (1951) artifacts and occupation debris. Over 85 percent of artifacts recovered from the cave in 1951 came from this bed	0.3 ± 0.15	1.0±
First interlake unit equivalent:		
3. Silt and fine sand, poorly sorted, with many angular rock fragments; probably slope wash. Local guano parting, 0.1 to 0.5 in. thick, about 7 in. below top. Rather constant sandy silt (eolian?) layer about 0.2 ft. thick in middle of unit, with dark-brown staining and local midden parting at top. Sparse artifacts, of Lovelock phase	0.7 ± 0.2	1.7±
4. Silt and fine sand, well-bedded, bedding thin and parallel. Probably eolian	0.2±	1.9±
First lake unit equivalent:		
5. "32-inch midden." One or more midden layers, interstratified with silt and fine sand (eolian?) and with rocky silt (slope wash) layers. Continuous midden 0.2 ± 0.15 ft. thick at top; several discontinuous local midden partings below. Midden consists of rotted bat guano, plant matter (tule, cane, and cattail); has numerous artifacts of the Lovelock Phase of Heizer (1951)	1.1±	3.0±
Turupah formation:		
6. Silt and fine sand, pale-gray, evenly and horizontally bedded (loess), with local lenticular layers of gravelly silt (slope wash); latter increase in proportion toward cave portal; ¾-in. discontinuous midden parting in middle. Unit thickens to more than 3 ft. in east wall of pit and there contains a white pumiceous ash parting, ¼ to ½ in. thick, several inches above base. Two obsidian points obtained from upper part of unit	1.7±	4.7±
Indian Lakes formation (late Sehoo correlative):		
7. Gravel, coarse to fine, poorly sorted, much interstitial sand and silt, many blocks and boulders, some 1.5 ft. in diameter. Slope wash. Thickens to more than 1 ft. in east wall of pit. Local discontinuous rotted guano partings. Many bones of small mammals and birds. Four projectile points assigned to the Hidden Cave (cultural) Phase by Grosscup (1956)	0.9±	5.6±
Sehoo formation:		
Dendritic member (regressive phase):		
8. Gravel, very fine pebble. Lacustrine. Well sorted (little interstitial sand or silt), uncemented. Thickens to about ½ ft. at east wall of pit, and here is underlain by 0.6 ft. of lake sand. Barren of artifacts	0.1	5.7±

TABLE 4—(*Continued*)

	Thickness (feet)	Depth (feet)
Dendritic member:		
9. At top, half a foot of massive lacustrine limestone, white; smooth upper surface, dips about 15° E, flattening to less than 5° at east wall of pit. Well-bedded, strata about 1 in. thick, thinning eastward; many fish bones. In lower several inches thinly bedded brown lake clay alternates with partings of white, soft, lacustrine limestone; this part becomes increasingly clayey eastward. Barren of artifacts	0.9	6.6±
Indian Lakes formation:		
Middle tongue:		
10. Gravel, coarse, very poorly sorted, containing angular blocks and boulders as much as 18 in. but mostly less than 6 in. diameter, with some interstitial sand and silt; slightly cemented with calcium carbonate. Slope wash. Barren of artifacts. Yielded a block of cellular tufa (of the lower member of the Sehoo). Thins rapidly eastward to 0–0.1 ft. thick at east wall of pit	1.7	8.3±
Sehoo formation:		
Lower member (regressive phase):		
11. Lake sand, pebbly, clean, uncemented; no artifacts	0.1	8.4±
Lower member (high-level phase):		
12. Lake clay, silt and silty fine sand. Top third is faintly laminated brown clay; middle third is brown silt; lower third, brown silty fine sand. Clay is slightly gypsiferous. Nearly uniform in thickness over pit floor, but dips several degrees westward. Upper surface broken by deep gaping cracks, probably desiccation cracks, and these are filled by gravelly sand from bed 11. A bird bone found in one of the cracks	1.3	9.7±
Lower member (transgressive phase):		
13. Lake gravel, pebble and cobble. Roundstones locally derived, mainly of red volcanic breccia and black andesite similar to that in walls of Hidden Cave and exposed in slopes above the cave. Uncemented.	1+	10.7±
Base not exposed		

[a] From Morrison, 1964, pp. 134–135.

rison (unit 13) is cobble to pebble gravel, which he believed was deposited by Lake Lahontan as it rose at the beginning of Sehoo time. This was overlain by 40 cm. of fine sand grading upward to clay (unit 12) attributed to deep water during the deposition of the Lower Member of the Sehoo. Unit 12 was overlain by a thin (3 cm.) layer of pebbly sand (unit 11) which intruded unit 12 down desiccation cracks in the clay. Units 11, 12, and 13 were assigned to the Lower Member of the Sehoo Formation as a transgressive-regressive sequence.

The lower sediments were overlain in turn by a lens of poorly sorted gravel, including boulders (unit 10), which thinned to the east (toward the back of the cave) and were slightly cemented by calcium carbonate. Morrison assigned this to the Middle Tongue of the Indian Lakes Formation, deposited subaerially during a brief low stand of Lake Lahontan during Sehoo time. Hidden Cave is the type locality of the Middle Tongue of the Indian Lakes Formation, and Morrison (1964, p. 68) believed it to be colluvium in the cave. Fossils recovered from unit 10 include *Marmota flaviventer, Neotoma* sp., *Lepus* sp., and *Sylvilagus* sp. (1964, p. 73), each of which still live in the area, as well as an unidentified bird.[3]

[3] Editor's Note: The fauna of Hidden Cave is discussed by Grayson, Mead, and Smith (chaps. 10–12, this volume).

The Middle Tongue of the Indian Lakes Formation was overlain by unit 9, which comprised thinly bedded brown clay at the base, overlain by 15 cm. of oolitic tufa. This tufa "diaphragm" was radiocarbon dated by Broecker and Orr (1958, p. 1017) at 15,130 ± 400 B.P. Overlying the tufa was 3 cm. of very well-sorted gravel (unit 8). Morrison included units 8 and 9 in the Dendritic Member of the Sehoo Formation, inferring that Lake Lahontan had risen once again and drowned the cave, depositing the clay and tufa while the water surface was above the cave and the gravel during regression.

Colluvial gravel (unit 7) of the Upper Tongue of the Indian Lakes Formation overlay unit 8, the two gravels being distinguished from one another by the much poorer sorting of unit 7. This layer was a lens which extended only a few feet into the cave and was deposited by slope wash (Morrison, 1964, p. 71). This gravel yielded a rich mammal and bird fauna. Although four projectile points had been attributed previously to this stratum (Roust and Clewlow, 1968) it now seems likely that these artifacts, in fact, were from higher in the stratigraphic section (see chap. 26).

Overlying the gravel of the Upper Tongue of the Indian Lakes Formation were finely layered silt and fine sand about 1.5 m. thick. Morrison assigned the lower 50 cm. of this sediment to the Turupah Formation, calling it loess. Within the base of the Turupah Formation was a layer of white tephra 6 to 18 mm. thick. Davis (1978) described this tephra and correlated it with the Tsoyawata Bed of the Mazama Member, about 7000 years old.

The remainder of the layered silt and fine sand (the "striated silts") was assigned to the Fallon Formation, as were the layers of organic debris and churned silt interbedded with the layered silt. Morrison attributed the layers of organic debris (the "middens") to episodes during which low lakes existed in the Carson Sink, and the layered silt to nonlake intervals. Davis (1978) described a tephra layer from the upper portion of the Fallon Formation (not included in Morrison's description) as a correlative of the Turupah Flat Bed from Mono-Inyo Craters. The best estimate of the age of this bed is about 1500 B.P. (Bell, personal commun.; Valastro, personal commun.). Almost all the artifacts found in Hidden Cave have been recovered from the Fallon Formation.

Summary

Previous geological work in Hidden Cave by Morrison, Broecker and Orr, and Davis has produced a portrayal of the stratigraphic section shown in table 4 and in figure 25. According to this, the basal deposits are gravels and finer sediments, including tufa, which reflect the repeated rise and fall of Lake Lahontan during the Sehoo (Wisconsin) interval. A radiocarbon date from tufa is 15,130 ± 400 B.P. No artifacts have been recovered from these basal sediments, but the Upper Tongue of the Indian Lakes Formation has yielded perhaps the best dated and most varied vertebrate fauna in the Lahontan area.

Overlying the basal gravels and lacustrine sediments are about 1.5 m. of layered silt and fine sand with interlayered "middens." In the base of the silt is tephra of the Mazama eruptions (6900 B.P.), and near the top of the silt is tephra of the Turupah Flat Bed (1500 B.P.?). The Top Midden and the 32 Inch Midden lie between the tephra layers. The silt and middens have been attributed to eolian and human deposition, for the most part.

1979–1980 RESEARCH OBJECTIVES AT HIDDEN CAVE

With the comparatively complete geological description of Hidden Cave in existence, the questions investigated during 1979 and 1980 were more detailed, and perhaps better directed, than is usual in an archaeological site. These involved questions of physical relations of the previously described strata, now much better exposed by two additional field seasons of excavation, and questions of interpretation and dating of the deposits. Several specific questions can be phrased:

1. Morrison's interpretation of depositional environment for some of the sediments was re-examined. The layered silt and fine sand of the Turupah and Fallon formations are now thought to be alluvial, rather than eolian in origin. However, the poorly sorted gravel of the Indian Lakes Formation still seems to be derived from colluvial processes

as Morrison suggested. The remainder of Morrison's interpretations seem reasonable and were not subjected to intense scrutiny.

2. Davis's conclusions regarding tephrochronology were based on only two specimens which had already been removed from stratigraphic context. The tephra layers were examined in the new excavations, and reanalyzed. It was discovered that the Mazama Bed overlies the Tsoyawata Bed in the base of the Turupah Formation, and that the base of the Turupah Formation is to some extent time-transgressive, for the tephra layers extend from the Turupah Formation into the Upper Tongue of the Indian Lakes Formation. The Turupah Flat Bed of tephra was so contaminated with clastic sediment that further petrographic analysis was not fruitful.

3. The new excavations required that the earlier geologic framework be extended to in-

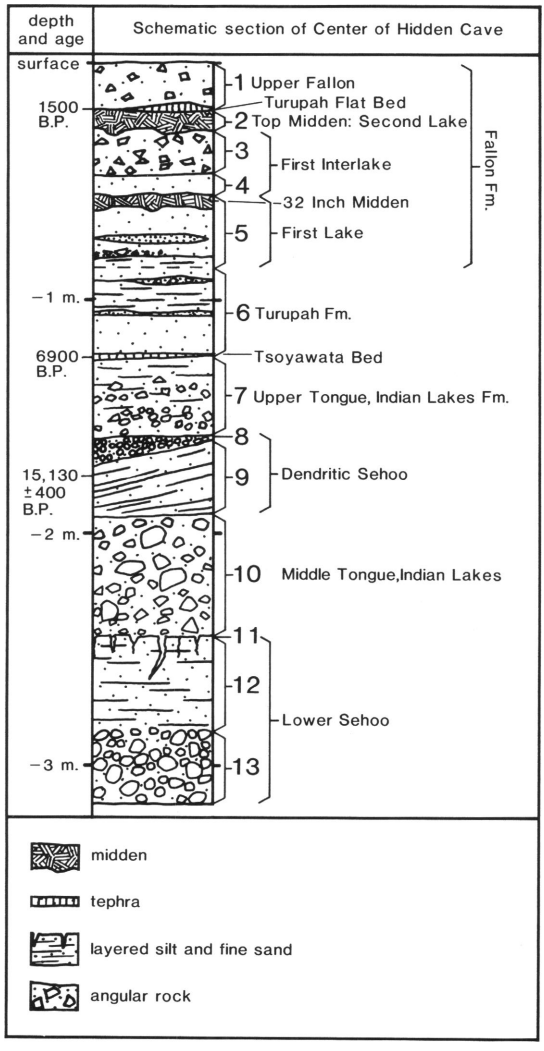

FIG. 25. Schematic section of Center of Hidden Cave (after Morrison, 1964; Davis, 1978).

TABLE 5
Stratigraphic Nomenclature Used During 1980 Field Season

1980 Stratum	Morrison Unit
I, XVII	1. Upper Fallon
II	2. Top Midden: Second Fallon Lake
III, XVIII, XX	3. and 4. First interlake
IV	5. In part; 32 Inch Midden
V, XIX	5. In part and 6 in part; from the bottom of the 32 Inch Midden to the Mazama Ash
BXVI VI	6. In part; the Mazama Bed, Tsoyawata Bed, and any sediment between them
VII	6. In part; striated silt between Mazama member and topmost rubble
VIII	7. In part; interbedded silt and rubble
BXV	7. In part; reddish bone hash between rubble and silt in back of cave
IX	7. Rubble
X	8. Clean pebble gravel, Dendritic Sehoo
XVI	Not in Morrison's section: 0 to 30 cm. of rubble and organic material between clean pebble gravel and oolitic tufa in back of cave
XI	9. Dendritic Sehoo: oolitic tufa
XII	10. and 11. Gravel and sand, Middle tongue of Indian Lakes
XIII	12. Graded bed from sand to clay, deeply fractured
XIV	13. Reddish gravel, bottom not observed

TABLE 6
Geological Units in Hidden Cave (Center Facies)

Geological Unit	1980 Strata	Morrison Nomenclature
45–51	CI	1. Upper Fallon
43, 44	CII (Top Midden)	2. Second Fallon Lake
38–42	CIII	3. and 4. First Fallon Interlake
35–37	CIV (32 Inch Midden)	Part of 5.
29–34	CV in part	Remainder of 5.
15, 20–28[a]	Remainder of CV	Top of 6., Turupah
14	CVI, Tsoyawata Bed	Within 6.
12, 13	CVII	Remainder of 6., lower Turupah
52–58	CIX, CX	7. and 8. Indian Lakes and Sehoo
9–11	XI, oolitic tufa	9. Dendritic Sehoo
2–8	XII, XIII, clay and gravel	10., 11. and 12. Sehoo and Indian Lakes
1	XIV, reddish gravel	13. Sehoo

[a] No samples 16, 17, 18, or 19 were collected.

clude the materials recovered, and that new strata encountered be described and named. Whereas, the stratigraphic column set up by Morrison was very useful in general, some new layers beneath the Turupah Formation were discovered, and thinner layers were recognized within the Turupah and Fallon formations to aid in archaeological provenience.

NEW EVIDENCE

Stratigraphic Units

The excavations made during the 1979–1980 investigation were much more extensive than those previously dug, and certain stratigraphic relations were exposed which had not been observed earlier. Also, various units (notably 6 and 7) interfinger, so that they cannot be used unambiguously during archaeological excavation. Therefore, a new set of stratigraphic units was devised during 1980 for use in excavation and interpretation of the sediments of Hidden Cave. The basic vertical sequence is presented in table 5. The new units are designated by Roman numerals, which are not entirely consistent in vertical sequence, due to the recognition of additional units after the first 15 had been designated. In addition to the vertical sequence of units shown in table 5, three facies assemblages were recognized in the cave: the Entrance, the Center, and the Back. Some stratigraphic units occur in only one or two of the facies assemblages, whereas the others are present with somewhat different characteristics.

Geological Units (GUs)

In order to sample meaningfully the sediments in Hidden Cave for pollen and granulometry, it was necessary to designate thinner layers than either of those used by Morrison, or by the excavators. These layers are called Geological Units, or "GUs," and they were established in the Center facies assemblage, where the Holocene sediments are thickest and most easily subdivided. There were 54 GUs recognized at the outset of work in 1979, and these are shown in table 6. Each GU was one or more depositional units, that is, the product of one or a few episodes of deposition, with well-defined boundaries. Because the silts of I, III, V, VI, and VII comprise a series of lenses, several additional GUs were defined during excavation; however, these were not analyzed for pollen and so they need not be discussed here.

Facies Assemblages

Except during lacustrine episodes which flooded the cave, deposition in Hidden Cave has been dominated by three sources: creep and slopewash from the back slope of the cave, the deposition of a cone of debris sloping from the entrance into the interior of the cave, and accumulation of alluvium in the central portion of the cave. Accordingly, the

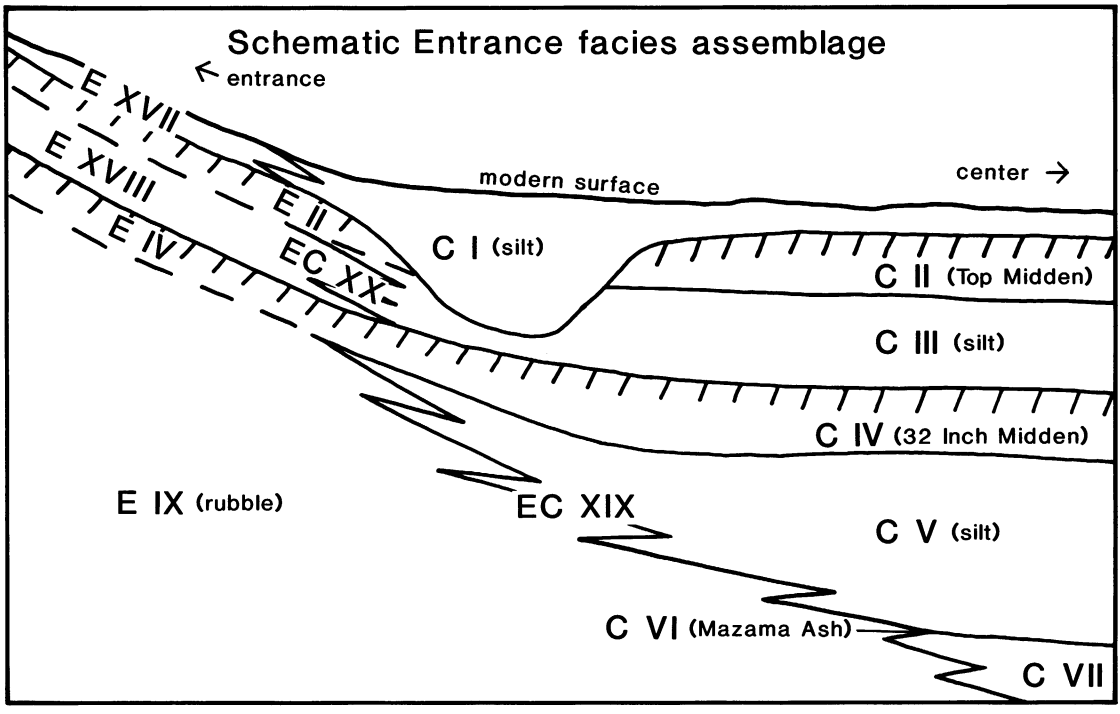

FIG. 26. Schematic view of Entrance facies assemblage. In addition to units shown, the following relations are evident:
EXVII: silt and rubble laterally interfingered with CI.
ECXIX: interbedded silt and rubble between EIX and CVI; later equivalent of CV.
EXX: interbedded silt and rubble, lateral equivalent of CIII and EXVIII.
EXVIII: silt and rubble laterally interfingered with CIII.

depositional sequence and character of the layers is different in the three areas. The letters E, C, and B have been appended to the Roman numerals to produce a specific nomenclature, e.g., EIV is unit IV in the Entrance facies, and ECXX is transitional from Entrance to Center.

ENTRANCE FACIES

Figure 26 shows the relations of stratigraphic units in the Entrance area. The salient features of the Entrance facies are: the persistent presence of the Entrance rubble pile, so that each silt and midden unit (VII through I) interfingers and grades laterally into rubble (EIX, EXIX, EXVIII, EXX, and EXVII); and the presence within the rubble units of distinctive lithoid and dendritic tufa clasts, derived from the hillside outside the entrance. Within 5 m. of the entrance, the post-Lahontan sediment comprises a continuous pile of tufa-containing rubble. However, the "middens" can be traced through the rubble because the organic material is continuous from the center of the cave into the rubble. Therefore, the Entrance rubble can be broken into seven stratigraphic units.

Unit EXVII is the rubble from the modern surface down to the top of the Top Midden (unit II). Unit EII is the top midden, which in the Entrance facies assemblage comprises organically stained rubble. Unit EXVIII is the rubble between the Top Midden and the 32 Inch Midden, and unit ECXX is the interfingering rubble and silt between the two middens. Unit EIV is the 32 Inch Midden, which like EII comprises organically stained rubble, and the rubble below EIV is desig-

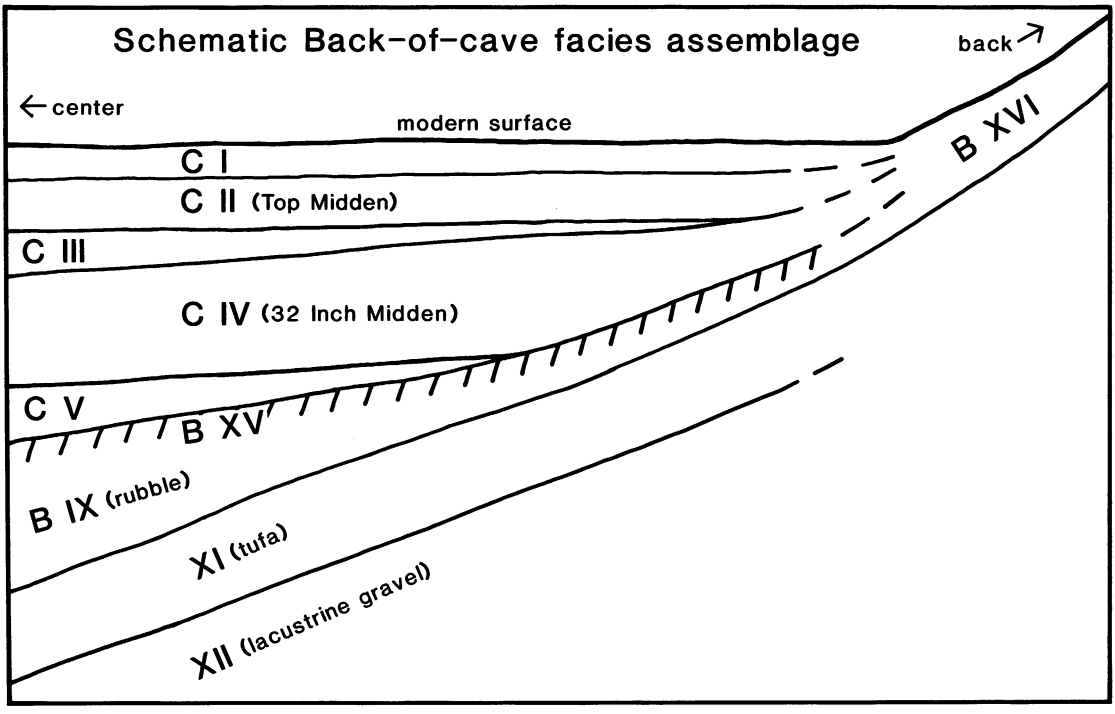

FIG. 27. Back of cave facies assemblage. In addition to units shown, the following relations are evident:
BXVI: 0–30 cm. of rubble and organic material on top of XI (oolitic tufa) on back slope of cave.
BXV: reddish bone hash zone in top 10 cm. of BIX rubble.

nated EIX, because it is continuous with CIX and BIX, although all portions of IX are not the same age. EIX interfingers with CV, CVI, and CVII; the body of sediment in which EIX interfingers with CV is unit ECXIX.

BACK FACIES

Figures 27 and 28 illustrate the relations of stratigraphic units in the Back area. The salient features of the Back facies are: thinning of the silt units I, III, and V and increase in organic content of IX so that units CII, CIV, and BXV merge together and become undistinguishable as a layer of organic material on top of XI (oolitic tufa); the presence of a layer of bone hash, unit BXV, on top of rubble BIX; the fact that rubble BIX does not interfinger with the overlying silts so that there is no Back facies unit equivalent to ECXIX; and the absence of lithoid and dendritic tufa and presence of oolitic tufa within rubble BIX. Whereas, a debris slope existed in the back of the cave during the early Holocene, no later deposition occurred on this slope except for addition of organic material, so Back facies rubble does not interfinger with Center facies silt and midden.

CENTER FACIES

Morrison (1964, pp. 134–135) described the Center facies in Hidden Cave, and the upper portion of figure 25 shows the section schematically. The Center facies is characterized by finely layered silt (layers *ca.* 2 cm. at bottom of Stratum CV to 6 cm. in Stratum III) with occasional stones, blocks of oolitic tufa, and lenses of Entrance facies pebbly sand. The layered silt of Strata CVII, CVI, CV, CIII, and CI is interbedded with fluffy, largely unstratified, powdered vegetal material and guano of Strata CII and CIV (the "middens"). Rodent burrows are characteristic of the Cen-

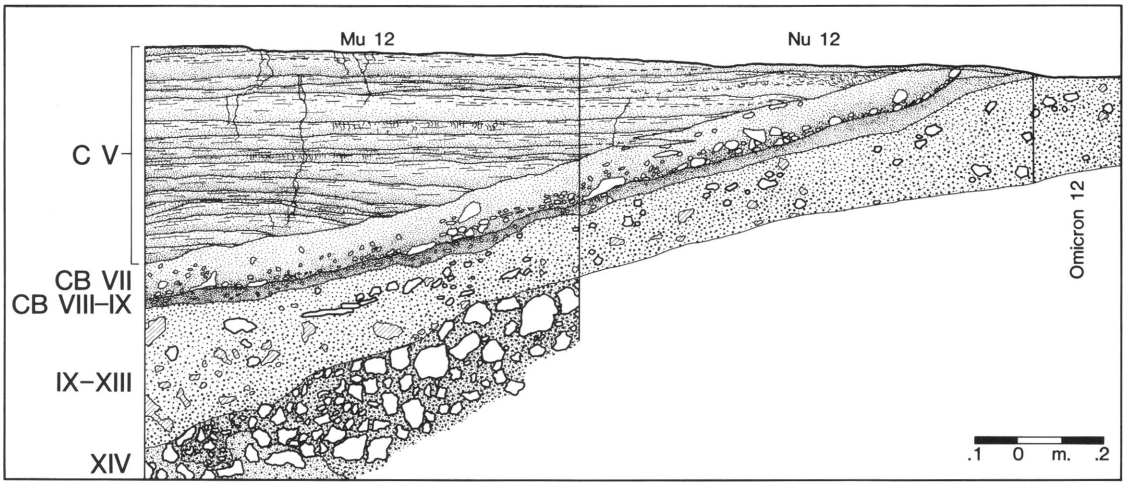

FIG. 28. Profile showing stratigraphic relationships along back slope of Hidden Cave (looking toward operational north).

ter facies assemblage, and intense burrowing occurred in Strata CII, CIII, and CIV. The Center facies interfingers extensively with the Entrance facies, and to a large extent the two are coeval. However, the center facies does not interfinger with the Back facies; Strata CII and CIV continue in the Back Facies and overlie Stratum BIX, but Strata CI, CIII, CV, CVI, and CVII lens out above BIX (see also fig. 29).

TEPHRA LAYERS

MAZAMA MEMBER

Prior to the 1979 excavations, a single layer of white tephra had been observed by Morrison in the base of the silts. Davis (1978) reported that this was the Tsoyawata Bed of the Mazama Member, which he claimed to be an early lobe from the catastrophic series of eruptions at Crater Lake, Oregon, about 6900 B.P. The Tsoyawata Bed occurs from the Fallon and Lovelock, Nevada, area, west to the crest of the Sierra Nevada, and at several places underlies tephra which correspond to the Mazama Ash *sensu strictu*. The Tsoyawata Bed differs from the Mazama Bed in that the Tsoyawata Bed contains great numbers of felty hornblende laths, and proportionally fewer crystals of orthopyroxene; however, according to Davis (1978) the glass chemistry of the Tsoyawata Bed is indistinguishable from that of the Mazama Bed.

Once excavation began in 1979, it became apparent that another white tephra bed about 1 cm. thick occurred in the base of the silts, about 4 cm. above the Tsoyawata Bed (fig. 30). Analysis showed this to be the Mazama Bed, adding Hidden Cave to the list of localities where the two are found in superposition. Table 7 shows the glass chemistry of the two beds, and table 8 shows the phenocryst mineralogy. The glass chemistry of the upper bed (Mazama) is well within the range of variation of the average Mazama ash; however, the lower (Tsoyawata) bed seems significantly different in Fe, Mg, and Ca. The data shown in table 7 are both more precise and more accurate than those presented by Davis (1978), and may represent actual differences in glass chemistry between the beds. It is possible that the Tsoyawata Bed is not in fact from Crater Lake, but from some other source, as Kittleman (personal commun.) has suggested. Nonetheless, Davis (1978) provided several indications that the Tsoyawata Bed is very nearly the same age as the Mazama ash.

The petrographic data presented in table 8 are less precise than the chemical data in table 7 because they depend upon optical recognition of phenocrysts under the microscope,

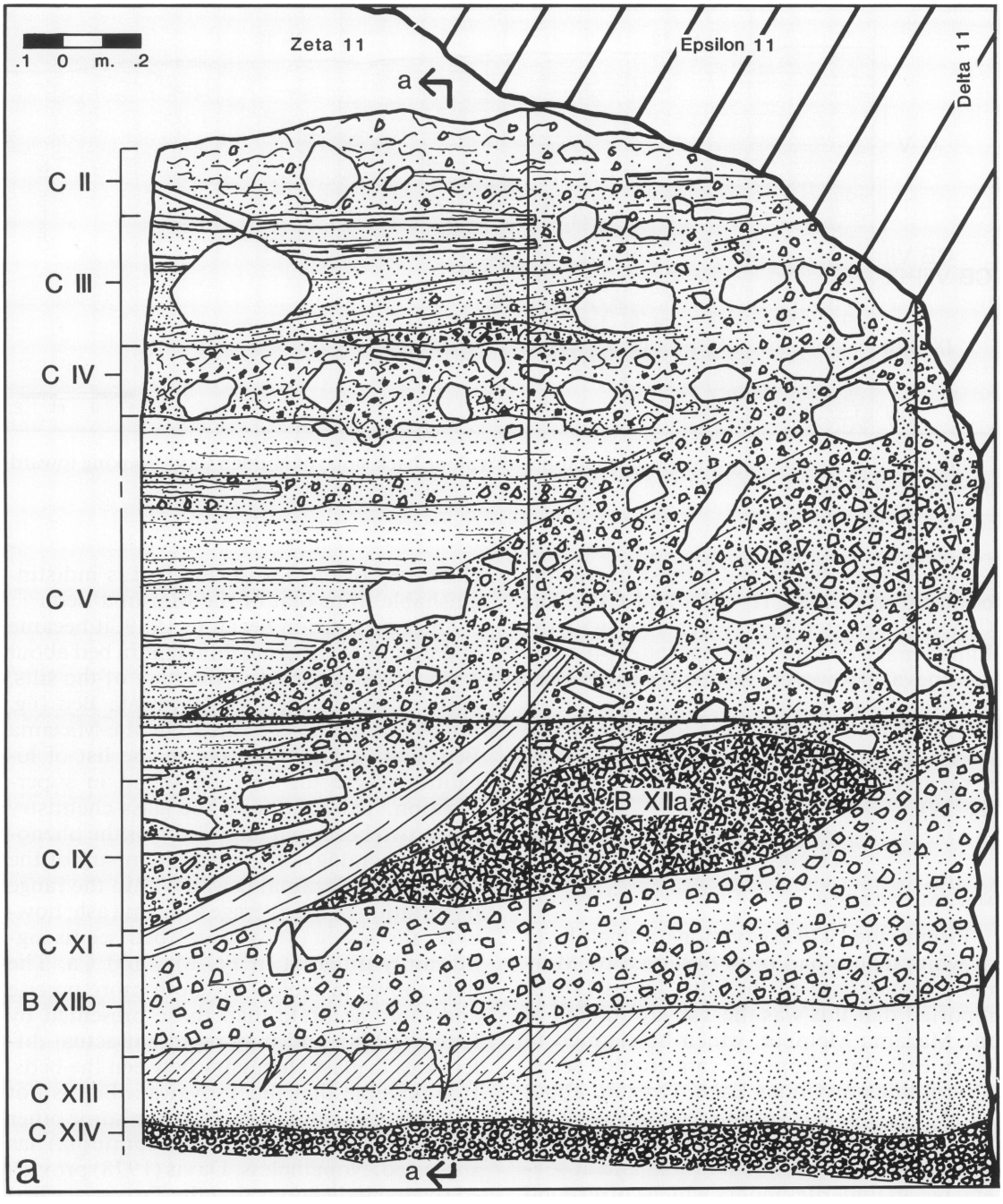

FIG. 29. Profiles showing stratigraphic relationships along northern wall of Hidden Cave (profile at left [29a] is looking toward operational east; profile at right [29b] is looking toward operational south).

and because phenocryst percentages are likely to be changed by depositional winnowing, whereas glass chemistry should be unaffected by depositional processes (Smith and West-

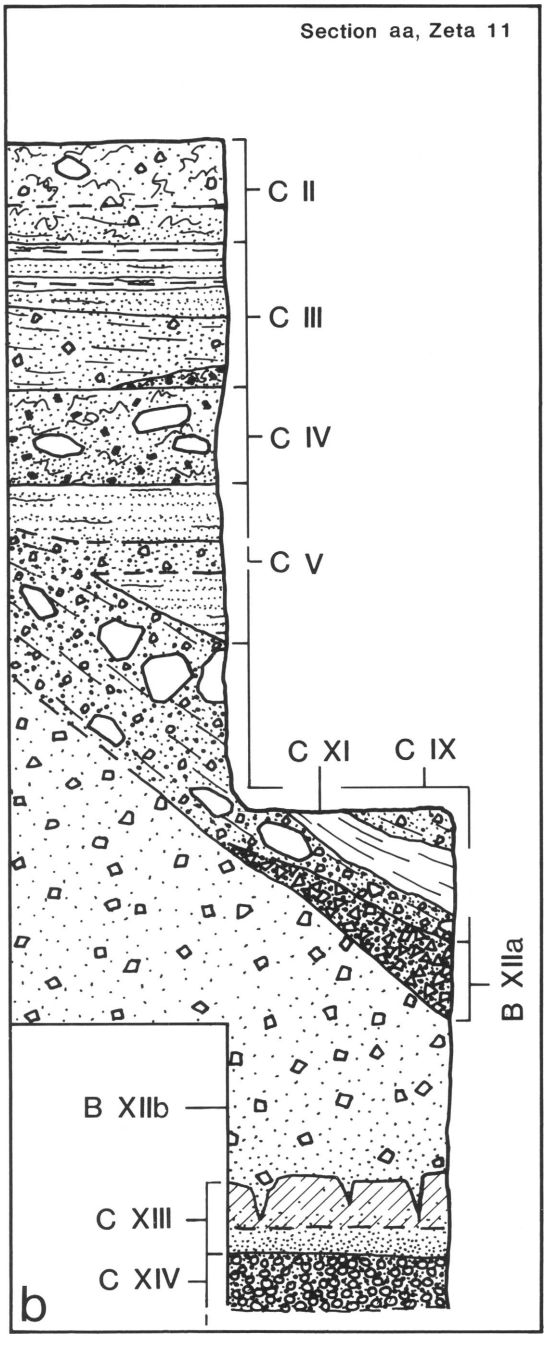

FIG. 30. View of base of Stratum CV, Stratum CVI, and Stratum CVII overlying Stratum EIX on the left. Note also Mazama tephra bed above Tsoyawata tephra bed in Stratum CVI.

gate, 1969). However, the petrographic data serve to illustrate several important characteristics of the two layers. The upper layer is very poor in crystals, and those that are present are very small, so that they are difficult to identify. The crystals in the upper layer comprise hornblende, opaques, plagioclase, apatite, and quartz, in descending order of abundance. It is unusually poor in pyroxene for a sample of the Mazama Bed, which usually has more pyroxene than any other dark mineral. This anomaly suggests that considerable winnowing of the tephra took place; the layer has been redeposited into the cave, and is not a primary airfall.

The petrography of the lower layer is less peculiar in comparison to the Tsoyawata Bed, but the same lack of pyroxene is observed. Crystals are far more abundant than in the upper bed, but these are mostly tiny hornblende laths. The remainder of the phenocryst suite is similarly impoverished, and again suggests that the layer has been redeposited. However, an abundance of tiny felted hornblende laths is a distinctive characteristic of the Tsoyawata Bed, so that the petrography strongly supports the identification of the lower layer from Hidden Cave as the Tsoyawata Bed.

SALT WELLS MEMBER

Although Morrison did not describe tephra from the Fallon Formation in Hidden Cave, Davis (1978) analyzed a specimen from the earlier excavations and identified it as the Turupah Flat Bed of the Salt Wells Member.

TABLE 7
Glass Chemistry of Tephra Beds of the Mazama Member in the Base of Silts, Hidden Cave[a]

Element	Upper (Mazama) Percent	Lower (Tsoyawata) Percent	Average Mazama Percent
Si	33.4	33.6	32.8 ± 0.4
Al	7.6	7.5	7.7 ± 0.1
Fe	1.56	1.43	1.51 ± 0.04
Mg	0.26	0.20	0.27 ± 0.01
Mn	0.04	0.03	0.04 ± 0.01
Ca	1.15	0.98	1.15 ± 0.03
Ba	0.07	0.07	0.08 ± 0.01
Ti	0.24	0.21	0.26 ± 0.03
Na[b]	3.5	2.7	3.0 ± 0.3
K	2.19	2.24	2.25 ± 0.06
Cl	0.16	0.16	0.15 ± 0.01

[a] Data from electron probe analysis of glass.
[b] Na data are erratic in this type of analysis and do not normally provide basis for correlation.

TABLE 8
Phenocryst Mineralogy of Tephra Beds in the Base of Silts, Hidden Cave

	Constituent	Upper (Mazama) Percent	Lower (Tsoyawata) Percent
Major Components	Clear glass	96	78
	Crystal-containing glass	3	18
	Brown glass	1	0
	Microlite-rich glass	0	4
Minor Components	Hornblende:		
	Tabular	7	4
	Laths	25	57
	Opaques	10	16
	Plagioclase	10	4
	Quartz	2	1
	Sanidine	0	3
	Apatite	5	1
	Aggregates	0	1 (hornblende/plagioclase/opaque)
	Brown glass	18	3
	Unidentified crystals	18	10

The Salt Wells Member is from the Mono-Inyo Craters, about 150 km. to the south of Hidden Cave. Davis reported that the Salt Wells Member comprises at least two layers of white tephra which cannot be distinguished from each other either by petrography or by chemical composition; both layers are younger than 2000 B.P.

Wood (1977; Wood and Brooks, 1979) described three layers of tephra in the Mono-Inyo area; a layer about 650 B.P. that went to the east, a layer about 750 B.P. that went to the south, and a layer about 1120 B.P. Bell (personal commun.) reports that the Turupah Flat Bed of the Salt Wells Member is bracketed by charcoal radiocarbon dates at about 1500 B.P., and evidence described by Wood (1977) can be interpreted to suggest that a layer of this age is found to the south, as well. However, the recent Mono-Inyo tephra are extremely difficult to distinguish from one another, and in particular, microprobe analyses of the glass from these layers provide no means of distinguishing them. Wood and Brooks (1979) suggest that petrography may allow the layers to be distinguished.

The Salt Wells Member in Hidden Cave is "dirty" (mixed with nonpyroclastic sediment) gray tephra in one to several layers at the base of 1980 unit CI, or Morrison's unit #1 (fig. 31). Table 9 shows the glass chemistry of this tephra, but the samples contained so much nonpyroclastic sediment that petrographic examination proved impossible. Table 9 indicates that two samples from Hidden Cave (4 and 6) are so similar in composition that they cannot be distinguished from each other; this supports the interpretation made in the field that they represent the same layer multiply redeposited. The other samples shown in table 9 are from Salt Wells, where the Turupah Flat Bed is found (approximately 1500 B.P.) and the Walker Lake Bed from cores from the bottom of Walker Lake (approx. 1100 B.P.). Although there is very little difference among the samples, the Hidden Cave samples more closely resemble the Turupah Flat Bed (in Si and K, particularly), and so tentatively the upper tephra in Hidden Cave is assigned an age of 1500 B.P.

FIG. 31. View of north wall of excavation square Kappa 13, showing Strata CI, CII, and part of CIII. The Turupah Flat tephra bed is a series of white layers at base of CI.

TABLE 9
Glass Chemistry of Salt Wells Member Tephra from CI, Hidden Cave, and Other Comparable Specimens

Element	Hidden Cave 4 Percent	Hidden Cave 6 Percent	Salt Wells LD-12[a] Percent	Walker Lake LD-86[a] Percent
Si	35.0	35.0	35.0	35.5
Al	6.6	6.8	6.5	6.9
Fe	0.83	0.82	0.79	0.81
Mg	0.02	0.02	0.02	0.02
Mn	0.02	0.03	0.05	0.05
Ca	0.39	0.41	0.37	0.41
Ba	0.01	0.00	0.02	0.02
Ti	0.04	0.03	0.04	0.05
Na[b]	2.5	2.8	2.8	2.8
K	3.74	3.75	3.75	3.88
Cl	0.08	0.07	0.07	0.09

[a] Analyses by Charles Meyer, U.S. Geological Survey, localities described by Davis (1978).

[b] Na data for microprobe analysis of this sort are often too erratic to be used in correlation.

DEPOSITIONAL ENVIRONMENT OF THE LAYERED SILT

It is apparent from Morrison's description of Hidden Cave (table 4) that he believes much of the layered silt was eolian loess, derived from the desiccated bottom of Lake Lahontan. With the improved exposures created by the excavations of 1979–1980, it seems clear that the silt is alluvial, and was washed into the cave from the hillslope outside. The reasons for this conclusion include observations of the form of the bodies of silt, the internal sedimentary structures in the silt, and processes observed to act on the hillside and in the cave today.

FORM

The silt in Hidden Cave is a series of lenses which together comprise a large lens about 2 m. thick at its thickest point. The silt lies in the lowest part of the cave, at the foot of the back slope, and the entrance slope. The top of the silt deposit, and of each individual lens within it, is nearly flat and level, and each lens and the deposit as a whole pinches out against the underlying slopes without any draping of silt over the slopes. In contrast, dust raised during excavation drapes over the back slope, covering all surfaces except those so steep that it slides off, to a depth of about 1 cm. It seems reasonable to conclude that any eolian dust should drape over gentle slopes, rather than lens out abruptly against them; therefore, the form of the silt deposit suggests that the silt was deposited from aqueous suspension and traction, rather than from the air.

SEDIMENTARY STRUCTURES

Many other characteristics of the silt, when observed in detail, lead also to the conclusion that it is eolian.

FINE LAYERING: Loess is characteristically vaguely stratified, if at all, whereas the silt of Hidden Cave is finely layered, with laminae a millimeter or two thick. Although it may be argued that the lack of stratification in loess normally results from churning from plant growth, and that this has not occurred in Hidden Cave, laminae can only be created by a medium moving over the depositional surface at some varying velocity. The situation in the interior of Hidden Cave is such that significant wind velocity at the floor seems impossible; therefore, the fine laminae can only have been produced by moving water.

FIG. 32. View of Stratum CV, showing fine layering of silt and vesicular pores. Coin is 19 mm. in diameter.

FIG. 33. View of Stratum III, showing foreset crossbedding. Coin is 17.8 mm. in diameter.

VESICULAR POROSITY: Throughout the silt deposit, characteristically the upper portion of each silt bed contains vesicles, or spherical pores, about 0.5 to 1.0 mm. in diameter (fig. 32). Such vesicles are produced by sudden wetting of a silty deposit, so that interstitial air is trapped as bubbles; when the sediment dries out, the bubbles, if undisturbed, remain as vesicles. The process is characteristic of surficial horizons in desert soils. The vesicles in the Hidden Cave silt deposit bespeak frequent wetting of the silt, which although it does not disprove an eolian origin, demonstrates the repeated presence of water in the cave during the deposition of the silt.

FORESET BEDDING: In a few places in the silt deposit, notably in northwest corner of the 1979 excavation, individual layers of silt exhibit internal foreset cross stratification (fig. 33). Although wind can produce cross stratification in dune sand, such stratification is not characteristic of loess, and requires significant wind velocity at the ground surface. The foreset bedding in the Hidden Cave silt is much more likely the result of gently flowing, sediment-laden water.

DESICCATION CRACKS: Each layer of silt is interrupted by nearly vertical cracks a few millimeters wide, filled with sediment from the layer above, spaced about every 10 cm. These are desiccation cracks, created when the layer shrank due to drying. Although it is possible that a thin layer of eolian silt might later become wet and then develop desiccation cracks, the presence of the cracks, like the vesicles, demonstrates that the deposit has repeatedly and regularly been wet. It seems a parsimonious explanation that the sediment was deposited by water.

GUANO RAFTS: In the north wall of the 1979–1980 excavation, the bottom of Stratum III preserves rafts of bat guano which have floated up from the top of Stratum IV (fig. 34). The manner in which the guano layer is interrupted and the silt overlies, and then underlies, the guano can only be explained in terms of alluvial processes, for there seems to be no manner in which airborne dust could intrude and displace the guano layer.

STRATIFIED BURROW FILLS: The center portion of the silt deposit in Hidden Cave was riddled with burrows, and many of these were filled with finely layered sediment, including some crossbedding. Features of this sort are typically produced by sediment-laden water flowing into open burrows. It seems impossible for airborne dust to create the layering and crossbedding observed in the burrows.

OBSERVED FLOODING OF CAVE

During excavation in August 1979, an afternoon thundershower at Hidden Cave created enough surface flow on the hillside and into the cave to flood the deeper excavations inside the cave to a depth of 10 or 20 cm. The flow of muddy water came into the entrance as a frothy, turbid stream which continued for about 10 minutes. The sediment deposited was not sampled for com-

parison to the older silts because the presence of excavations in the floor of the cave had greatly altered the gradient, channel characteristics, and sediment available to the flow, so that the comparison would have been meaningless. However, this episode of slopewash and flooding demonstrates that slopewash can and does flood Hidden Cave occasionally today, and provides graphic demonstration of the mechanism of deposition of the layered silts.

Age of the Post-Mazama Deposits

Several radiocarbon dates were determined from specimens recovered during 1979–1980, and from a few specimens recovered by Wheeler during the 1940s. Table 10 summarizes these dates. It is immediately apparent from inspection of this list of dates that several specimens must have been moved from their original stratigraphic position before recovery. The list implies, for instance, that Stratum II (Top Midden) was deposited from 3850 to 810 B.P., whereas Stratum IV (32 Inch Midden) was deposited from 5365 to 1880 B.P. In order to decipher these dates and arrive at a reasonable interpretation of the absolute age of the deposits, it is necessary to disregard certain dates, and the process of choosing which dates to ignore is a subjective one. Two hypotheses as to actual age are presented below. The first interpretation presented seems more parsimonious, but the second is favored because it corresponds better with the Holocene record in other sites in Nevada.

If dates are to be disregarded, there should be substantial evidence that mixing or some other process has occurred. In Hidden Cave, there was abundant evidence of mixing; a large chunk of Strata CII, CIII, CIV, and CV was so riddled by filled rodent burrows that stratigraphic digging was impossible. Furthermore, several large deep cache pits were discovered, and much of Wheeler's excavation was conducted in Stratum BXVI, in which the major cultural Strata (BII and BIV) come together and are very difficult to distinguish.

First Hypothesis

The youngest date (WSU-2457) 810 ± 80 B.P. from Stratum II, is younger than the tephra which lies on top of that stratum (about 1500 B.P.); therefore, this specimen was probably from Stratum I.[4] The other date from Stratum II, 3850 ± 110 B.P. (WSU-2458) overlies four dates which are significantly younger, and agrees well with four dates on Stratum IV; therefore, this specimen probably originally came from Stratum IV.

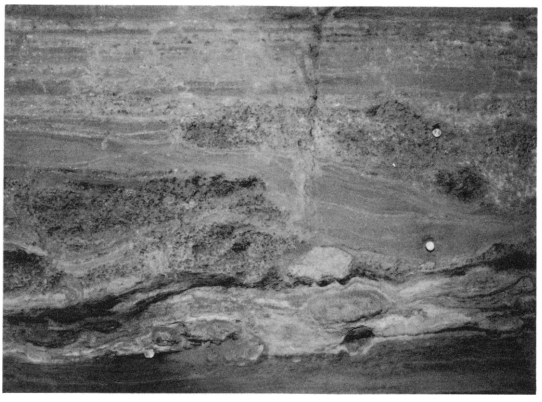

FIG. 34. View of contact between Stratum BIV (below) and BIII (above), showing rafting of guano layer.

Dates from Stratum III are 1950 ± 90 B.P. (WSU-2463) and 2200 ± 95 B.P. (WSU-2461), which seem to be reasonable if it is assumed that the underlying date of 1880 ± 90 B.P. (WSU-2453) was out of place.

Of the remaining dates from Stratum IV (32 Inch Midden), all but one are reasonable. Dates of 3050 ± 200 B.P. (L289-BB), 3140 ± 110 B.P. (WSU-2462), 3575 ± 120 B.P. (WSU-2451), 3800 ± 80 B.P. (WSU-2454), 3790 ± 110 B.P. (WSU-2460), and 3520 ± 120 B.P. (WSU-2459) are all consistent with the notion that the actual age of these specimens is from about 3050 to about 3800 B.P. The single remaining date from Stratum IV, 5365 ± 90 (WSU-2452) is significantly older than the others and probably originated in Stratum V.

Dates from oolitic tufa seem reasonable, although we have little to compare them with.

[4] Editor's Note: Wigand and Mehringer (chap. 9, this volume) show the Mono ash lying *within* Stratum I. The area which they sampled did contain sediments between the top of Stratum II and the Mono ash; these sediments were lacking in other parts of the site, where the Mono ash sat directly on top of Stratum II.

TABLE 10
Radiocarbon Dates from Hidden Cave

Stratum	Lab Number	Date (B.P.)	Material
I	no dates	—	—
II	WSU-2457	810 ± 80	Wheeler fiber bundle
	WSU-2458	3850 ± 110	Wheeler tule bag
III	WSU-2463	1950 ± 90	Organic material
	WSU-2461	2200 ± 95	Burnt wood
IV	WSU-2453	1880 ± 90	Wood
	WSU-2462	3140 ± 110	Burnt organic material
	WSU-2451	3575 ± 120	Silty sediment & organic debris
	WSU-2454	3800 ± 80	Charred wood
	WSU-2460	3790 ± 110	Burnt organic material
	WSU-2459	3520 ± 120	Wheeler organic material & matting
	WSU-2452	5365 ± 90	Burnt organic debris
	L289-BB	3050 ± 200	Wood
XI	WSU-2455A	16,340 ± 190	Oolitic tufa, outer portion
	WSU-2455B	17,850 ± 240	Oolitic tufa, inner portion
	L289-AA	15,130 ± 400	Oolitic tufa

Table 11 presents the interpretations made above, with each date shown in its reinterpreted stratigraphic position. Four dates have been interpreted in original provenience, and four have been "moved." However, when these dates are considered together with the tephrochronology and thickness of the section, an intriguing pattern emerges.

Table 15 presents the tephra, radiocarbon, and thickness data together. The chronology proposed is as follows: Stratum I was deposited from about 1500 B.P. (because it contains the Turupah Flat tephra in its base) until the present. Stratum II was deposited from about 1900 B.P. (a radiocarbon date of 1880 ± 90 B.P. is assigned to it) until 1500 B.P.; this is the Top Midden and contains much cultural organic material. Stratum III was deposited from about 3150 until about 1900 B.P., and has radiocarbon dates of 1950 ± 90 B.P. and 2200 ± 95 B.P. Stratum IV was deposited from about 3800 until about 3150 B.P., and seven radiocarbon dates reflect this age range. Stratum V was deposited from 6900 B.P. (the Mazama Member is the bottom of Stratum V) until about 3800 B.P. The sediments below Stratum V cannot be dated with any precision.

Table 12 also presents the average depositional rate for Strata I through V. It is striking that the depositional rates for Strata I, II, III, and V are fairly similar. The depositional rate for Stratum IV, which contains considerable cultural organic material, is higher. This means that the interpretation of the radiocarbon results presented here is consistent with the idea that the layered silts have accumulated essentially continuously and at the same rate through the middle and Late Holocene, and that the "middens" represent episodes of occupation superimposed upon the

TABLE 11
First Hypothesis: Interpretations of Radiocarbon Dates[a]

Stratum	Lab Number	Date (B.P.)
I	(WSU-2457	810 ± 80)
II	(WSU-2453	1880 ± 90)
III	WSU-2463	1950 ± 90)
	WSU-2461	2200 ± 95
IV	L289-BB	3050 ± 200
	WSU-2462	3140 ± 110
	WSU-2459	3520 ± 120
	WSU-2451	3575 ± 120
	WSU-2460	3790 ± 110
	WSU-2454	3800 ± 80
	(WSU-2458	3850 ± 110)
V	(WSU-2452	5365 ± 90)

[a] Parentheses indicate dates whose provenience has been reinterpreted.

TABLE 12
First Hypothesis: Age and Depositional Rate

Stratum	Age (B.P.)	Radiocarbon Dates, Tephra	Morrison's Section: Thickness (cm.)	Morrison's Section: Depositional Rate (cm./yr.)
I	—	810 ± 80	21	0.014
—	1500	Turupah Flat tephra	—	—
II	—	1880 ± 90	9	0.023
—	1900	—	—	—
—	—	1950 ± 90	—	—
III	—	2200 ± 95	27	0.022
—	3150	—	—	—
—	—	3050 ± 200	—	—
—	—	3140 ± 110	—	—
—	—	3520 ± 120	34	0.052
IV	—	3575 ± 120	—	—
—	—	3790 ± 110	—	—
—	—	3800 ± 80	—	—
—	—	3850 ± 110	—	—
—	3800	—	—	—
V	—	5365 ± 90	43	0.014
—	6900	Mazama Member	—	—

continuous accumulation, rather than depositional hiati.

SECOND HYPOTHESIS[5]

Because the radiocarbon dates are not consistent with the stratigraphic positions of the specimens dated, there are several possible interpretations of the actual age relations of the strata. Another reasonable, if less geologically parsimonious, interpretation follows. WSU-2457 (810 ± 80) still seems to belong in Stratum I because it underlies a tephra about 1500 years old. However, WSU-2458 (3850 ± 110) may belong in Stratum II. If so, then Strata IV, III, and II were deposited over only a few hundred years, and the top of Stratum II represents a depositional hiatus of about 2000 years. WSU-2461 (2200 ± 95), WSU-2453 (1880 ± 90), and WSU-2462 (3140 ± 110) then all belong at the top of Stratum II, as does L289-BB (3050 ± 200). WSU-2452 (5365 ± 90) may indicate that Stratum IV also includes a depositional hiatus from perhaps 5400 until 3700 B.P.

[5] Editor's Note: Davis's "second hypothesis" is the chronology used throughout the remainder of this volume.

TABLE 13
Second Hypothesis: Interpretation of Radiocarbon Dates[a]

Stratum	Lab Number	Date (B.P.)
I	(WSU-2457	810 ± 80)
Top of	(WSU-2463	1950 ± 90)
Stratum II:	(WSU-2461	2200 ± 95)
	(WSU-2453	1880 ± 90)
	(WSU-2462	3140 ± 110)
	(L289-BB	3050 ± 200)
II	WSU-2458	3850 ± 110
III	no dates	
IV	WSU-2451	3575 ± 120
	WSU-2460	3790 ± 110
	WSU-2459	3520 ± 120
	WSU-2452	5365 ± 90

[a] Parentheses indicate dates whose provenience has been reinterpreted.

Table 13 shows the second hypothesis, and table 14 shows the corollary ages of the strata. This hypothesis involves "moving" six of the radiocarbon dates, rather than four, as required by the first hypothesis. The depositional rates implied by this hypothesis vary widely for the same facies, from 1.35 cm./yr. to 0.029 to 0.014 for silt and from 0.020 to 0.004 for midden. However, a specific geologic observation does support this hypothesis: the depositional units in Stratum III (GUs 38, 39, 40, 41, and 42) are each about 6 cm. thick, whereas those in Stratum V average perhaps 1.5 cm. in thickness. Therefore, if the rate of occurrence of depositional events were constant, the rate of accumulation should be greater in III than in V.

Furthermore, if the second hypothesis be compared with the depositional record at Gatecliff Shelter (Davis, 1983), 150 km. to the east, a striking correlation of dates and events is seen. Table 15 shows this correlation. In both sites, the Mazama ashfall was followed by accumulation of many thin beds of alluvium until about 5450 B.P. Then at Gatecliff, a few very thick beds of alluvium

TABLE 14
Second Hypothesis: Age and Depositional Rate

Stratum	Age (B.P.)	Radiocarbon Dates, Tephra (B.P.)	Morrison's Section: Thickness (cm.)	Morrison's Section: Depositional Rate (cm./yr.)
—	0	—	—	—
I	—	810 ± 80	21	0.014
—	1500	Turupah Flat tephra	—	—
On top of II	—	1880 ± 90	—	—
Hiatus	—	1950 ± 90	—	—
—	—	2200 ± 95	—	—
—	—	3050 ± 200	—	—
—	—	3140 ± 110	—	—
II	—	3850 ± 110	9	0.004
—	3680	—	—	—
III	—	—	27	1.35
—	3700	—	—	—
—	—	3520 ± 120	—	—
IV: Hiatus	—	3575 ± 120	34	0.020
—	—	3790 ± 110	—	—
—	—	5365 ± 90	—	—
—	5400	—	—	—
V	—	—	43	0.029
—	6900	Mazama tephra	—	—

TABLE 15
Correlation Between Hidden Cave (Second Hypothesis) and Gatecliff Shelter

Hidden Cave: Stratum	Hidden Cave: Age (years)	Stage	Gatecliff Shelter: Age (years)
I	0–1500	8	0–1250
Hiatus	1500–3600	7	1250–1350
II	3600–3680	6	1350–3200
III	3680–3700	5	3200–4250
IV	3700–3800	4	4250–5100
		(largely hiatus)	
Hiatus	3800–5400	—	—
—	—	3	5100–5500
V	5400–6900	—	—
—	—	2	5500–6500
—	—	1	Contains Mazama ash

accumulated from 5500 until 5100 when deposition essentially ceased; at Hidden Cave deposition ceased about 5400 B.P. At Hidden Cave, deposition of alluvium began again briefly at about 3800 B.P. (Stratum III) but alluvium otherwise did not begin to accumulate again until after 1500 B.P. At Gatecliff, alluvium accumulated from 4250 until 3200; thereafter, deposition was dominated by slope sediments. Similarities at both sites are the accumulation of many thin beds of alluvium from about Mazama time until about 5400 B.P.; depositional hiatus from about 5400 until about 4000 B.P.; brief resumption of alluvial accumulation after 4000 B.P. Although Hidden Cave and Gatecliff Shelter are located in quite different environments, they share certain important similarities; each is below a debris-covered slope, and each is subject to alluvial deposition derived from the slope above. In each site, alluvial deposition is probably the result of torrential summer rainfall, and not suprisingly, each records similar intervals of such precipitation during the Holocene. However, Gatecliff also receives coarse slope sediment, as talus and debris flows, whereas Hidden Cave does not, so the record of periods of time not dominated by summer rainfall is different in the two sites.

Implications of the Age and Origin of the Post-Mazama Deposits

If the layered silts in Hidden Cave are indeed alluvial, and if their age is as described in the second hypothesis above, certain stratigraphic and climatic implications follow. Stratigraphically, there seems little basis for dividing the silts into Fallon and Turupah formations. The silts are extremely similar through the section, except for an increase in the thickness of the bedding upward. Unconformities occur at or in each of the middens (Strata II and IV), and if the silts are to be subdivided lithostratigraphically, the divisions should be made at the middens. If Stratum V was deposited before about 5300 B.P., then it corresponds in its entirety with Morrison's Turupah Formation. However, Davis (1978) proposed that the name Turupah be

dropped because the type section of the Turupah Formation is in fact part of the Fallon Formation. This report is not a suitable vehicle for redefinition of the Turupah Formation, but such a stratigraphic clarification is needed.

If Stratum V is the Turupah Formation, then there is little problem with including Strata IV, III, II, and I in the Fallon Formation. The ages of these units correspond with the episode of increased moisture during the late Holocene which created the Fallon lakes, although it could be argued that the strata in Hidden Cave do not reflect this change in their lithology and that they, therefore, should be included in the Turupah Formation. However, the hiatuses which occurred 5400 to 4000 and 3600 to 1500 B.P. probably were associated with this climatic change, and as they are lithologic breaks, the upper strata can be assigned to the Fallon Formation.

CLIMATIC CHANGE

The major Holocene climatic change recorded in Hidden Cave is shown by the cessation of slope processes within the cave (end of deposition of BIX) and beginning of accumulation of layered silt, about 7500 B.P. This change in depositional regime corresponds well with a vegetational change at the same time described by Wigand and Mehringer (chap. 9, this volume). The cause of this depositional change is probably that climate became drier, so that the back slope of the cave ceased to creep and be washed, and precipitation became concentrated more in the summer, and therefore became more torrential. This would lead to increased erosion of the hillslope above the cave by sudden downpours, and resulting shallow flooding of the cave by silt-laden water. This climatic change is similar to that hypothesized at Gatecliff Shelter at about the same time (Davis, 1983). Subsequent Holocene climatic changes at Hidden Cave were minor in comparison to the change at about the time of the Mazama ash.

There are two possible explanations for the depositional hiatuses at Hidden Cave from 5400 to 3800 and from 3600 to 1500 B.P.

TABLE 16
Climatic Inferences from Hidden Cave

Stratum	Age (years)	Climate
I	0–1500	Summer precipitation, dry
Hiatus	1500–3600	Winter precipitation, moderate amount?
II	3600–3680	Human activity, winter precipitation
III	3680–3700	Summer precipitation, dry
IV	3700–3800	Human activity, dry?
Hiatus	5400–3800	Extremely dry
V, VI, VII	7500–5400	Summer precipitation, dry
BIX	10,000–7500	Winter precipitation, wet

Dry climate could cause the lack of deposition, by removing the agent of deposition; this is inferred to have happened at Gatecliff from 5100 until 4250 B.P., and may explain the Hidden Cave hiatus from 5400 until 3800 B.P. However, the entrance cone in Hidden Cave continued to grow throughout the Late Holocene, and by historic times had almost completely blocked off the cave entrance; this progressive blockage may have limited sediment influx. On the other hand, the resumption of deposition after 1500 B.P. militates against this explanation.

Conversely, a shift of precipitation to the winter might reduce deposition of silt in Hidden Cave while the entrance cone continued to grow. Tentatively, then, the hiatus from 5400 until 3800 B.P. indicates dry climate, as at Gatecliff, and the hiatus from 3600 until 1500 B.P. reflects a shift toward winter precipitation. Stratum III reflects a brief episode of summer precipitation about 3700 B.P., and Stratum I reflects another summer precipitation episode about 1500 B.P. Table 16 summarizes these inferences.

If the stratigraphic relations in the entrance cone were better preserved and exposed, there might be a less ambiguous interpretation of the late Holocene at Hidden Cave. If the tentative interpretation above is correct, then the 5400–3800 hiatus should have occurred on the entrance cone as well as in the cave interior; however, the 3600–1500 hiatus

should not be reflected on the cone. Study of these relations should be a fruitful direction for future geological research.

Age of the Pre-Mazama Deposits

Little new evidence was produced from the 1979–1980 investigations concerning the age of the sediments which underlie the silt in Hidden Cave. Radiocarbon dates WSU-2455A (16,340 ± 190) and WSU-2455B (17,850 ± 240) were determined from the oolitic tufa of Stratum XI. WSU-2455A represents the first half of the disaggregated sample to dissolve, and WSU-2455B represents the second half, so that 16,340 ± 190 indicates the age of the outer half of the oolites, whereas 17,850 ± 240 indicates the age of the inner half. These dates show that L289-AA (15,130 ± 400) is approximately correct, and the fact that the inner half of the oolites is significantly older than the outer half suggests that the oolites have not recrystalized since their formation.

Although we have little new evidence from the Hidden Cave studies concerning the pre-Mazama sediments since Morrison's description, significant strides have been made in understanding of the absolute chronology of Lake Lahontan. It may be fruitful to reinterpret the earlier sediments of Hidden Cave in this light. Pioneering radiocarbon investigations by Broecker (Broecker and Orr, 1958; Broecker and Kaufman, 1965) were disputed by Morrison (Morrison and Frye, 1965). Benson (1978) determined that at least some of Broecker's conclusions were correct. Davis (1982) has summarized the current state of knowledge of Lahontan chronology.

ORIGIN OF THE CAVE

Morrison (1964, pp. 29, 48) believed that the roof of Hidden Cave was formed of Eetza gravel cemented by lithoid tufa, also of Eetza age. The tufa cementation did not extend through the entire thickness of the gravel mantle, but formed a "rind" over less consolidated gravel. When later shoreline processes (presumably early Sehoo) eroded a hole in the rind, the waves were able to wash the loose gravel out from beneath it, and the cave was created. Because the roof of the cave is Eetza in age, and no sediments have been observed beneath the Sehoo sediments within the cave which could be correlated with the Wyemaha Formation, the excavation of the cave was during Sehoo time, rather than late in the Eetza. If this were the case, then soil horizonation during the Churchill interval would have added to the cementation of the roof prior to its excavation.

PRE-MAZAMA DEPOSITS

STRATUM XIV; REDDISH GRAVEL: This is the basal deposit in the cave, described by Morrison as uncemented lake gravel. However, the 1979-1980 investigation found this sediment to be distinctly reddish in color, partially cemented, and strikingly different in lithology from any other sediment in the cave. Stratum XIV contains no tufa clasts, but is entirely subrounded to subangular basalt cobbles in a decomposed basalt matrix. It is likely that Stratum XIV represents the top of the Cocoon Soil, as a residual soil weathered upon the basalt hillside. The cementation, lack of rounding, lack of tufa clasts, and red color all support this interpretation, as does the slope of the top of Stratum XIV, which parallels the hillside above the cave. The absolute age of the Cocoon Soil is not well known, but Davis (1978) reported that it is underlain by the Pearlette Type 0 tephra, which is about 600,000 years old.

Stratum XIV was covered by shore gravel during Eetza time, and this gravel became cemented by tufa, and then by soil carbonate during Churchill time, perhaps 75,000 B.P. Hidden Cave was excavated by the waves of Lake Lahontan as the lake next rose past 1250 m.; Davis (1982) reported that this occurred about 22,000 B.P. Therefore, the Pleistocene sediment of Hidden Cave was deposited after this time.

STRATUM XIII: This graded bed of sand to clay reflects water standing quite deeply at Hidden Cave. Benson (1978, p. 307) reported a high stand of Lake Lahontan about 18,000 to 20,000 B.P., during which the water stood at least 1270 m. The probable age of Stratum XIII, then, is from 18,000 to 20,000 B.P.

STRATUM XII: This is the type section of the Middle Tongue of Morrison's Indian Lakes Formation, comprising poorly sorted gravel and sand derived by creep and slope

wash from the back slope of the cave interior, and from the entrance. There are no actual dates on this sediment, but it is overlain by tufa dated at 15,130 ± 400, 16,340 ± 190, and 17,850 ± 240, B.P., and Benson's data show that water should have been deep until about 18,000 B.P., so Stratum XII is about 18,000 years old.

STRATUM XI: This is the oolitic tufa dated by Broecker and Orr (1958) at 15,130 ± 400 B.P., and by this study at 16,340 ± 190 to 17,850 ± 240 B.P. Oolites are formed in shallow, alkaline water, where they are subject to gentle oscillation, as by waves. The dates on the oolites suggest that Lake Lahontan was only slightly above the level of the cave entrance from about 18,000 until about 15,000 B.P.

STRATUM XVI: This is a lens of rubble and organic material above the tufa and below the clean gravel of Stratum X at the back of the cave. This sediment seems to have been deposited subaerially during a low stand of Lahontan about 15,000 B.P. If Stratum XVI is about 10,000 years old, very little sediment was deposited in the cave during the highstand about 13,000 B.P. This is not hard to understand, because sources of sediment were far removed from the cave, which lay in deep, still water.

STRATUM X: This is clean pebble gravel, deposited by waves as Lake Lahontan receded from Hidden Cave for the last time. The age of this event is uncertain, but the best approximation from Benson's data is about 10,000 B.P.

STRATUM IX: In the Back facies assemblage, Stratum IX does not interfinger with the overlying silt, except at the very base of the silt (Stratum VIII). So Stratum BIX is older than about 7500 B.P., and younger than about 10,000 B.P. However, Stratum IX in the Entrance facies interfingers extensively with the silts (fig. 26) so that its top is about 4010 B.P.

TABLE 17
Estimated Age of the Hidden Cave Strata

Stratum	Age (years)	Lithology
I	0–1500	Silt
Hiatus	3600–1500	Unconformity
II	3600–3680	Midden
III	3680–3700	Silt
IV	3700–3800	Midden
Hiatus	5400–3800	Unconformity
V	6900–5400	Silt
VI	6900	Mazama Member and enclosed silt
VII	7500–6900	Silt
BIX	10,000–7500	Pebbles and sand ("Mudflow Gravels")
X	10,000	Lacustrine gravel
XI	15,000–18,000	Oolitic tufa
XII	18,000	Pebbles and sand
XIII	18,000–21,000	Lacustrine sand and clay
Cave roof	Eetza	Tufa-cemented lacustrine gravel
XIV	Cocoon Soil	Reddish residual gravel and soil

SUMMARY

AGE OF THE SEDIMENTS

Estimated age of major strata is shown in table 17. Strata not shown in table 13 are laterally equivalent to the major strata, as shown in figures 26 and 27. Hidden Cave has preserved a moderately complete stratigraphic section since about 21,000 B.P. Although considerable mixing has occurred during late Holocene time due to the actions of rodents and humans, 15 radiocarbon dates and three tephra layers allow moderately precise understanding of the age of the deposits.

DEPOSITIONAL MODELS

EARLY HOLOCENE

Figure 35 illustrates the pre-Mazama, post-Lahontan depositional system in Hidden Cave. Three processes were functioning: slopewash from the hillside was building a poorly sorted rubble cone at the entrance. Rodents (probably *Neotoma* sp.) were collecting bones from the hillside and leaving them on the back slope of the cave. Creep and slopewash on the back slope of the cave were redepositing the lacrustrine gravel there into a rubble pile. The only surficial (or "soil forming") process within the cave was accumulation of bones at the surface in areas where deposition was slow. Mixing was prevented apparently by the coarse texture of

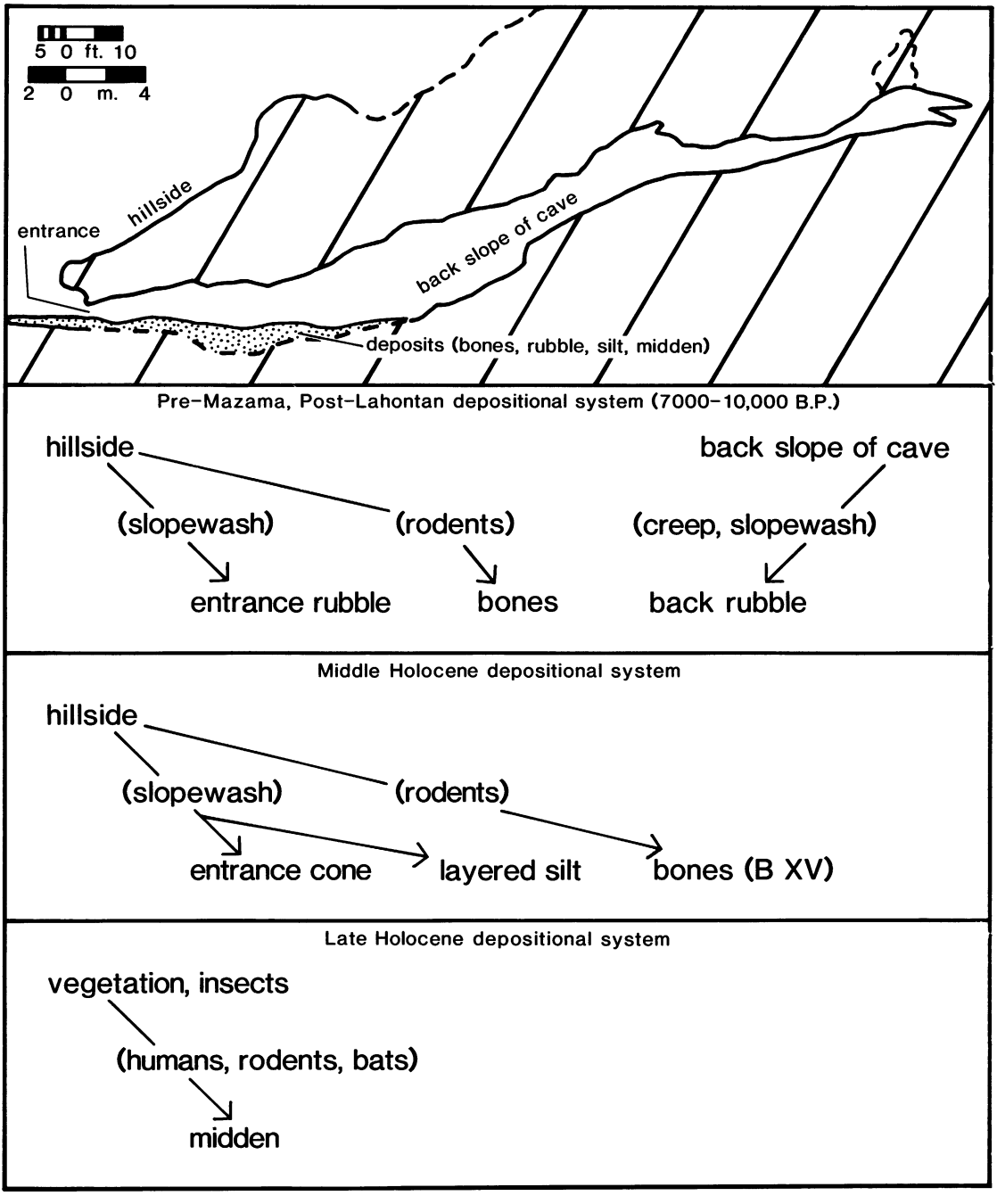

FIG. 35. Composite diagram showing depositional models for Pre-Mazama, Middle Holocene, and Late Holocene periods at Hidden Cave.

the sediment, and the sediment may have been perennially wet.

MIDDLE HOLOCENE

Figure 35 illustrates the depositional systems acting from about 7000 B.P. until about 5400 B.P. Slopewash from the hillside was constructing an entrance rubble cone as before; however, silt from the entrance was filling in the lower portion of the cave. Rodents continued to deposit bones on the back slope of the cave (Stratum BXV) until at least 4000 B.P. Creep and slopewash at the back of the cave had ceased, and the cave probably had become a dry environment, except when briefly flooded from the entrance. Therefore, the rubble slope (BIX) no longer accumulated at the back of the cave.

LATE HOLOCENE

Since about 5400 B.P., the major depositional agent has been animals, including humans, rodents, and bats. Vegetal material and guano has accumulated on the surface of the sediment, and burrowing by humans and rodents has caused mixing of the sediment. Much of the organic material has become dry and pulverized, perhaps through trampling by humans. Strata I and III were deposited by the depositional system typifying the Middle Holocene, but these were brief episodes only. Figure 35 diagrams the Late Holocene depositional regime.

Geologic History of Hidden Cave

Hidden Cave was created about 21,000 B.P., when the waves of rising Lake Lahontan excavated a hole beneath the tufa-cemented gravel on Eetza Mountain. The cave was filled with water until about 18,000 B.P. when it was briefly exposed and rubble accumulated in it (Stratum XII). The water of the lake rose and shallowly drowned the cave from about 18,000 until about 15,000 B.P. The cave was briefly above water again about 15,000 B.P., then deeply drowned until about 10,000 B.P. From 10,000 until about 7500 B.P., the interior was moist, and debris accumulated on slopes from the entrance and from the back of the cave. About 7500 B.P. a climatic change allowed it to dry out, and the accumulation of debris ceased at the back of the cave, but continued at the front. Increasingly torrential rainfall along with drying climate carried silt into the cave as small floods, so the lower portion began to fill with layered silt. When the Tsoyawata and Mazama tephras fell about 6900 years ago, they were washed into the cave as layers of silt and fine sand.

From about 5400 until about 3800 B.P., the climate was so dry that little sediment of any kind was deposited in the cave. From 3800 until about 3700 B.P., humans carried large quantities of vegetal material into the cave, creating the 32 Inch Midden (Stratum IV). Briefly, about 3680–3700 B.P., summer precipitation brought silt in (Stratum III), but this soon ceased as precipitation became more winter-dominated. Humans continued to occupy the cave until perhaps 3600 B.P., and thereafter they used it occasionally; the accumulated organic material from this time is Stratum II. At 1500 B.P., summer precipitation carried silt into the cave again, creating Stratum I.

CHAPTER 8. NOTES ON CORRELATING THE VARIOUS HIDDEN CAVE COLLECTIONS

DAVID HURST THOMAS AND NANCY K. BERNSTEIN[1]

This monograph discusses Hidden Cave data recovered from three separate excavations, conducted by three independent teams of archaeologists over a period of four decades. Although such diverse excavation techniques and strategies invariably lose some information, we think it possible to meld these three discrete data sets into a single, coherent Hidden Cave assemblage. Because all the analysis in this volume is presented in terms of the 1979–1980 American Museum nomenclature, it becomes necessary for us to correlate both the Wheeler and the Roust-Grosscup collections into the 1979–1980 stratigraphic sequence. We are confident about the accuracy of these correlations, but scientific veracity requires that we explain our procedures to enable other investigators to assess the decisions we made in the correlation process.

CORRELATING THE 1940 WHEELER COLLECTION

Our most difficult correlation was to bridge the gap between the Wheelers' 1940 excavation and the stratigraphic units employed by the American Museum of Natural History in 1979–1980. We attacked the correlation problem during the 1980 Hidden Cave field season and this was fortunate since it turned out that the final correlation required testing by further excavation.

Previously, Dr. Gordon Grosscup had attempted to correlate the 1940 Hidden Cave collection, without success. Grosscup (n.d.) discussed the problem: "Although the artifacts which Wheeler recovered were made available to us by the Nevada State Museum, we were unable to correlate our (1951) strata with his, since there were no stratigraphic records at the Museum. It is hoped that someday this material will be published for it will not only augment, but will also check our work."

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Fortunately for us, Donald Tuohy (Curator of Anthropology, Nevada State Museum) has since located the missing 1940 stratigraphic drawings, and he generously made this newly found data accessible to us. Without Tuohy's help, a workable correlation would have been impossible.

Wheeler's field notes and artifact records are so meticulous that we could plot most artifacts both stratigraphically and horizontally for each stratum. For some reason, Wheeler never compiled a master stratigraphic description, meaning that we could judge the efficacy of his stratigraphy only according to the artifact inventory. In practice, this meant that if a particular stratum was sterile or absent in a given area, no mention was made of it in the field notes. Fortunately, Wheeler's Strata #1–6 were relatively well represented in most excavation units, and we could reconstruct the stratigraphic profile across most excavation trenches. The only apparent anomalies are "Stratum #7" and "Floor IA," which appeared in units E/8/7 and E/7/6 (respectively) in the northern portion of the excavation, but were absent to the south.

Provisional correlations were established in this manner, but this method proved unsatisfactory because artifact plots alone did not provide definite characteristic stratigraphic signatures. That is, using only field notes, we could not establish one-to-one correlations between Wheeler and American Museum excavation units.

To remedy this, we initiated test excavations in July 1980 to test our provisional 1940–1980 correlation. A 1 × 2 m. test pit was excavated along the southern slope of the cave, where Wheeler had mapped and described a profile that included Strata #1–6. The north wall of E/5/3 provided a reference point from which to measure the boundaries of Wheeler's main north-south trench and of the east-west extension of that trench (where unit E/5/3 was located).

We then probed the deposit along the

southern portion of Wheeler's trench, to determine the exact placement of the test pit. The 1 × 2 m. unit, aligned according to the American Museum grid lines, was positioned so as to intersect Wheeler's 1940 trench. This stratigraphic test unit was labeled RT 1.7 because it spanned AMNH grid lines Rho, Sigma, and Tau in an E/W direction, and 0.7 to 1.7 m. in a N/S direction.

Unit RT 1.7 conclusively established the 1940–1980 correlation. Using stratigraphic descriptions from Wheeler's cross-section of the west side of E/8 and F/8, we could readily identify the 1940 Strata #3–6. Stratum #4 (described by Wheeler as "tule, cane, grass, guano—matted—rotten—mouldy, some pebbles") is particularly diagnostic, covering most of the test unit RT 1.7 (except in the eastern half where it was disturbed by the 1940 Wheeler trench).

Wheeler's Stratum #4 thus became the marker bed to which the other stratigraphic units were correlated. Stratum #3, occurring immediately above Stratum #4, was better preserved and considerably less matted. AMNH Feature 113 (a concentration of well-preserved grass and reeds, some of which were twisted and knotted) lay on the contact between Stratum #4 and Stratum #5 (described as "tule, cane, grass—guano covered—good condition"). The stratum observed in 1980 did indeed contain tule, cane, and grass but in a rather good state of preservation. The underlying Stratum #6, containing considerably less organic material, was only slightly compacted and a lighter color than the three overlying strata. Stratum #6 lay directly above the tufa floor, (what Wheeler referred to as "laminated white rock floor").

The 1940–1980 correlation column existed in a stratigraphic sequence about 20 cm. thick, and each stratum was distinct. A number of artifacts were recovered in this strata test, including Gatecliff Split Stem and Contracting Stem points, juniper berry seeds, and pieces of leather (described below).

CORRELATING THE 1951 ROUST-GROSSCUP COLLECTION

Correlating the 1951 Roust-Grosscup material was relatively simple. Through the courtesy of Dr. Gordon Grosscup, we had access to the original color-coded stratigraphic profiles prepared during the 1951 excavations. The Roust-Grosscup sidewalls were largely intact when we began our 1979 excavations, and we had little difficulty in determining vertical and horizontal correspondences between Morrison's (1964) stratigraphic units and those defined in 1979–1980. Dr. Grosscup was also extremely helpful in clearing up specific stratigraphic difficulties.

THE MASTER 1940–1951–1980 CORRELATION

The only stratigraphic profiles in the Wheeler field notes show the southern portion of his main north-south trench. Our correlation is based on these profiles and the accompanying stratigraphic descriptions. The correlation effort is hampered, to some degree, by the 1951 Roust-Grosscup Trench K because it separated Center-Back and Back facies, rendering a continuous profile impossible.

Wheeler noted on his cross-section of the west side of E/8 and F/8 that most of Strata #1 and #2 had been destroyed by guano hunters. Stratum #3 was evidently found intact in most of his units, as were Strata #4–6. Stratum #7 is not shown in this cross-section and was not described in the field notes for this area of excavation.

As noted earlier, Stratum #4 was the marker bed for the 1940–1980 correlations. AMNH units Pi 5 and Pi 6 occurred in the upper part of the Roust-Grosscup 32 Inch Midden. Wheeler's Stratum #3—and probably also Strata #1 and #2 (although they were absent)—correlate to the Roust-Grosscup Surface Midden (AMNH Stratum II), deposited after Stratum #4 had already become compact. This suggests a temporal discontinuity between Wheeler's Strata #4 and #3, correlating with the AMNH Stratum CIII striated silts.

Wheeler's Strata #4 and #5 are separate extensions of two layers within the Roust-Grosscup 32 Inch Midden, and a hiatus may be indicated in their stratigraphic profile at the rear of the site. AMNH Feature 113 lay between Wheeler's Strata #4 and #5, and was

TABLE 18
Summary of the 1940-1951-1980 Correlations

Wheeler—1940	Morrison (1964)—1951	AMNH—1980 Strata
Surface	1. Upper Fallon	I, XVII
Strata #1–3; Stratum #4 E/W Trench; Stratum #5 E/W Trench	2. Top Midden: Second Fallon Lake	II
Stratum #6 E/W Trench	3. and 4. First Interlake	III, XVIII, XX
Stratum #4 N/S Trench; Stratum #5 N/S Trench; Stratum #7	5. (in part). 32-Inch Midden	IV
Stratum #6 N/S Trench	5. (in part) and 6. (in part, from bottom of 32-Inch Midden to Mazama Ash)	V, XIX
	6. (in part). Mazama bed, Tsoyawata bed, and any sediment in between	VI
	6. (in part). Striated silts between Mazama member and topmost rubble	VII
	7. (in part). Interbedded silts and rubble	VIII
	7. (in part). Reddish bone hash between rubble and silt in back of cave	BXV
	7. Rubble	IX
	8. Clean pebble gravel, dendritic Sehoo	X
	(not in Morrison's section: 0–30 cm. of rubble and organic material between clean pebble gravel and oolitic tufa in back of cave)	XVI
	9. Dendritic Sehoo: oolitic tufa	XI
	10. and 11. Gravel and sand, middle tongue of Indian Lakes	XII
	12. Graded bed from sand to clay, deeply fractured	XIII
	13. Reddish gravel, bottom not observed	XIV

neither as matted nor as decayed as the contact layers.

Wheeler's Stratum #6 lies above the tufa and is probably equivalent to a Back facies of AMNH Strata V–IX.

The 1940 field notes discuss a Stratum #7 and also mention Stratum #5 in E/5/3 above a "hard clay" layer (above the 32 Inch Midden); this suggests to us that Wheeler may have lost track of his strata as he moved from the Back facies through the Center-Back to the Center facies. Near the Roust-Grosscup Trench K and AMNH grid lines 5 and 6, the Surface Midden and the two layers of the 32 Inch Midden seem to merge into a single stratigraphic unit. If one viewed this change in the north-south direction, it would be easy to believe mistakenly that the silts separating the Surface from the 32 Inch Midden are equivalent to Wheeler's Stratum #6 in the Back facies. Wheeler's limited excavations did not reveal the sloping profile of the 32 Inch Midden, and he quite naturally thought that the Surface Midden was an extension of organic layers in the back of the cave. Because he thought that the striated, inorganic silts were the extension of his Stratum #6, Wheeler assigned the term Stratum #7 to the remaining 32 Inch Midden in the central facies.

Once the artifacts and ecofacts from Stra-

tum #6 were correlated, it was necessary to take into account the excavation square from which they derived. Whenever Stratum #6 was listed for Wheeler's east-west extension units (i.e., E/5/3, E/5/4, E/6/3, etc.), it was correlated with AMNH Stratum CIII. But whenever horizontal provenience derived from the north-south trench (from F/8/3 and F/9/3 to E/8/1 and E/9/1), Wheeler's Stratum #6 is correlated to AMNH Stratum BV–IX. The same procedure applies to Strata #4 and #5; these strata correlate to AMNH Stratum II in the 1940 east-west extension.

1940–1951–1980 correlations are summarized on table 18.

A GENERAL NOTE ABOUT HIDDEN CAVE CORRELATIONS

Operating within these guidelines, actual correlation of artifacts and ecofacts from the Hidden Cave collections posed no major analytical difficulty.

But even so, it was necessary to establish additional ground rules defining what items were to be included in our analysis, and what items would be excluded.

We include in this volume only artifacts and ecofacts known to have come from inside Hidden Cave. This is important because Hidden Cave has had a rather different historical and functional structure from the open-air sites surrounding it. The temporal duration of activities at Hidden Cave is rather restricted, and this critical distinction can be easily blurred when items from outside Hidden Cave are lumped into the analysis.

There is, for instance, some indication that the two "Hidden Cave" fish nets (Ambro, 1966) actually came from one of the other large caves in the Grimes Point area (see chap. 22). This is not a trivial matter, since one of the nets was repaired with cotton, thereby implying historic usage of these artifacts. We exclude those two artifacts from consideration because of their questionable provenience. Similar caution is applied to all other artifacts of questionable provenience.

The term "no provenience" thus has little meaning in this analysis; if an item is described in this volume, we are satisfied that it was recovered from inside Hidden Cave. But artifacts and ecofacts are correlated to AMNH stratigraphic units only with caution: *if there is any doubt as to the correlation of an item, it is assigned to a "not correlated (N.C.)" category.*

Items provenienced as "N.C." are thus known to have come from Hidden Cave, but from an unknown stratigraphic context.

Finally, despite our attempt to reanalyze all extant Hidden Cave materials, a few artifacts have been either lost or are currently inaccessible to us. In such cases, the existence of additional yet unavailable material is noted. Our objective is to provide as comprehensive a set of artifact and ecofact descriptions for the Hidden Cave collection as possible, regardless of when the materials were excavated or where they are currently curated.

CHAPTER 9. POLLEN AND SEED ANALYSES

PETER E. WIGAND[1] AND PETER J. MEHRINGER, JR.[2]

Hidden Cave has been known to guano miners since the 1920s and was last investigated by archaeologists and geologists in the 1950s (Grosscup, 1956; Roust and Grosscup, 1957; Morrison, 1964). Its record of late Quaternary lake deposits overlain by silts, containing volcanic ash and archaeological midden, made it a potentially important locality for establishing the ages and relationships of the environments and human occupations of the Carson Sink area.

By 1978 it was clear that the remaining cave deposits, along with their fossils and artifacts, were in danger of total destruction by looters and vandals. When it was decided to continue excavation of the remaining undisturbed deposits, reconstruction of late Quaternary paleoenvironmental settings became a prime objective (chap. 5). By studying the pollen and seeds in cave fill and human coprolites we hoped to contribute to a better understanding of the relations between vegetation history and climatic change, and the resources utilized by the inhabitants of the cave.

The effects of climatic and vegetational changes upon cultural adaptations is clearly seen in archaeological remains from caves in the pluvial lake basins of the northern Great Basin. Here, fluctuating lakes and water tables directly affected subsistence practices of Great Basin hunter-gatherers. We anticipated—in accord with the aims of the Hidden Cave Project—reconstructing environmental changes that influenced ancient lifeways. However, primarily because of the insensitive position of Hidden Cave well within the shadscale zone, initial analysis showed that a study of pollen from the sediments of the cave was unlikely to produce the clear evidence necessary for vegetational reconstruction.

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We therefore directed attention to those problems of cave and human history that could be more efficiently investigated through study of pollen grains from cave fill and coprolites. Samples initially collected for the study of environmental change were used instead, along with sediment analysis, for other inquiries. Our limited participation in the project (two short visits to the cave in summer of 1979) prevented us from pursuing some of the suggestions presented here with further sampling during subsequent field seasons.

Great Basin paleoecologists are fortunate in having the good works of others as guides to what might be most productively pursued. We knew, for example, that pollen analysis of coprolites was likely to give direct information on prehistoric diet, including the kinds of food eaten (Kelso, 1970, fig. 1), its preparation (Napton and Kelso, 1969, p. 26), and the season and region of its collection (Heizer and Napton, 1969; Fry, 1977, p. 25). Seeds from coprolites, in conjunction with pollen, can further delimit the time of harvest (Hogan, 1980, table 4). Kelso (1970, fig. 2) illustrated the usefulness of pollen spectra for correlating cave strata and, along with others, suggested vegetational reconstructions from the pollen of Great Basin caves (Sears and Roosma, 1961; Kautz and Thomas, 1972; Byrne, Busby, and Heizer, 1979; Lindsay, 1980).

Analysis of pollen contained in sediments from Hidden Cave could reveal changes caused by either natural processes or human activity. Pollen per volume and weight of cave fill could vary with the size of the cave entrance, depositional environments, sedimentary processes or rates of deposition. The latter would provide a relative measure of the duration of specific events (e.g., deposition of Mazama Ash [Blinman, Mehringer, and Sheppard, 1979]). Human intrusion is readily recognized by unusual abundances (e.g., cattail pollen) or specific types (e.g., dock pollen). Changes in the abundance of particular pollen types from one stratigraphic unit to

the next might also measure variation in the use of Hidden Cave. Although analysis of cave sediments containing pollen introduced through storage or processing may reveal the kind of plants collected and the areas of the cave where they were treated (Pippin, 1979, pp. 253–254), intensive activity could result in lateral mixing of cave deposits thereby masking evidence of use areas.

We expected study of the pollen contained in the numerous coprolites from the dated middens of Hidden Cave to reveal information about what the ancient foragers ate, how they prepared it, and where and when they obtained it. In addition, associations of seeds and pollen that matured in different seasons would suggest something about food storage. In these studies we were aided by K. L. Petersen, A. G. Marshall, M. A. Mehringer, A. L. Runnings, C. S. Smith, and J. Mastrogiuseppe and the staff of the Marion Ownbey Herbarium.

METHODS

Cave Fill

A profile of 54 pollen samples was collected from cave fill. Location of the profile was determined by the project geologist to most completely represent the sequence of deposits available at the time (July 1979). The samples were continuous or nearly so, and sample height varied from 2 to 12 cm. (fig. 36).

Upon being returned to the Laboratory of Anthropology, Washington State University, 26.8 cu. cm. of each sample was oven-dried, weighed, and placed in a beaker. To estimate the number of microfossils per volume and weight of sediment, eight commercially prepared tablets (Batch No. 212761), each containing 12,500 ± 500 *Lycopodium* spores (Stockmarr, 1971, 1973), were added to each sample as a first extraction procedure. A minimum of 50 *Lycopodium* tracers were counted for each level. Pollen extraction generally followed Mehringer (1967); the samples were acetolyzed and mounted in silicone oil (2000 cs).

Before extraction the samples were washed through a 100-mesh (<150 μm.) screen to separate organic debris and rock fragments. Because the weight of coarse rock fragments varied from sample to sample, all material remaining on the screens was oven dried and weighed to determine pollen per total sample weight and per fine fraction (<150 μm.). Microfossil counts and sediment weights were entered on a computer file for future manipulation.

Coprolites

Of the 58 coprolites initially received for analysis, 12 were selected as human coprolites by their physical characteristics (Kelso, 1976; Fry, 1977), especially color and larger size. They also contained comparatively little bone and hair. In addition, 14 previously unrecognized human coprolites were later located in level bags and processed for pollen.

Samples of coprolites were taken by removing a piece (about 3 cu. cm.) from the specimen. This subsample was washed with distilled water to remove dust adhering to the surface, placed in a weighing pan, and then oven dried at 105°C. for at least 24 hours. The weighed specimen, together with 13 *Lycopodium* tracer tablets, each containing 10,850 ± 250 spores (Batch No. 006720; 141,050 ± 720 total tracers), was placed in 5 percent trisodium phosphate solution. Following Kelso (1976), the sample was kept covered at 45°C. for seven days, screened, extracted routinely for pollen (HCl, HF), acetolyzed, and mounted in silicone oil (2000 cs). Material remaining on the 100-mesh screen was later examined for macrofossils. The residues were returned to the project for future analyses (e.g., parasites). At least 262 pollen grains (13,190 maximum) were counted for each sample, whereas *Lycopodium* counts varied from eight to 1012. In contrast with the cave fill samples, all pollen and spores are included in the pollen sum of coprolites.

Seeds

Although we intended no complete analyses of plant macrofossils from Hidden Cave, in the process of searching level bags for human coprolites, we separated seeds, fruits, and inflorescences. These were identified using seed atlases (Martin and Barkley, 1961; Berggren, 1969; Montgomery, 1977), floras (Hitchcock and Cronquist, 1973; Munz and Keck, 1973), and the comparative seed collection of the Laboratory of Anthropology,

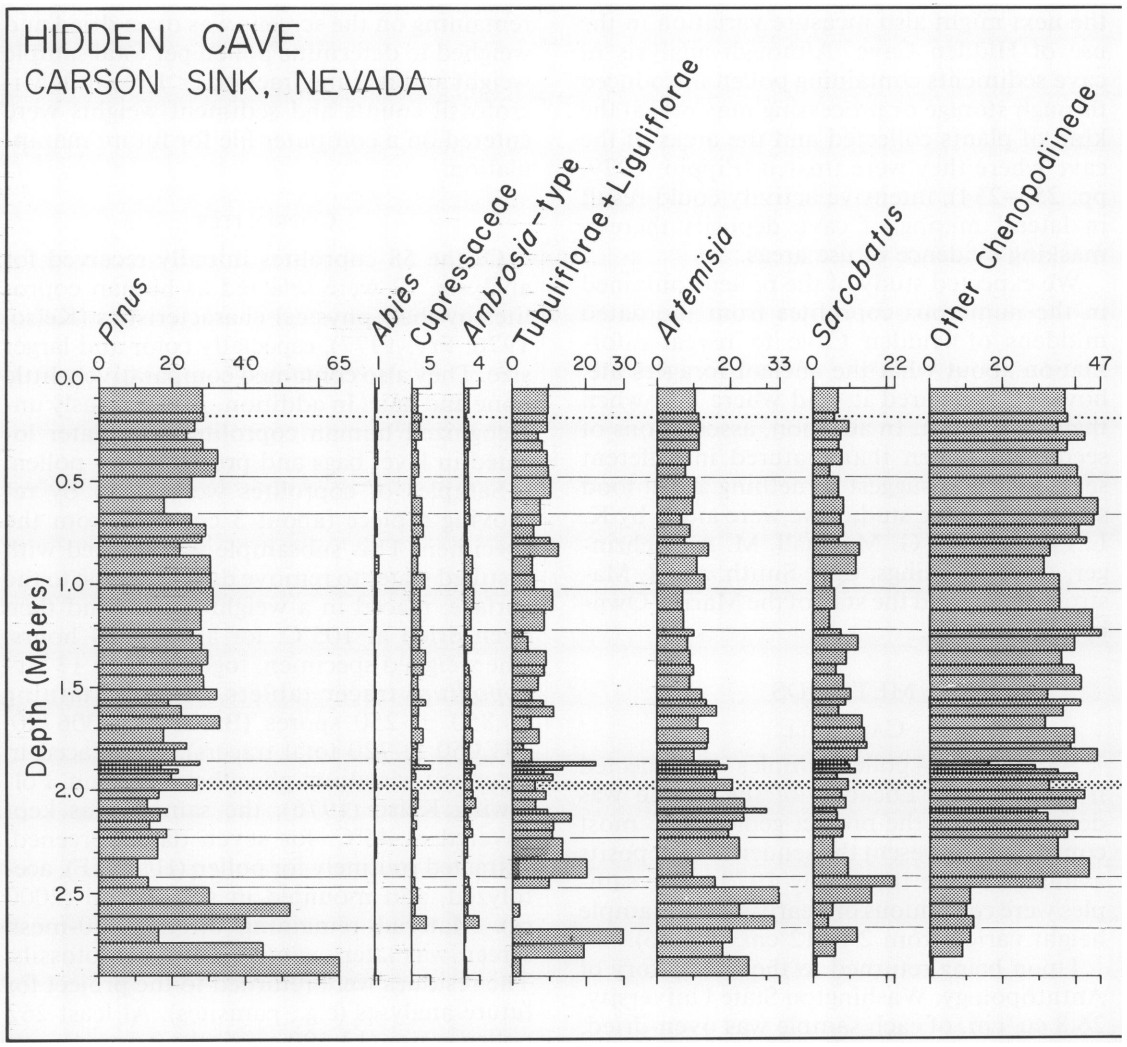

FIG. 36. Pollen diagram from Hidden Cave, Nevada. The diagram is based on analysis of 49 sediment samples spanning the last 18,000 years or so. According to Davis (chap. 7, this volume), Stratum XI, the "carbonate" layer of Morrison (1964) dates from sometime between 15,000 and 10,000 B.P. The Tsoyawata tephra dates from about 7000 B.P., and the Mono tephra dates about 1100 B.P. (chap. 7,

Washington State University. Identified seeds were returned to the project staff for cataloging and assignment to stratigraphic units. Common names used in this text follow Munz and Keck (1973).

SEDIMENT ANALYSIS

In addition to the pollen and seed studies, sediment-size analyses of 21 samples from the pollen profile were completed by wet screen and hydrometer methods after routine pretreatment to remove carbonates and organic matter (HCl, H_2O_2; see Black, 1965). These were divided into 26 size classes at 0.5 phi intervals from -3.5 to $+9$ phi. Results of these analyses were forwarded to the project geologist and are discussed here only as they pertain to pollen influx estimates and generalized characterization of Hidden Cave sediments.

To compare both sediment size parameters

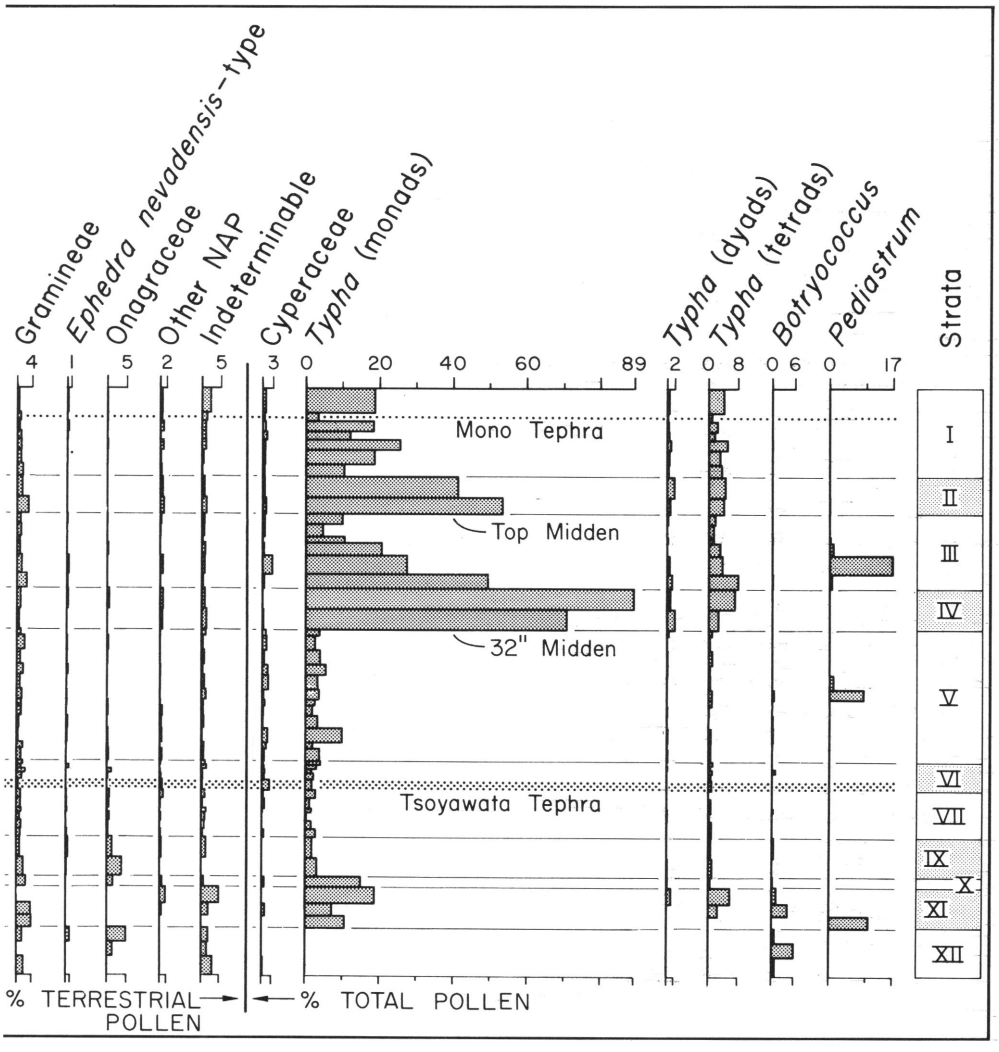

FIG. 36. Continued.

this volume; Davis, personal commun.). Aquatic and marsh species, as well as algae and spores, are excluded from the pollen sum (terrestrial pollen). Geological units assigned to the strata follow Davis (table 6, this volume).

and pollen content from various localities within the cave we requested sets of samples from clearly traceable stratigraphic units. The project geologist forwarded 13 samples with sufficient material for both sediment size and pollen analyses; of these, we studied 10 samples from two stratigraphic units. Using the sediment size analyses from the pollen profile and from two stratigraphic units, we hoped to examine relationships between pollen abundance and the volume, weight, size distribution, and lateral position of samples collected from Hidden Cave.

THE FOSSIL POLLEN RECORD

CAVE FILL

All pollen counts from cave fill are plotted on the percentage diagram (fig. 36) as percentage of the sum of terrestrial pollen. Pollen of aquatic and marsh species, spores, and algae are excluded from the pollen sum. The

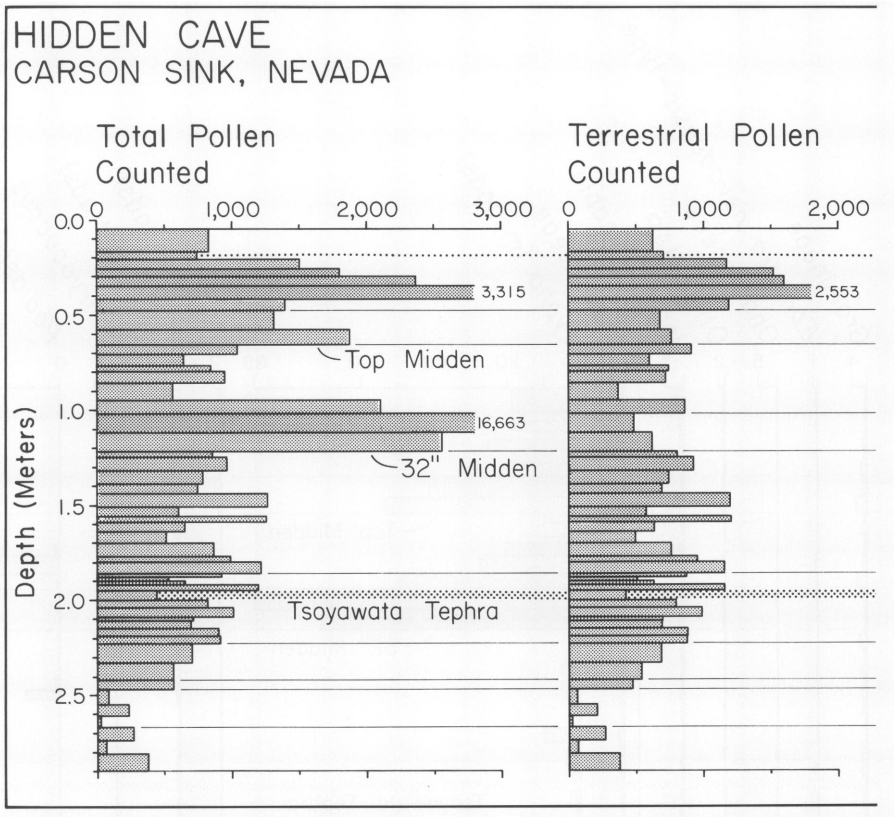

FIG. 37. Population estimates for total pollen and terrestrial pollen based on the number of *Lycopodium* tracers (100,000 were introduced to each sample) encountered while making the pollen counts of cave fill.

depths given for each sample are in meters below the surface at the pollen profile (base of Tsoyawata Bed is at 2 m.).

Pollen was relatively sparse in the deepest samples collected from lake clays overlain by gravels (Strata XIII and XII). Of eight samples extracted from these sediments only two contained sufficient pollen for reasonable population estimates; four samples contained few pollen and abundant *Lycopodium* tracers, whereas two contained only the introduced tracers. Only the middle of three samples from the overlying "carbonate" layer (Stratum XI) contained sufficient pollen for reliable comparisons. Several pollen counts, from within and below the "carbonate" layer (Strata XII and XI) are, however, included on the pollen diagram and on figures 37 and 38. These counts illustrate both the sparse pollen in samples collected from below Stratum X and, because so few pollen are present, the unlikelihood of major contamination by the pollen-rich dust from younger cave deposits.

We anticipated difficulty in collecting contamination-free pollen samples; in fact to avoid such contamination our sampling was done at night, after the dust of the day's excavation had settled. However, whatever contamination might have occurred during collection of the samples must have been minor because there are such clear differences in the pollen content of sediments from above and below Stratum IX.

The only significant change in the percentages of terrestrial pollen occurs at the upper boundary of the "carbonate" layer (between Strata XI and X) 15,000 to 10,000 B.P. (chap. 7, table 6, this volume). Here, *Pinus* and *Artemisia* pollen values decline, and Chenopodiineae pollen (amaranths and salt-

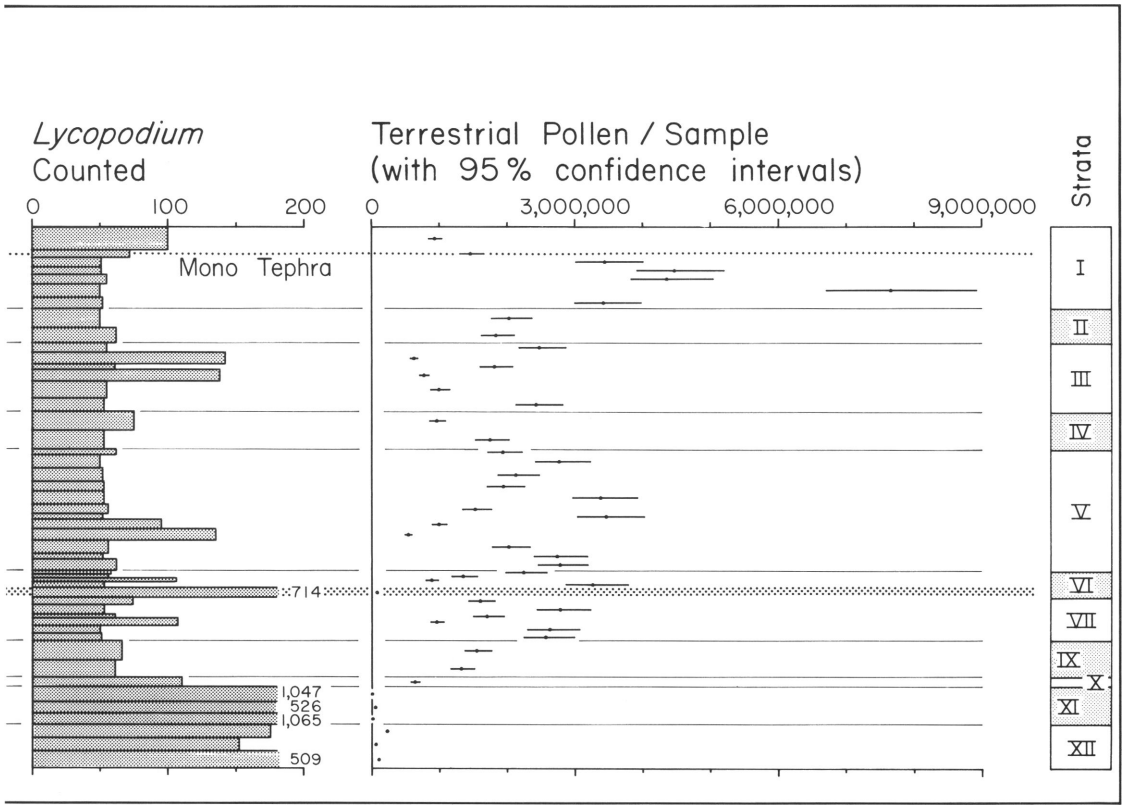

FIG. 37. Continued.

bushes, excluding *Sarcobatus*) is dominant thereafter. This abrupt change leads us to suspect a significant hiatus in deposition between Strata XI and X. *Artemisia* pollen values continue to decline until shortly after deposition of the mid-Holocene volcanic ash (Tsoyawata Bed).

Above the volcanic ash, which fell about 7000 radiocarbon years ago, all important changes probably resulted from the collecting activities of man. This is clear from the abundance of cat-tail (*Typha*) pollen in both the 32 Inch (Stratum IV) and Top Midden (Stratum II) samples. For example, the 16,663 cat-tail pollen counted while observing only 75 *Lycopodium* tracers in the upper of two samples from the 32 Inch Midden (Stratum IV) results in a population estimate of 1,207,013 pollen per cubic centimeter of sediment (figs. 37 and 38). This figure exceeds, by thousands of times, the amount of cat-tail pollen that could conceivably have been wind-borne from the valley marshes. There is no doubt that two species of cat-tail and their hybrids were carried to the cave by foragers during the summer when cat-tails flower. The cat-tail pollen monads are produced by *Typha angustifolia,* the tetrads by *Typha latifolia,* and the dyads most probably represent hybrids of these two (Mehringer, 1967, pp. 170–172).

Occurrences of freshwater, acid-resistant algae (*Botryococcus* and *Pediastrum*) within the cave fill are puzzling. If the lake edge stood near the cave, low percentages of algae could have been transported by wind from the seasonally dry shore. This most probably accounts for the *Pediastrum* and *Botryococcus* occurring within or below the "carbonate" layer (Stratum XI). The algae could also have been brought in with pond mud adhering to plants or persons. *Pediastrum*-containing materials (tules, cat-tails, and even algal

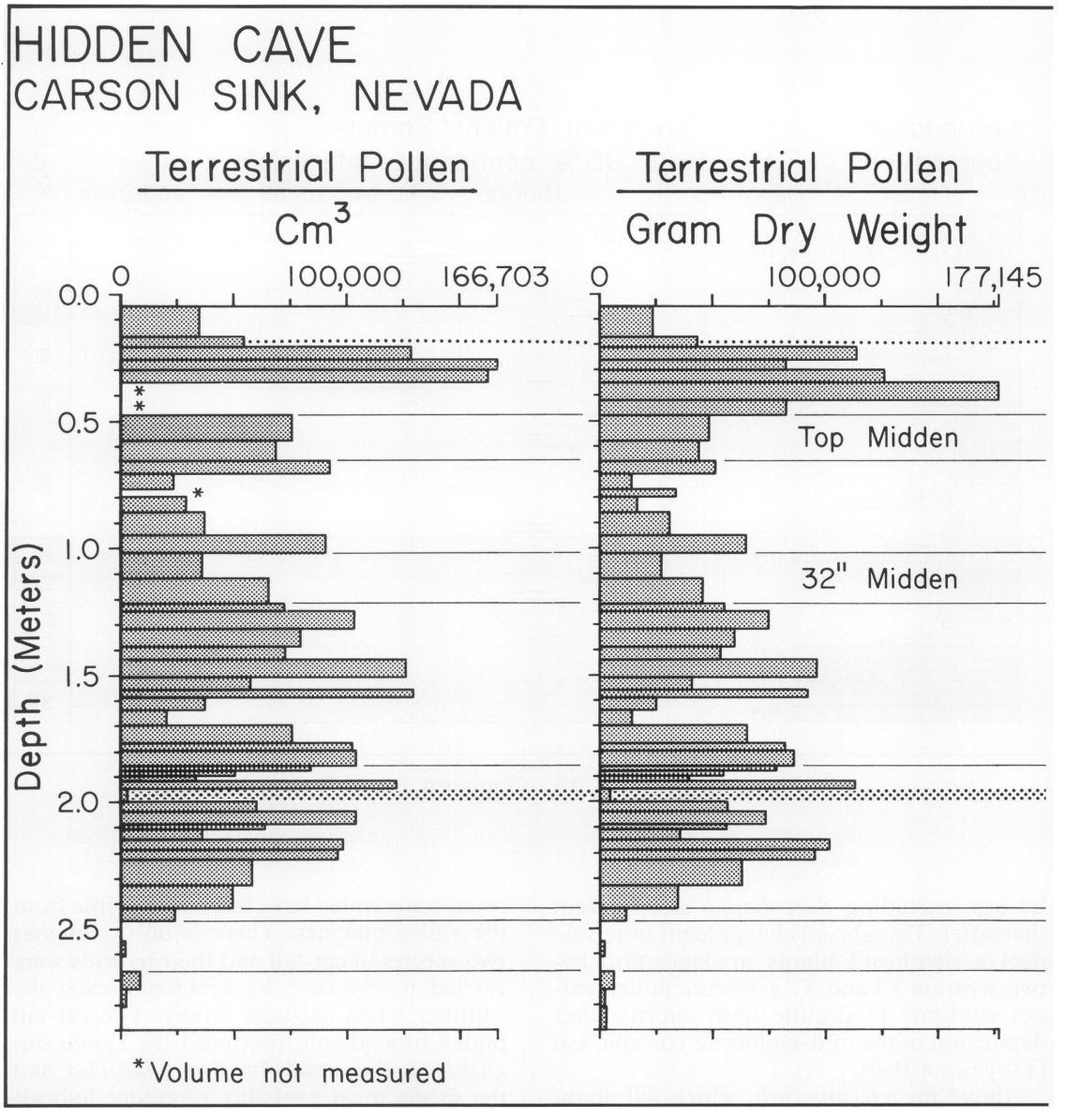

FIG. 38. Population estimates (fig. 37) per cubic centimeter, per gram dry weight of cave fill, and per gram dry weight of cave fill less than 150 μm.

mats) were used to line and cap storage pits and to cover living floors (Hattori, 1982, p. 11). In any case, we attribute the *Pediastrum* in Strata V and III to human activity.

Although terrestrial pollen percentages (fig. 36) reveal only two important changes in the regional vegetation, influx estimates indicate several fluctuations in pollen production and/or deposition rates. Figures 37 and 38 show the population estimates for terrestrial pollen for each sample, per cubic centimeter and per gram dry weight of the entire sample, and of the fine fraction (<150 μm.). Regardless which of these measurements is used (sample weight or volume), the results are consistent and clearly indicate differences in pollen ac-

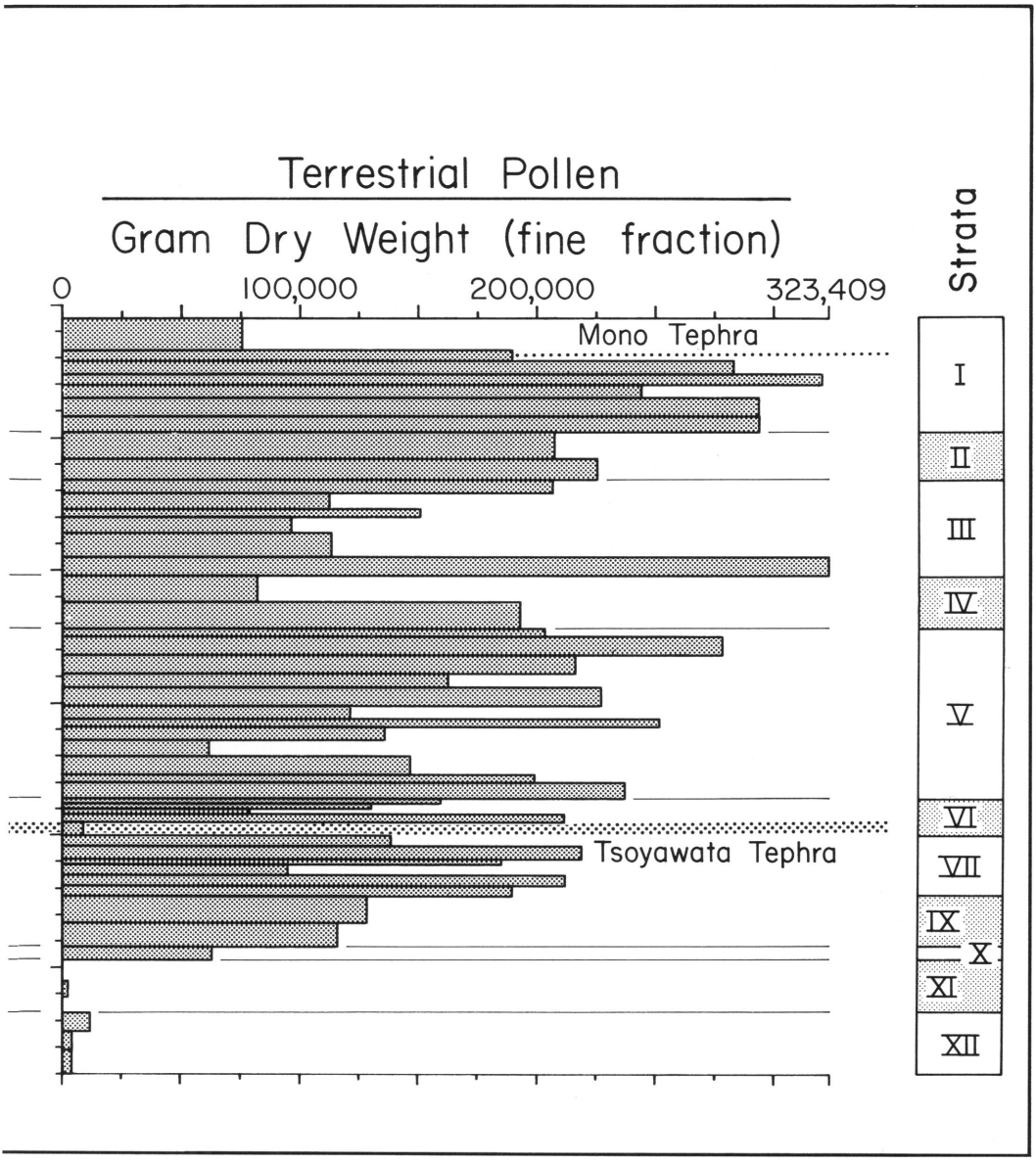

FIG. 38. Continued.

cumulation rates or in deposition rates. The extremes of pollen content between Stratum I and the Tsoyawata Bed illustrate this point.

Excluding the uppermost sample, Stratum I samples deposited within the last 1500 years or more (chap. 7, table 6, this volume) contain more terrestrial pollen on the average than those of any other stratum (figs. 37 and 38). These large values in pollen per cubic centimeter or gram dry weight could result from decreased sedimentation rates through restriction of the cave entrance or stabilization of the slopes supplying colluvium to the cave. Increased vegetation cover on the slopes adjacent to the cave could account for increased pollen production as well as a less easily eroded slope. The low pollen values of the Tsoyawata tephra illustrate the effect of

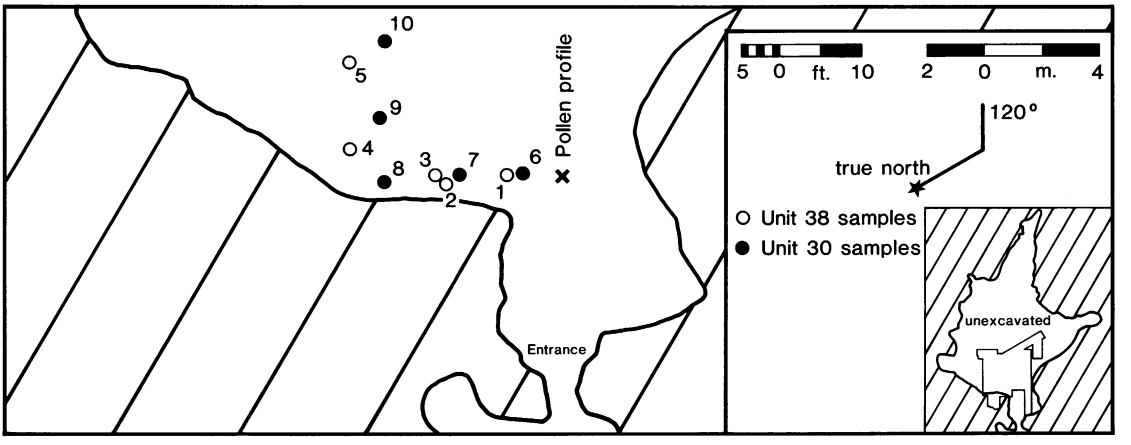

FIG. 39. Map of Hidden Cave at level of sediment surface before excavations, and location of main pollen profile (fig. 36) and samples collected laterally from stratigraphic units 30 (Stratum V) and 38 (Stratum III).

rapid deposition. We also conclude that this tephra remained on the slope for a short time, perhaps only a few days, before being washed into the cave; otherwise more pollen would have collected on the surface and would have been deposited with the volcanic ash.

By comparison with others from Stratum I the uppermost sample contains fewer terrestrial pollen per cubic centimeter, and per gram dry weight. Increased sedimentation rates within the cave could account for this decreased terrestrial pollen value. Enlargement of the cave entrance or increased slope wash into the cave would account for increased sedimentation rates. Perhaps the cave entrance was either intentionally or naturally enlarged at this time, or erosion rates on the slopes surrounding Hidden Cave increased due to reduced vegetation cover or a change to a more torrential rainfall regime. Changing climate or human disturbance could have resulted in decreased vegetation cover.

Low pollen numbers of the rapidly deposited Tsoyawata tephra contrast sharply with the abundant pollen of Stratum I at the pollen profile site (figs. 37 and 39). Because the pollen content of the sediments appeared to provide a measure of deposition rates, we decided to study the lateral distribution of pollen abundance in Stratum III (Unit 38) and Stratum V (Unit 30). The results (table 19) clearly show that pollen abundance (per cu. cm. and per gram dry weight) varies laterally within the same stratigraphic unit. As might be expected from the similar results of two pollen profiles analyzed from Hogup Cave, Utah (Kelso, 1970), pollen percentages distinguish Strata III and V throughout the cave.

We believe that, even with the observed lateral variation, pollen abundance in cave fill could provide information on deposition rates and chronology (Mehringer, Blinman, and Petersen, 1977; Birks and Birks, 1980, pp. 206–227). Any such attempts would require unusually good chronological control for at least a portion of the sequence; this was not available for the Hidden Cave deposits. We speculate, however, that considering pollen abundance, a time span of 2000 or even 3000 years seems a reasonable estimate for Stratum I.

COPROLITES

Pollen counts, sample dry weight, number of *Lycopodium* tracers, and total pollen per gram dry weight for 26 human coprolites appear in table 20. Fifteen of the coprolites came from the two midden levels; eight were collected from between the middens (Stratum III); one was collected from Stratum V, and the remaining two came from back dirt.

Nineteen of the 26 coprolites contain over 36 percent *Typha* pollen; 12 of these contain

over 85 percent. Of the seven remaining coprolites analyzed, four are dominated by Chenopodiineae pollen (36%–72%), two by grass pollen (33% and 65%), and one by Compositae and chenopod pollen (27% each). In table 20 the Compositae category includes only long-spined Compositae (*Aster*-type) pollen. Occasional occurrences of other Compositae (*Ambrosia* type or Liguliflorae) are included in "Other NAP."

Cat-tail pollen is the most common in the human coprolites and represents at least two species, *Typha latifolia* and *T. angustifolia.* Only three coprolites are dominated (62%–96%) by *Typha* tetrads (*T. latifolia*). *Typha* monads (*T. angustifolia*) are the most common pollen type in the *Typha* dominated samples. *Typha* dyads, which make up no more than 2.6 percent of any one sample, have been included in the *Typha* tetrad category of table 20.

Of the five coprolites containing abundant Chenopodiineae pollen, three are from the Top Midden (Stratum II), and two are from disturbed contexts; all five differ markedly in other components. In addition to *Typha* these include *Rumex* sp. (dock), Compositae, *Artemisia, Sarcobatus,* Cyperaceae (sedge), *Holodiscus*-type (ocean-spray) pollen, and sample HC-65 contains 2.9 percent *Pilularia americana* (pillwort) spores.

Coprolite HC-554 from the 32 Inch Midden, which in its high Gramineae (grass) pollen percentage is similar to two coprolites from Lovelock Cave (Napton and Kelso, 1969, p. 23 and table 1), has much less of other pollen. Although cat-tail pollen makes up only 16.7 percent of the sample (11.7% *Typha* monad and 5.0% *Typha* tetrad), its presence reflects the importance of cat-tail in the diet. Occurrence of Chenopodiineae pollen (10.7%) may indicate ingestion of specific chenopods (e.g., *Allenrolfea* or *Chenopodium*) or may simply reflect other foods contaminated with Chenopodiineae pollen.

Sample HC-2344 from the Top Midden is of special interest because it contains 33 percent grass, 33 percent *Typha* monads, and 29 percent chenopod pollen, along with abundant charred, but unmilled, seeds of *Scirpus maritimus* (=*S. robustus*). Because *Typha* pollen would have been collected at least six weeks before mature fruits of *Scirpus maritimus* became available, we believe it likely that the *Scirpus* seeds had been stored since the previous fall or that the *Typha* pollen had been saved for several weeks or months. Of course we cannot exclude the possibility that this coprolite represents a mid-winter or spring meal of cached sedge seeds and cattail pollen.

Pine pollen occurs in most coprolites in very low frequencies as a background type ingested with other plant foods. Although *Pinus* exceeds 5 percent in three coprolites, this is still 10 percent below the pine pollen percentages of sediments surrounding the coprolites.

Artemisia (sagebrush) pollen is also rare except in one sample and totally absent from 10 samples. This may reflect the overwhelming abundance of *Typha* pollen, which has submerged the background pollen. In sample HC-25, however, the 20.2 percent sagebrush pollen is interesting because this percentage exceeds those obtained from sediments of comparable age and suggests two explanations. The first, especially considering the domination of the sample by generally nonfood plants such as *Sarcobatus* (greasewood) and long spine Compositae, is that the coprolite is nonhuman, coming instead from a browsing animal. On the other hand, if the coprolite is human, the high *Artemisia* pollen percentage suggests that the food forming the coprolite was eaten in the spring of the year when bud sage (*Artemisia spinescens*), which occurs locally, blooms.

Cyperaceae pollen, common in only one sample (HC-65, 34.6%), does occur in significant numbers in two other samples, one from just below the 32 Inch Midden (16.8%) and another from the 32 Inch Midden (9.1%). All three samples suggest ingestion of Cyperaceae flowers or plant material with Cyperaceae pollen adhering to it. In all other coprolites Cyperaceae pollen represents background pollen rain.

Two other relatively rare types, Onagraceae (evening-primrose) and Capparidaceae (caper), were included under "other NAP." In coprolite HC-25, Capparidaceae pollen is 4.1 percent and Onagraceae 2.7 percent of the sample. One other pollen of Capparidaceae occurs in coprolite HC-65. In coprolite HC-527, which is from the Top Midden and

TABLE 19
Selected Microfossil Counts and Percentages of Ten Sediment Samples from Hidden Cave, with Sample Weights and Pollen per Cubic Centimeter and per Gram Weight

Provenience	Sample	*Pinus*		Other AP		*Artemisia*		Compositae		*Sarcobatus*	
		No.	%	No.	%	No.	%	No.	%	No.	%
Stratum III Unit 38	P[a]	112	30.52	12	3.27	40	10.90	28	7.63	43	11.72
(between middens)	1	309	32.73	26	2.75	90	9.53	74	7.84	76	8.05
	2	483	36.95	32	2.45	142	10.86	69	5.28	94	7.19
	3	467	33.99	39	2.84	119	8.66	95	6.91	102	7.42
	4	722	27.37	113	4.28	345	13.08	133	5.04	202	7.66
	5	413	35.79	49	4.25	104	9.01	56	4.85	70	6.07
Stratum V Unit 30	P[a]	342	28.52	21	1.75	107	8.92	103	8.59	99	8.26
(below middens)	6	139	28.66	9	1.86	105	21.65	54	11.13	27	5.57
	7	148	31.36	8	1.69	92	19.49	46	9.75	39	8.26
	8	185	32.98	9	1.60	89	15.86	64	11.41	40	7.13
	9	329	32.74	32	3.18	134	13.33	87	8.66	80	7.96
	10	201	24.39	13	1.58	170	20.63	71	8.62	53	6.43

[a] P = sample from the pollen profile.

dominated by cat-tail pollen monads, Onagraceae reaches 2.3 percent. Most genera of the Onagraceae likely to have occurred in the Hidden Cave area bloom in the spring.

Pollen per gram dry weight varies considerably from sample to sample, but samples with over 96.0 percent *Typha* monad pollen have the greatest pollen abundance, from nearly 3,000,000 to over 14,000,000 grains per gram (table 20). These amounts suggest that the pollen itself was eaten even though it was not scorched as has been reported for cat-tail pollen from Lovelock Cave coprolites (Napton and Kelso, 1969, p. 22). Therefore, we assume that fresh pollen was ingested with little or no preparation.

Seeds

The most common plant remains from Hidden Cave were the inflorescences, fruits, or seeds of six species: *Atriplex confertifolia* (shadscale); two grasses, *Distichlis stricta* var. *dentata* (salt grass) and *Oryzopsis hymenoides* (Indian ricegrass); and three sedges, *Scirpus americanus, Scirpus maritimus,* and *Eleocharis palustris* (table 21).

The most frequently identified plant species was *Atriplex confertifolia.* Shadscale is abundant on the slopes today and occurred from Stratum V upward in the cave sediments, but not always in undisturbed contexts. Usually the leaves were found and occasionally fruits and male flowers. Often the *Atriplex* remains came from areas of rodent disturbance or were associated with other materials (e.g., rodent dung), which suggests to us that *Atriplex confertifolia* made up part of the rodent nests. This does not, however, rule out the possibility that some of this material was brought into the cave by either man or some natural agency (e.g., slopewash). It occurred most commonly either in or adjacent to Stratum II, the Top Midden.

Of the two grasses (*Oryzopsis hymenoides* and *Distichlis stricta* var. *dentata*), *Distichlis* is by far the most common. *Distichlis* spikelets, glumes, and flowers are concentrated in the Top Midden or just above and below it. It does not occur in the 32 Inch Midden, nor below Stratum III except in one case that may result from rodent activity. *Oryzopsis* is rare among the identified species and its distribution is scattered from Stratum V upward.

Perhaps the most important seeds and inflorescences identified with respect to human activity are those of the three sedges. *Eleocharis palustris* remains consisted mainly of flower spikes, most with seeds. These were distributed in the upper three strata of the

TABLE 19—(*Continued*)

Other Chenopodiineae		Gramineae		*Typha* (monad)		*Pediastrum*		Pollen Sum		*Lycopodium*	Dry	Terrestrial	Terrestrial
								Terrestrial	Total	Tracers	Weight	Pollen/	Pollen/
No.	%	No.	%	No.	%	No.	%				(grams)	cu. cm.	gram
115	31.34	5	1.36	158	28.16	96	17.11	367	561	55	32.1739	37,347	31,109
325	34.43	21	2.22	484	31.49	97	6.31	944	1537	113	37.1306	67,642	48,823
429	32.82	38	2.91	1086	40.16	246	9.10	1307	2704	103	32.2374	102,746	85,416
503	36.61	25	1.82	392	20.07	188	9.63	1374	1953	115	34.8203	96,741	74,459
1000	37.91	86	3.26	694	18.89	390	10.62	2638	3674	85	31.8918	251,293	211,172
405	35.10	33	2.86	686	32.96	302	14.51	1154	2081	112	34.7572	83,428	64,328
495	41.28	11	0.92	41	3.24	13	1.03	1199	1267	53	35.0100	—	96,926
139	28.66	9	1.86	13	2.53	0	0.00	485	513	183	33.4122	21,459	17,213
125	26.48	3	0.64	16	3.19	3	0.60	472	502	207	41.3807	18,463	11,957
162	28.88	8	1.43	14	2.41	1	0.17	561	581	119	36.2001	38,172	28,260
308	30.65	9	0.90	33	3.08	7	0.65	1005	1070	108	13.4088	75,347	75,298
290	35.19	9	1.09	32	3.65	3	0.34	824	877	127	37.9370	52,535	37,112

cave except for one specimen which occurred in Stratum IX and may have been deposited there by rodents. A few inflorescences but primarily seeds, charred and uncharred, of both *Scirpus americanus* and *Scirpus maritimus* make up the bulk of the identified sedge remains. Again they are most common in the Top Midden or immediately below it in rodent-disturbed sediment. Fruits of these sedges would have become available in late summer to early fall.

Juniperus, Lomatium, Sparganium, and *Typha* are other important genera represented by macrofossils. We identified 10 beads made from the seeds of *Juniperus osteosperma* from the 32 Inch Midden, and additional juniper seed beads were recovered and identified from Hidden Cave after our work had been completed (chap. 18, table 66, this volume). Hattori (1982) reported 2123 juniper beads from Kramer Cave, Winnemucca Lake, and reviewed their occurrence in other Great Basin archaeological sites. A *Lomatium* root (biscuit-root, either *L. cous* or *L. gormanii*), a mainstay of the ethnographically reported diet of Columbia Plateau and northern Great Basin peoples (Marshall, 1977; Couture, 1978), came from Stratum IV. Surprisingly, of the plant materials sent to us only one spike of *Typha latifolia* was recognized; this came from Stratum I. Two seeds of *Sparganium eurycarpum* were recovered from Strata II/III.

Disturbance of the sediments as a result of burrowing and nest building is important to the interpretation of the plant remains. Vegetal materials found outside the middens or away from the surface (which has been disturbed by rodent activity) are generally associated with rodent feces or nests. Some materials were so fresh that they were still green (e.g., a raceme of *Draba incerta* from Stratum VII). Therefore, we believe that many plant remains from various levels originated from the surface or from the two middens. Some plants recovered from the middens could also have been deposited by rodents favoring these strata for nesting. Mixing undoubtedly occurred as people, at least occasionally, utilized Hidden Cave over the past 4000 years.

SEDIMENTS

Four grain-size distributions typify the sediments of Hidden Cave (fig. 40). Cumulative weight percentage curve A illustrates the fine-grain sediments (55% fine silts) deposited when the cave lay beneath the waters of Pluvial Lake Lahontan. Curve B shows the

TABLE 20
Microfossil Counts and Percentages from Twenty-Six Human Coprolites from Hidden Cave, with Sample Weights and Pollen per Dry Weight

Provenience		*Pinus*		Other AP		*Artemisia*		Compositae		*Sarcobatus*		Other Chenopodiineae		Gramineae	
Strata	Sample	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
II	HC-167	7	2.67	0	0.00	5	1.91	4	1.53	5	1.91	102	38.93	1	0.38
	HC-431	1	0.01	0	0.00	0	0.00	3	0.02	0	0.00	2	0.02	0	0.00
	HC-527	78	9.15	13	1.52	38	4.46	21	2.46	39	4.58	142	16.67	79	9.27
	HC-2339	22	2.67	2	0.24	11	1.33	5	0.61	20	2.43	299	36.29	231	28.03
	HC-2340[a]	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	1	0.01	0	0.00
	HC-2341	12	3.52	4	1.17	3	0.88	5	1.47	17	4.99	92	26.98	7	2.05
	HC-2342	5	1.45	0	0.00	1	0.29	2	0.58	3	0.87	250	72.25	5	1.45
	HC-2343	20	6.25	3	0.94	7	2.19	9	2.81	7	2.19	66	20.63	10	3.13
II(K)	HC-2344[b]	12	0.88	0	0.00	13	0.95	7	0.51	5	0.37	397	29.11	454	33.28
II/III	HC-534	0	0.00	0	0.00	0	0.00	0	0.00	1	0.01	5	0.05	5	0.05
III	HC-341	8	0.32	1	0.04	1	0.04	2	0.08	2	0.08	6	0.24	2	0.08
	HC-223	22	5.19	1	0.24	13	3.07	9	2.12	18	4.25	48	11.32	12	2.83
	HC-361	0	0.00	0	0.00	0	0.00	1	0.03	0	0.00	1	0.03	5	0.14
	HC-2345	2	0.06	0	0.00	0	0.00	0	0.00	0	0.00	1	0.03	3	0.03
III(D)[c]/IV	HC-2346	29	0.50	0	0.00	3	0.05	1	0.02	2	0.03	26	0.45	8	0.14
III/IV	HC-2347[a]	1	0.01	0	0.00	0	0.00	0	0.00	0	0.00	4	0.03	2	0.02
K(III)/IV	HC-2348	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	10	0.85	6	0.51
IV	HC-501	60	7.10	2	0.24	7	0.83	1	0.12	10	1.18	32	3.79	24	2.84
	HC-554	7	1.20	1	0.17	4	0.69	6	1.03	5	0.86	62	10.67	380	65.40
	HC-2349	5	0.97	0	0.00	1	0.19	5	0.97	2	0.39	34	6.61	154	29.96
	HC-2350[a]	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	1	0.01	10	0.10
	HC-2351	3	0.45	0	0.00	0	0.00	0	0.00	2	0.30	9	1.34	9	1.34
	HC-2352	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	7	0.06	3	0.03
V	HC-342	5	0.61	0	0.00	2	0.24	3	0.37	6	0.73	25	3.05	1	0.12
Back-dirt	HC-25	14	0.81	1	0.06	351	20.24	471	27.16	240	13.84	467	26.93	9	0.52
	HC-65	14	0.93	0	0.00	11	0.73	5	0.33	30	2.00	662	44.07	42	2.80

[a] Sample contains male flower of *Typha* sp.
[b] Sample contains *Scirpus maritimus* L. (=*S. robustus*) seeds.
[c] (D) = disturbed.

size distribution of coarse grain deposits (62% gravels) occurring between the lower lake sediments and overlying cave fill. The effect of redeposited tephra in cave fill directly overlying the Tsoyawata Bed is illustrated by curve C. Curve D is typical of most deposits accumulated in Hidden Cave over the past 8000 years or so.

Size distributions, when compared with examples presented by Krumbein and Sloss (1963), Folk (1966), Reineck and Singh (1975), as well as the structure of the deposits (chap. 7, this volume), best reflect initial deposition in standing water (curve A) and reworking by wave action (curve B). Later sediments reflect wash-in from the surrounding slopes with an eolian component as indicated by the positive skewness of the typical cave fill samples (curve D) and especially the post Tsoyawata tephra sample (curve C). Curves C and D (as well as the sorting coefficient, fig. 41) correspond closely to those from Holocene deposits of Sentinel Cave, Alvord Valley, southeastern Oregon. Sentinel Cave is filled by colluvium washed-in from the surrounding slopes, that were mantled with eolian dust from the playa of Lake Alvord.

Lateral variation, or lack of it, in distribution of sediment grain-size may provide clues to periods of human activity in Hidden

TABLE 20—(*Continued*)

Rumex sp.		*Typha* (monad)		*Typha* (tetrad)		Cyperaceae		Other NAP		Spores			*Lycopodium* Tracers	Dry Weight (grams)	Pollen/gram
No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	Total			
41	15.65	78	29.77	14	5.34	4	1.53	1	0.38	0	0.00	262	489	1.5636	48,333
0	0.00	12,810	99.92	3	0.02	0	0.00	1	0.01	0	0.00	12,820	22	1.4130	58,169,625
1	0.12	369	43.31	32	3.76	8	0.94	33	3.87	0	0.00	852	950	1.4349	88,159
0	0.00	144	17.48	53	6.43	10	1.21	20	2.43	0	0.00	824	814	1.5471	92,291
0	0.00	10,859	98.26	191	1.73	0	0.00	0	0.00	0	0.00	11,051	9	1.2185	142,136,820
0	0.00	124	36.36	57	16.72	18	5.28	2	0.59	0	0.00	341	603	0.9342	85,383
0	0.00	55	15.90	10	2.89	15	4.34	0	0.00	0	0.00	346	377	3.0320	42,695
0	0.00	131	40.94	42	13.13	18	5.63	7	2.19	0	0.00	320	1012	0.5383	82,854
0	0.00	440	32.26	22	1.61	11	0.81	3	0.22	0	0.00	1364	241	2.8509	280,020
0	0.00	9311	99.85	2	0.02	1	0.01	0	0.00	0	0.00	9325	53	1.4907	16,647,759
0	0.00	203	8.17	2220	89.33	39	1.57	1	0.04	0	0.00	2485	259	1.7863	757,609
1	0.24	222	52.36	66	15.57	6	1.42	6	1.42	0	0.00	424	676	0.9452	93,598
0	0.00	3626	99.67	3	0.08	2	0.05	0	0.00	0	0.00	3638	61	0.7224	11,644,697
0	0.00	3283	98.65	36	1.08	3	0.09	0	0.00	0	0.00	3328	59	2.2463	3,541,903
0	0.00	5643	98.09	41	0.71	0	0.00	0	0.00	0	0.00	5753	168	1.6832	2,869,607
0	0.00	13,179	99.92	4	0.03	0	0.00	0	0.00	0	0.00	13,190	57	0.6749	48,361,926
0	0.00	1127	96.16	28	2.39	0	0.00	1	0.09	0	0.00	1172	116	1.9263	739,808
0	0.00	581	68.84	48	5.69	77	9.12	2	0.24	0	0.00	844	438	1.2406	219,083
0	0.00	68	11.70	33	5.68	9	1.55	5	0.86	1	0.17	581	813	1.5942	63,229
0	0.00	264	51.36	40	7.78	4	0.78	5	0.97	0	0.00	514	240	1.9432	155,456
0	0.00	372	3.71	9632	96.18	0	0.00	0	0.00	0	0.00	10,015	18	1.5087	52,017,400
16	2.38	586	87.33	37	5.51	9	1.34	0	0.00	0	0.00	671	124	1.3187	578,799
0	0.00	11,405	99.90	0	0.00	0	0.00	1	0.01	0	0.00	11,416	8	2.8608	70,357,365
0	0.00	126	15.37	513	62.56	138	16.83	1	0.12	0	0.00	820	381	3.1512	96,335
0	0.00	13	0.75	14	0.81	4	0.23	150	8.65	0	0.00	1734	253	1.8206	530,991
0	0.00	17	1.13	1	0.07	519	34.55	154	10.25	46	3.06	1502	185	2.3318	491,111

Cave. Samples collected from Unit 30, below the 32 Inch Midden, show the expected fining and poor sorting away from the cave entrance. Samples from Unit 38, between the middens, are more uniform in their grain size parameters (fig. 41). Pre-midden samples contain little cat-tail pollen (3.7%) whereas the Unit 38 samples contain the abundant cat-tail pollen (19%–40%) that characterizes obvious occupation levels (table 19). The latter samples also contain occasional colonies of the acid resistant algae *Pediastrum* that must have been transported on the roots and stems of cat-tails, bulrushes, or other marsh resources.

Although increased activity of rodents or large animals could also account for the lateral uniformity of Unit 38 sediments, these deposits had to have been mixed as they were formed. This mixing, the *Typha* pollen, and the *Pediastrum* colonies lead us to conclude that Hidden Cave continued to be visited during the interval between deposition of the 32 Inch and Top middens.

DISCUSSION AND CONCLUSIONS

Two kinds of changes are seen in the percentage pollen diagram. One results from climatic and corresponding vegetation shifts, and the other results from activities of man. The only clearly natural vegetational differences reflected in the fossil pollen record occur at the top of the "carbonate" layer (Stra-

TABLE 21
Seeds, Inflorescences, and Roots from Hidden Cave, Nevada

	Strata								
	I	I/II	II	II/III	III	IV	V	VII	IX
Juniperus osteosperma seeds	P	—	C	—	—	C	P	—	—
Raphanus cf. *sativa*	—	—	—	—	P	—	—	—	—
Draba incerta inflorescence	—	—	—	—	—	—	—	C	—
Atriplex confertifolia leaves, fruits, flowers	P	P	C	P	C	P	C	—	—
Lomatium sp. root	—	—	—	—	—	P	—	—	—
Sparganium eurycarpum seeds	—	—	—	P	—	—	—	—	—
Typha latifolia flower spike	P	—	—	—	—	P	—	—	—
Juncus sp. seeds	P	—	P	—	—	—	—	—	—
Scirpus maritimus seeds	C	C	C	—	C	C	P	—	—
Scirpus americanus seeds	P	—	C	—	P	—	—	—	—
Scirpus sp. seeds	—	—	P	—	—	—	—	—	—
Eleocharis palustris seeds	P	P	P	—	P	P	—	—	P
Carex sp. seeds	—	—	P	—	—	—	—	—	—
Distichlis stricta var. *dentata* spikelets, glumes, and flowers	C	P	C	—	P	—	P	—	P
Oryzopsis hymenoides seeds	—	—	P	—	—	P	P	—	—

P = present, C = common.

tum XI) and, again, a few centimeters above the mid-Holocene volcanic ash. The first of these shows a sharp decline of *Pinus* and *Artemisia* (sagebrush) pollen that characterizes the late Pleistocene to Holocene vegetational change apparent in pollen records throughout the Great Basin (Mehringer, 1977); it predates known occupation of Hidden Cave.

This change corresponds to shrinking of the Pleistocene lakes and replacement of woodland or steppe by the present sagebrush or shadscale desert. *Artemisia* pollen does, however, remain relatively abundant until at least 6500 radiocarbon years ago. Perhaps it is at this time that vegetation resembling the shadscale zone first dominates the Hidden Cave area. Otherwise the "traditional" three-part Holocene climatic sequence is not apparent.

Lack of clear climatic fluctuations, such as those reported from nearby Leonard Rockshelter in the Humboldt Sink (Byrne, Busby, and Heizer, 1979), may result from the fact that this sequence has been greatly oversimplified. On the other hand, typical shadscale genera have probably been dominant on the slopes near Hidden Cave for the past 6000–7000 years, and climatic changes since that time may have had little effect on their distribution at this low elevation.

If at times the cave mouth had been closed or restricted, then the sedimentary sequence would be discontinuous, or at least the deposition rates would vary greatly. In this case, the pollen record would represent only parts of the last several thousand years. Whatever the reason(s) for stability of the terrestrial pollen percentages, we expect that significant changes in local vegetation would have been revealed by pollen in the cave fill (Kelso, 1970). We do not doubt climatic change in the late Holocene. In fact, our current work in the shadscale desert of southeastern Oregon reveals considerable evidence for such change (Mehringer [in press]; Mehringer and Wigand, 1985). But, given the record from Hidden Cave alone and the available chronological controls, we do not feel justified in drawing further conclusions about Holocene climate or in comparing the Hidden Cave pollen sequence with others from the Great Basin.

Occupation of the cave itself, along with the striking evidence for use of marsh species, may be the best evidence for high effective moisture, higher water tables, and expanding lakes in Carson Sink. Under these conditions marshes would have been closer to the cave and would have, perhaps, attracted its human

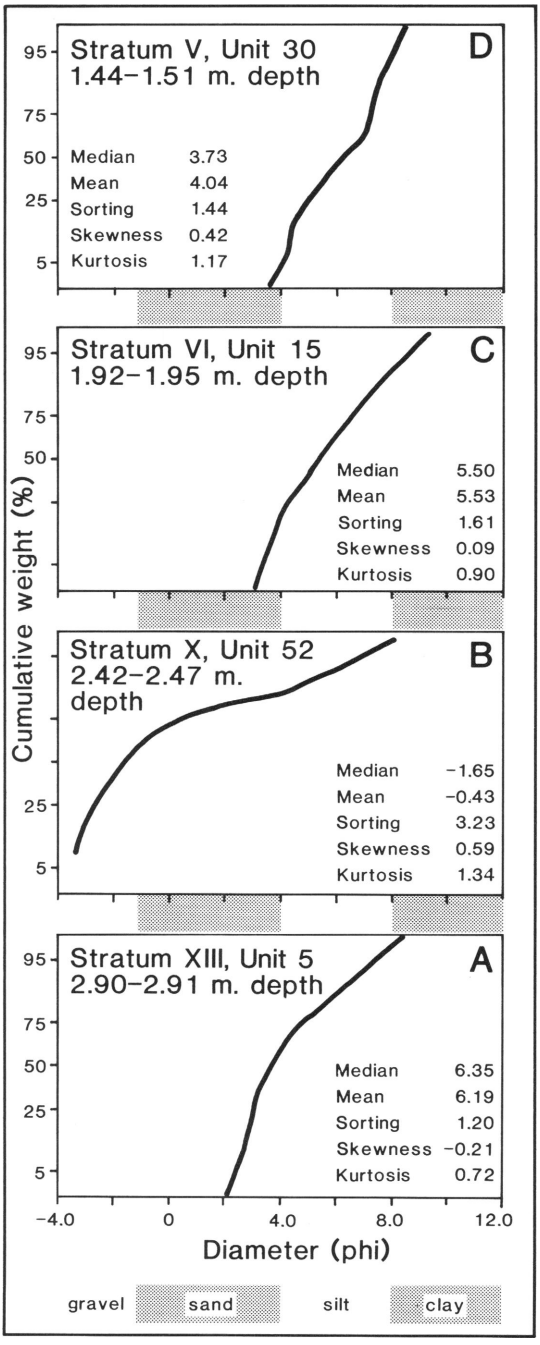

FIG. 40. A comparison of four cumulative weight percentage curves from size analysis of Hidden Cave sediments.

occupants. This was particularly true at times between 4000 and 3000 B.P. (Hattori, 1982).

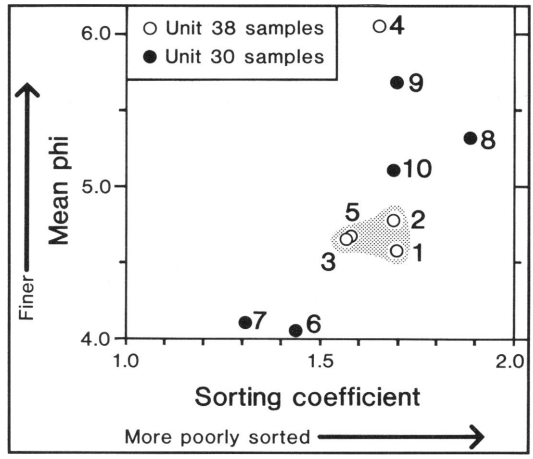

FIG. 41. A comparison, using sorting coefficient and mean, of sediment samples from stratigraphic Units 30 and 38 (fig. 39). Samples from Unit 30 show fining and poorer sorting with distance from the cave entrance. Excepting sample 4, collected at cave wall, samples from Unit 38 are relatively more uniform; we interpret this similarity to indicate lateral mixing of the deposits by people using Hidden Cave.

Pollen and macrofossil content of coprolites suggests three points. First, the human coprolites, by their predominance in the two middens, indicate that human occupation was most frequent during the periods represented by Strata IV and II. Second, the abundance of cat-tail pollen and sedge seeds indicates the proximity of marsh resources and their utilization by the inhabitants of the cave. On the other hand, the background of shadscale community pollen in many of the coprolites suggests that conditions around the cave differed little from today. Third, the dominance of cat-tail pollen shows that the cave was utilized during the summer. The presence of sedge seeds and cat-tail pollen in the same coprolite indicates caching of one or both of these foods.

Fossil seeds give additional support to these conclusions. Concentration of seeds in the middens suggests that humans used Hidden Cave most frequently during periods represented by the midden deposits. The greater abundance of seeds in the Top Midden has two obvious explanations. First, a greater volume of sediment could have been excavated from the Top Midden than from the 32 Inch Midden. Second, intensity of occu-

pation may have been greater when the Top Midden was deposited than during deposition of the 32 Inch Midden.

The relationship between pollen abundance and grain-size distribution of Hidden Cave sediments is unclear. However, the sediment studies combined with pollen influx estimates per weight and volume do indicate potential for comparing deposition rates. The high pollen content of Stratum I samples indicates clearly that this unit could have taken 3000 or more years to accumulate.

Relatively undisturbed sediments are finer and more poorly sorted away from the cave entrance. Therefore, more intense utilization and thus increased disturbance during formation of stratigraphic units should lead to greater uniformity. From the relatively uniform grain-size parameters exhibited by the suite of samples from Stratum III we conclude that Hidden Cave continued to be used at times between deposition of the 32 Inch and the Top middens.

In conclusion, the fossil pollen record from the cave fill pollen profile shows no clear change in local terrestrial vegetation over the past 6000–7000 years. But perhaps the few thousand years preceding that period were cooler and/or wetter. These samples also give no clue to the intensity of occupation before or after deposition of the 32 Inch and Top middens. They do, however, show that when the cave was occupied, cat-tails were a most important resource (Madsen, 1979). With few exceptions, cat-tail pollen is abundant from the 32 Inch Midden to the surface.

According to the coprolite contents and seeds, the cave was occupied from midsummer to fall, and marsh species were important foods for inhabitants of the cave. The concentration of these materials in and around the middens suggests that use of the cave was most intense at the time the middens were formed. The relative abundance of seeds indicates that either the duration or intensity of human utilization of Hidden Cave was greatest during deposition of the Top Midden.

CHAPTER 10. THE PALEONTOLOGY OF HIDDEN CAVE: BIRDS AND MAMMALS

DONALD K. GRAYSON[1]

> "In reference to the evidence furnished by the Lahontan fossils as to the climate of the Quaternary, a conclusion seems impossible at this stage of the investigation . . . the fossils that might be expected to throw the most light on the climatic problem are the mammalian remains, but, unfortunately, up to the present time, these have been found in such limited numbers that but little evidence as to the nature of former climatic changes can be derived from them . . . ."
> (Russell, 1885, pp. 243–245).

With these words, Israel C. Russell summarized the light that could be shed by the mammalian fossils known from the Lahontan Basin at the end of the nineteenth century on the nature of the Pleistocene in general, and on the history of Lake Lahontan in particular. Although important contributions to the paleontology of the Lahontan Basin were made during the first half of the twentieth century (e.g., Merriam, 1915, 1918), it was not until 1964 that the situation described by Russell began to change in any significant way. In that year, Roger B. Morrison described a stratigraphic section from Hidden Cave in the southern Carson Desert of western Nevada, a section that had been exposed by excavations conducted for archaeological purposes by the University of California in 1951 (Morrison, 1964; see Davis, chap. 7, this volume). In addition to describing the stratigraphy of the exposed Hidden Cave section, Morrison also presented lists of the species represented by the fossils that had been retrieved during the course of the Hidden Cave excavations. Most of those fossils consisted of the remains of birds, identified by Hildegarde Howard, and mammals, identified under the direction of S. B. Benson and E. L. Furlong. The earliest of these remains were attributed by Morrison to the Middle Tongue of the Indian Lakes Formation, of late Pleistocene age (see Davis, chap. 7, this volume); the most recent material came from the uppermost of the two middens in the cave, and were clearly late Holocene in age. Eighty years after Russell noted the dearth of fossils from the Lahontan Basin, Hidden Cave had begun to fill the void.

Excavations conducted in Hidden Cave in 1979 and 1980 provided a much larger sample of vertebrate remains than was available to Morrison in 1964. Sizable collections of fish (Smith, chap. 12, this volume), amphibians and reptiles (Mead, chap. 11, this volume), and birds and mammals resulted from these excavations. Coupled with the more detailed stratigraphic and chronologic information now available for the site, the Hidden Cave vertebrate remains allow deeper insight into the faunal history of the southern Carson Desert than has previously been available for any portion of the Lahontan Basin.

In this chapter, I present a description and analysis of the bird and mammal fossils and subfossils excavated from Hidden Cave by both the 1951 University of California and 1979–1980 American Museum of Natural History archaeological projects. The vast majority of the bones and teeth reported here resulted from the more recent of these two sets of excavations. Of the 7835 identified bird and mammal specimens, 7313 were provided by the 1979–1980 Hidden Cave excavations. In addition, of the 522 (183 bird, 339 mammal) specimens available to me from the 1951 excavations, 183 lack sufficient information on provenience to be placed into the Hidden Cave stratigraphic sequence.

I have identified all the 1951 material housed in the Lowie Museum of the University of California, and it is clear that the specimens reported by Morrison (1964) are

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not in those collections. All the birds and mammals described by Morrison (1964) apparently came from the University of California excavation unit N-6. The Lowie Museum collections, however, included only six identifiable specimens from this unit, all of which are mammalian: one specimen of *Sylvilagus* sp. (rabbit), four of *Lepus* sp. (hare), and one of *Marmota flaviventris* (yellow-bellied marmot). In addition, only a very small number of unidentifiable specimens from N-6 are present in the Lowie material, nearly all of which are extremely fragmented. Finally, several taxa reported by Morrison (1964, p. 90), including *Vulpes velox* (=*Vulpes macrotis,* kit fox) and *Peromyscus* sp. (white-footed mouse), are not represented in the Lowie Museum material. There is no doubt that the specimens reported by Morrison (1964) have not been reanalyzed here.

On the other hand, it is equally clear that Morrison did not have all the 1951 Hidden Cave vertebrates available for his summary, since there are taxa represented in the Lowie collections that were not reported by him. For instance, Morrison (1964) did not record *Mustela frenata* (long-tailed weasel) from the 32 Inch Midden, or *Sylvilagus* sp. from the Top Midden. The Lowie Museum collections, however, include an entire *M. frenata* skull from the lower midden (2-57744) and a series of 45 *Sylvilagus* specimens from the upper one (2-57794 and 2-57795). Thus, Morrison and I present information on two different sets of faunal material from the 1951 excavations. Nonetheless, only four taxa were reported by Morrison (1964) that are not represented in the material I have identified: *Branta bernicla (=nigricans)*? (Brant), *Melanitta fusca*? (White-winged scoter), *Pica* sp.? (Magpie), and *Vulpes velox.*

Although I have studied all the material available to me from the University of California excavations, I have not studied the material collected by S. M. and Georgia Wheeler in 1940. As Thomas (chap. 4, this volume) notes, the Wheelers' excavations produced two specimens identified as *Equus* sp. by Furlong. In addition, they also collected a small number of well-preserved vertebrates, consisting primarily of birds and mammals, that are currently housed in the Nevada State Museum. With the kind assistance of Ms. Amy Dansie, I have been able to examine this material, but I have not analyzed it in conjunction with this project.

As Davis has discussed (chap. 7, this volume), the deposits of Hidden Cave are complex. Although techniques for the excavation of cave sediments are now much more refined than they were in 1951, they are not sufficiently refined to fully resolve the complexity of deposits such as those contained in Hidden Cave. As Thomas and Bernstein (chap. 8) have discussed, the material collected from Hidden Cave falls on a continuum of stratigraphic resolution, from that which cannot be placed within the Hidden Cave stratigraphic sequence to that which can be placed within a single stratum within the cave. This continuum of stratigraphic resolution for the Hidden Cave vertebrates causes some analytic difficulties that must be addressed.

I do not check proveniences in identifying faunal materials, until after the identifications are complete. This procedure helps avoid any subtle biases in identification that might otherwise result from knowing the age of a set of specimens from a collection that spans a lengthy series of millennia. With one exception, I followed this procedure with the Hidden Cave birds and mammals. This exception was provided by those materials in containers labeled "no provenience," "backdirt," or "Wheeler backdirt." These I checked for specimens of an unusual nature (for instance, bones with cut marks or from species no longer present in the area), but did not further identify. Specimens that could not be correlated with the Hidden Cave stratigraphic sequence but that were not so labeled were identified. It was not until after the identifications were complete and the stratigraphic correlations done that I found that approximately 14 percent of the identified specimens could not be placed with the stratigraphic sequence for the site, and that a further 30 percent could only be assigned mixed proveniences.

Accordingly, I present the proveniences of the Hidden Cave birds and mammals in terms of three different provenience groups: those specimens that can be assigned to single strata, those that can be assigned only to mixed strata, and those that lack stratigraphic correlations (see tables 22–26). Both the single

TABLE 22
Numbers of Identified Specimens by Provenience Groups for the Hidden Cave Birds and Mammals
(N.C. = not correlated)

	Provenience			
	Single Stratum	Mixed Strata	N.C.	Totals
Birds	535	323	124	982
Mammals	3877	2012	964	6853
Totals	4412	2335	1088	7835

and mixed strata faunas are analyzed below, whereas the components of the uncorrelated fauna are simply described.

I have summarized the methodological and theoretical issues that guide my analysis of cave and rock-shelter faunas elsewhere (Grayson, 1983, 1984a), and I do not repeat that summary here. Instead, I note that the ambiguities caused by our lack of knowledge of the nature and effects of the mechanisms that accumulate faunal material in such sites imply in turn that the meaning of the abundances of those taxa, and of changes in those abundances, are often similarly ambiguous: we cannot be sure that we are actually measuring what we are trying to measure (see also Grayson, 1979, 1981a). Only multiple faunal sequences from within the same region can circumvent this problem. Since such sequences are not currently available for the Carson Desert area, or, as I discuss below, for the entire shadscale vegetation zone of the western Great Basin, my analyses are conservative.

The unit I have employed to count taxonomic abundances here is the number of identified specimens (NISP). The reasons are simple: the number of identified specimens carries virtually all of the information on taxonomic abundances that is embodied by the minimum number of individuals, while minimum numbers are in turn a function of both the number of identified specimens and the techniques used to form the specimen clusters from which they are defined (Grayson, 1979, 1984a). Since I do not wish to measure clustering techniques, I have not used minimum numbers in this report.

Finally, I note that my identification of the Hidden Cave birds has been limited by the scope of the comparative collections available to me. While these collections are strong in some areas, they are weak in others. As a result, almost all the passerines in the collection remain unstudied, some identifications made only at the genus level (and in particular, identifications of *Aythya* spp., *Buteo* sp., and *Larus* spp.) can certainly be refined, and a number of unidentified specimens are clearly identifiable.

DESCRIPTIVE SUMMARY

Tables 23–26 present the numbers of identified specimens per taxon by stratum or mixed strata for the Hidden Cave birds (tables 23 and 24) and mammals (tables 25 and 26); uncorrelated specimens are presented in tables 23 and 24. In this section, I provide a description of the identified specimens and, as needed, a discussion of the criteria used to identify those specimens. I also provide comments on the local distribution of the taxa involved. My discussion of the modern distribution of birds is drawn almost entirely from the published literature. However, information on modern mammal distributions comes from three additional sources: the results of a small mammal survey (665 trapping nights) that I conducted on and adjacent to Eetza Mountain in July 1979 and July and August 1980; the small mammals represented in a collection of decomposed and decomposing owl pellets taken from the entrance of Fallen-in-Cave, approximately 200 m. north of Hidden Cave; and information kindly provided by Mr. J. R. Alcorn from his own trapping records in the Fallon area. The owl pellets from Fallen-in-Cave may have been deposited by the Barn Owl, *Tyto alba*: a Barn Owl was flushed from the rock rim near Fallen-in-Cave during my search for pellets, and the size and shape of the non-decomposed pellets themselves are conformable with those of Barn Owl (C. Maser, personal commun.).

AVES—BIRDS

Order Podicipediformes—Grebes

Family Podicipedidae—Grebes

Podilymbus podiceps—Pied-Billed Grebe

MATERIAL: One sternum, four coracoids, eight humeri, two radii, four femora, three

TABLE 23

Numbers of Identified Avian Specimens per Unmixed Stratum, or Which Remain Uncorrelated (N.C.), at Hidden Cave

	Podilymbus podiceps	*Podiceps* sp.	*Podiceps auritus*	*Podiceps nigricollis*	***Aechmophorus occidentalis***	*Pelecanus erythrorhynchos*	*Phalacrocorax auritus*	*Botaurus lentiginosus*	*Butoroides striatus*	*Nycticorax nycticorax*	*Anas* sp. (teal)	*Anas* sp. (mid-size)	***Anas platyrhynchos/strepera***	*Anas platyrhynchos*	*Aythya* spp.	*Aythya valisineria*	*Bucephala albeola*	*Mergus* sp.	*Mergus merganser*	*Mergus serrator*
Stratum:																				
I	4	1	1	1	2	—	2	—	—	—	3	1	1	—	4	—	—	1	—	—
II	5	3	—	—	8	—	2	2	—	—	8	3	—	1	8	1	—	—	—	—
III	—	1	1	—	—	1	—	—	—	—	3	2	—	—	7	—	—	—	—	—
IV	4	15	4	3	4	—	9	—	—	—	7	2	1	—	42	1	—	—	1	2
V	3	11	2	1	3	1	7	—	—	—	8	3	—	—	30	1	—	—	—	—
VI	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
VII	—	3	1	1	4	2	3	—	—	—	4	2	1	—	25	1	1	1	2	—
VIII	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
IX	1	2	1	—	5	1	3	—	—	—	—	2	1	—	22	—	—	—	—	—
X	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
XI	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
XII	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
XIII	1	1	1	1	12	—	6	—	—	—	—	—	—	—	20	2	—	—	—	—
XIV	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Totals:	18	37	11	7	38	5	32	2	0	0	33	15	4	1	158	6	1	2	3	2
N.C.	4	8	1	2	11	0	9	2	1	1	7	6	2	0	32	2	0	0	1	0

TABLE 23—(*Continued*)

	Oxyura jamaicensis	***Haliaeetus leucocephalus***	*Circus cyaneus*	*Buteo* sp.	*Aquila chrysaetos*	*Falco* sp.	*Falco peregrinus*	*Falco* cf. *mexicanus*	*Falco mexicanus*	*Centrocercus urophasianus*	*Gallinula chloropus*	*Fulica americana*	*Himantopus mexicanus*	*Larus* spp.	*Tyto alba*	*Bubo virginianus*	*Asio otus*	*Corvus corax*	Totals
Stratum:																			
I	1	—	—	—	—	—	—	—	—	—	—	7	—	1	—	—	—	—	30
II	4	—	—	—	—	2	—	—	—	—	2	18	1	3	1	1	—	—	73
III	1	—	—	—	—	—	—	—	—	—	—	5	—	2	—	—	—	—	23
IV	4	—	1	—	—	—	—	2	—	—	—	31	—	4	—	—	—	1	138
V	6	2	—	4	—	—	1	—	3	—	—	25	—	8	—	—	1	2	122
VI	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0
VII	1	—	—	—	1	—	—	—	1	1	—	1	—	2	—	—	—	—	58
VIII	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0
IX	—	—	—	—	—	—	—	—	—	—	—	1	—	1	—	—	—	2	42
X	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0
XI	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	1
XII	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0
XIII	1	—	—	—	—	—	—	—	—	—	—	2	—	—	—	—	—	1	48
XIV	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0
Totals:	18	2	1	4	1	2	1	2	4	1	2	90	1	22	1	1	1	6	535
N.C.	5	1	0	1	0	0	0	0	0	0	0	23	0	2	0	0	0	3	124

TABLE 24
Numbers of Identified Avian Specimens per Mixed Stratum at Hidden Cave

	Podilymbus podiceps	*Podiceps* sp.	*Podiceps auritus*	*Podiceps nigricollis*	*Aechmophorus occidentalis*	*Pelecanus erythrorhynchos*	*Phalacrocorax* cf. *auritus*	*Phalacrocorax auritus*	*Anas* sp. (teal)	*Anas* sp. (mid-size)	*Anas platyrhynchos/ strepera*	*Anas platyrhynchos*
Stratum:												
I–II	—	1	1	—	—	—	—	—	1	—	—	—
II–III	—	—	—	—	1	—	—	—	—	2	—	—
II–IV	—	—	—	—	—	—	—	—	1	—	—	—
III–IV	1	—	—	—	1	—	—	—	1	—	—	—
IV–V	1	—	—	—	—	—	—	—	—	—	—	—
IV–XIV	—	—	—	—	—	—	—	1	1	3	—	—
V–VI	—	3	1	—	3	—	—	3	1	—	—	—
V–XI	—	—	—	1	—	—	—	—	—	—	—	—
VI–VII	1	—	1	—	1	1	—	—	—	2	—	—
VII–IX	1	1	—	1	—	—	—	2	1	3	—	—
VII–X	—	—	—	—	3	—	—	—	—	—	—	—
VII–XII	—	—	—	—	—	—	—	—	—	—	—	—
VII–XIV	—	—	—	—	—	—	—	—	1	—	—	—
VIII–X	—	—	1	1	1	—	—	1	—	1	—	—
IX–X	—	—	—	—	13	—	—	3	—	—	—	—
IX–XI	—	—	—	—	3	—	—	—	—	—	—	1
IX–XII	1	6	—	1	12	—	—	4	—	2	1	—
IX–XIII	1	1	—	—	1	—	—	—	—	1	—	1
X–XIII	—	1	—	—	—	—	—	—	—	—	—	—
XI–XII	—	—	—	—	2	—	1	—	—	1	—	—
XI–XIII	—	1	1	1	5	—	—	1	—	1	—	—
XII–XIII	1	1	2	1	3	—	—	1	—	1	—	—
XIII–XIV	—	—	—	—	4	—	—	3	1	1	—	—
Totals:	7	15	7	6	53	1	1	19	8	18	1	2

tibiotarsi, seven tarsometatarsi: 29 specimens.

Podiceps sp.—Horned and/or Eared Grebes

MATERIAL: Five sterna, 12 coracoids, four humeri, five ulnae, two radii, 10 femora, nine tibiotarsi, 13 tarsometatarsi: 60 specimens.

Podiceps auritus—Horned Grebe

MATERIAL: Five scapulae, 12 humeri, two carpometacarpi: 19 specimens.

Podiceps nigricollis—Eared Grebe

MATERIAL: Six humeri, three ulnae, five carpometacarpi, one tibiotarsus: 15 specimens.

Aechmophorus occidentalis—Western Grebe

MATERIAL: Seven sterna, one furculum, 14 coracoids, four scapulae, nine humeri, 15 ulnae, seven radii, nine carpometacarpi, three phalanges, nine femora, 10 tibiotarsi, 14 tarsometatarsi: 102 specimens.

REMARKS: Horned Grebes (*Podiceps auritus*) are spring and fall migrants in northern Nevada; Eared Grebes (*P. nigricollis*) are year-round residents, while Western Grebes (*Aechmophorus occidentalis*) may also be seen at any time of the year (Linsdale, 1936). Alcorn (1946) observed Eared Grebes during all months of the year in the Lahontan Valley, Pied-billed Grebes (*Podilymbus podiceps*) during all months except June, and Western Grebes during all seasons of the year.

TABLE 24—(*Continued*)

Aythya spp.	*Aythya valisineria*	*Mergus* sp.	*Mergus merganser*	*Mergus serrator*	*Oxyura jamaicensis*	*Falco peregrinus*	*Falco mexicanus*	*Fulica americana*	*Larus* spp.	*Bubo virginianus*	*Asio* sp.	*Asio flammeus*	*Corvus corax*	Totals
1	—	—	1	—	—	—	—	—	—	—	—	—	—	5
1	—	—	—	—	—	—	—	5	—	—	—	—	—	9
2	—	—	—	—	—	—	—	1	—	—	—	—	—	4
1	—	—	—	—	—	—	—	5	—	—	—	—	—	9
—	—	—	1	—	—	—	—	—	—	—	—	—	—	2
6	—	—	—	—	1	—	—	—	2	—	—	—	—	14
4	—	—	—	—	—	—	—	—	—	—	1	1	—	17
—	—	—	—	—	—	—	—	—	—	—	—	—	—	1
7	—	—	1	—	1	—	—	—	1	—	—	—	—	16
16	—	—	—	1	2	1	1	2	3	—	—	—	—	35
2	2	—	1	—	—	—	—	—	2	—	—	—	—	10
—	—	—	—	—	—	—	—	—	1	—	—	—	—	1
2	—	—	—	—	—	—	—	—	1	—	—	—	—	4
7	1	—	—	—	1	—	—	1	—	—	—	—	—	15
5	—	—	—	—	—	—	—	—	1	—	—	—	—	22
5	1	—	—	—	—	—	—	—	1	1	—	—	1	13
19	1	1	—	—	1	—	—	2	2	—	—	—	1	54
6	—	—	—	1	—	—	—	2	2	—	—	—	—	16
—	—	—	—	—	—	—	—	—	—	—	—	—	—	1
2	—	—	—	—	—	—	—	—	—	—	—	—	—	6
6	1	—	—	1	1	—	—	—	—	—	—	—	—	19
12	—	—	1	1	1	—	—	—	—	—	—	—	—	25
14	1	—	—	—	—	—	—	—	1	—	—	—	—	25
118	7	1	5	4	8	1	1	18	17	1	1	1	2	323

Order Pelecaniformes—Pelicans and Allies

Family Pelecanidae—Pelicans

Pelecanus erythrorhynchos—White Pelican

MATERIAL: One radius, five vertebrae: six specimens.

REMARKS: Alcorn (1946) reports seeing White Pelicans in the Lahontan Valley during all months of the year except December and January, with greatest abundances from March to July. The five vertebrae and single fragmentary radius agree with *P. erythrorhynchos* in size, and are larger than the corresponding elements of Brown Pelican (*P. occidentalis*) available for inspection.

Family Phalacrocoracidae—Cormorants

Phalacrocorax cf. *auritus*—Double-crested Cormorant

MATERIAL: One tibiotarsus: one specimen.

Phalacrocorax auritus—Double-crested Cormorant

MATERIAL: One premaxilla, four sterna, 13 coracoids, two scapulae, two humeri, two ulnae, six radii, four carpometacarpi, eight vertebrae, 13 femora, one tibiotarsus, four tarsometatarsi: 60 specimens.

REMARKS: Alcorn (1946) reports Double-crested Cormorants in the Lahontan Valley during all months of the year except February and March, with single individuals and small

flocks in canals and on small pools, and flocks of up to 100 birds on larger bodies of water.

Order Ciconiiformes—Herons, Storks, Ibises, and Allies
Family Ardeidae—Herons and Bitterns
Botaurus lentiginosus—American Bittern

MATERIAL: Two coracoids, one humerus, one ulna: four specimens.

Butoroides striatus—Green-backed Heron

MATERIAL: One coracoid; one specimen.

Nycticorax nycticorax—Black-crowned Night Heron

MATERIAL: One tarsometatarsus: one specimen.

REMARKS: Both the American Bittern and the Black-crowned Night Heron are resident in the Lahontan Valley, whereas there is only a single, fall record for the Green-backed Heron in this area (Alcorn, 1946).

Order Anseriformes—Swans, Geese, Ducks, and Allies
Family Anatidae—Swans, Geese, and Ducks
Anas sp.—Green-winged Teal, Blue-winged Teal, and/or Cinnamon Teal

MATERIAL: One sternum, 14 coracoids, five scapulae, 20 humeri, five carpometacarpi, one femur, two tarsometatarsi: 48 specimens.

Anas sp.—Gadwall, Pintail, Wigeon, and/or Northern Shoveler

MATERIAL: Five sterna, eight coracoids, five scapulae, nine humeri, four carpometacarpi, eight tarsometatarsi: 39 specimens.

Anas platyrhynchos and/or *Anas strepera*—Mallard and/or Gadwall

MATERIAL: Two coracoids, two humeri, three carpometacarpi: seven specimens.

Anas platyrhynchos—Mallard

MATERIAL: One coracoid, two humeri: three specimens.

REMARKS: With the exception of the Blue-winged Teal (*A. discors*), which is not demonstrably present, all species of *Anas* that might be represented in the Hidden Cave fauna are year-round residents of the Lahontan Valley (Alcorn, 1946).

Aythya spp.—Redhead, Ring-necked Duck, Greater Scaup, Lesser Scaup

MATERIAL: Twenty-three sterna, 51 coracoids, 19 scapulae, 49 humeri, 55 ulnae, 36 carpometacarpi, 24 femora, 51 tarsometatarsi: 308 specimens.

Aythya valisineria—Canvasback

MATERIAL: One coracoid, two scapulae, six humeri, four carpometacarpi, one pelvis, one tarsometatarsus: 15 specimens.

REMARKS: Alcorn (1946) observed small numbers of Canvasbacks in the Lahontan Valley from October to April, and presents a single record for July. Redheads (*A. americana*) are present year-round in the Lahontan Valley, Ring-necked Ducks (*A. collaris*) from October to March. Alcorn (1946) reports Lesser Scaup (*A. affinis*) as present in limited numbers every month of the year except August and September and presents only a single Lahontan Valley record for the Greater Scaup (*A. marila*), an individual taken in November. I note again that many of the specimens of *Aythya* present in the Hidden Cave fauna could be more finely identified with larger comparative series than are available to me (e.g., Grayson, 1973).

Bucephala albeola—Bufflehead

MATERIAL: One humerus: one specimen.

REMARKS: Bufflehead are present in the Lahontan Valley during all seasons of the year except summer (Alcorn, 1946).

Mergus sp.—Mergansers

MATERIAL: Two humeri, one femur: three specimens.

Mergus merganser—Common Merganser

MATERIAL: One sternum, six humeri, one femur, one tarsometatarsus: 9 specimens.

Mergus serrator—Red-breasted Merganser

MATERIAL: Six coracoids: six specimens.

REMARKS: The fragmentary specimens assigned to *Mergus* sp. are either Common or Red-breasted Mergansers; the Hooded Merganser (*Lophodytes cucullatus*) is not represented. Common Mergansers were reported by Alcorn (1946) as present in the Lahontan Valley in all months except July, August, and September and as abundant from November to February. Elsewhere in northern Nevada, the Common Merganser may be present yearround (Linsdale, 1936). Red-breasted Mergansers are occasionally present in this area in all but the summer months (Alcorn, 1946).

Oxyura jamaicensis—Ruddy Duck

MATERIAL: Seven coracoids, eight humeri, eight ulnae, three carpometacarpi, four femora, one tarsometatarsus: 31 specimens.

REMARKS: Ruddy Ducks are abundant in the Lahontan Valley at all times of the year (Alcorn, 1946).

Order Falconiformes—Vultures, Hawks, and Falcons

Family Accipitridae—Hawks, Old World Vultures, and Harriers

Haliaeetus leucocephalus—Bald Eagle

MATERIAL: Three phalanges: three specimens.

Circus cyaneus—Northern Harrier

MATERIAL: One tibiotarsus: one specimen.

Buteo sp.—Hawks

MATERIAL: One humerus, two femora, two pelves: five specimens.

Aquila chrysaetos—Golden Eagle

MATERIAL: One premaxilla: one specimen.

REMARKS: Alcorn (1946) records small numbers of Bald Eagles in the Lahontan Valley between November and February; they nested at Pyramid Lake in the nineteenth century (Linsdale, 1936), and may also have nested in the Lahontan Valley during earlier historic times. The Northern Harrier is a common resident of the Lahontan Valley, as is the Golden Eagle (Alcorn, 1946).

Family Falconidae—Caracaras and Falcons

Falco sp.—Falcons

MATERIAL: One carpometacarpus, one tibiotarsus: two specimens.

Falco peregrinus—Peregrine Falcon

MATERIAL: One coracoid, one tarsometatarsus: two specimens.

Falco cf. *mexicanus*—Prairie Falcon

MATERIAL: Two scapulae: two specimens.

Falco mexicanus—Prairie Falcon

MATERIAL: One coracoid, two ulnae, one carpometacarpus, one tarsometatarsus: five specimens.

REMARKS: Although I am aware of no records for the Peregrine Falcon in the Carson Desert, there are several northern Nevada records (Pyramid Lake; Big Bend, Truckee River: Linsdale, 1936), and the bird was at one time a permanent resident in eastern Oregon (Gabrielson and Jewett, 1970). The Prairie Falcon is resident in the Lahontan Valley (Alcorn, 1946).

Order Galliformes—Grouse and Allies

Family Phasianidae—Grouse, Quails, and Allies

Centrocercus urophasianus—Sage Grouse

MATERIAL: One femur: one specimen.

REMARKS: Although there is a record for Sage Grouse from the West Humboldt Range at the northwestern edge of the Carson Sink (Linsdale, 1936), I am aware of no records for the Carson Desert itself. Perhaps it is significant that the Hidden Cave specimen came from Stratum VII, dated to between 7500 and 6900 B.P. Wigand and Mehringer (chap. 9, this volume) note that *Artemisia* pollen remains relatively abundant in the Hidden Cave sediments until approximately 6500 B.P., and that typical shadscale zone vegetation may not have become dominant in this area until after that time. Although the species of *Artemisia* involved is unknown, it would cer-

tainly appear that the vegetation surrounding Hidden Cave would have provided more appropriate habitat for Sage Grouse prior to the deposition of Mazama ash than after that event.

The Hidden Cave specimen is a proximal right femur; the maximum breadth of the trochanter is 13.3 mm. (see Grayson, 1977 for the definition of this measurement). In a series of eight female and eight male modern Sage Grouse, this measurement ranges from 12.7 to 14.0 mm. in females, and from 15.5 to 19.0 mm. in males, suggesting that this specimen came from a female.

Order Gruiformes—Cranes, Rails, and Allies
Family Rallidae—Rails, Gallinules, and Coots
Gallinula chloropus—Common Moorhen

MATERIAL: Two humeri: two specimens.

Fulica americana—American Coot

MATERIAL: Three premaxillae, eight sterna, 34 coracoids, 14 scapulae, 21 humeri, one ulna, two radii, 14 carpometacarpi, three femora, four tibiotarsi, 27 tarsometatarsi: 131 specimens.

REMARKS: Alcorn (1946) records several late summer and fall records for the Common Moorhen in Lahontan Valley. The American Coot, on the other hand, is an abundant, yearround resident of this area (Alcorn, 1946).

Order Charadriiformes—Shorebirds, Gulls, Auks, and Allies
Family Recurvirostridae—Avocets and Stilts
Himantopus mexicanus—Black-necked Stilt

MATERIAL: One tarsometatarsus: one specimen.

REMARKS: Alcorn (1946) lists the Black-necked Stilt as present in the Lahontan Valley from March through September.

Family Laridae—Gulls and Terns
Larus spp.—Gulls

MATERIAL: One premaxilla, two sterna, 11 coracoids, nine humeri, one ulna, five radii, three carpometacarpi, five phalanges, four femora: 41 specimens.

Order Strigiformes—Owls
Family Tytonidae—Barn Owls
Tyto alba—Barn Owl

MATERIAL: One coracoid: one specimen.

REMARKS: Barn Owls are resident in the Lahontan Valley (Alcorn, 1946); a single individual was observed adjacent to Hidden Cave in 1981, and the owl pellet collection from Fallen-in-Cave, discussed below, was apparently contributed by this species.

Family Strigidae—Typical Owls
Bubo virginianus—Great Horned Owl

MATERIAL: One coracoid, one scapula: two specimens.

Asio otus or *Asio flammeus*—Long-eared Owl or Short-eared Owl

MATERIAL: One tarsometatarsus: one specimen.

Asio otus—Long-eared Owl

MATERIAL: One tarsometatarsus: one specimen.

Asio flammeus—Short-eared Owl

MATERIAL: One tarsometatarsus: one specimen.

REMARKS: Alcorn (1946) notes that the Long-eared Owl is resident in the Lahontan Valley, and that the Short-eared Owl is frequently seen between September and February, with a single record for July.

Order Passeriformes—Perching Birds
Family Corvidae—Jays, Magpies, and Crows
Corvus corax—Common Raven

MATERIAL: Two coracoids, two humeri, one carpometacarpus, three tibiotarsi, three tarsometatarsi: 11 specimens.

REMARKS: Common Ravens are resident in the Lahontan Valley (Alcorn, 1946), and were frequently seen in the vicinity of Hidden Cave during the summers of 1979 and 1980.

MAMMALIA—MAMMALS
Order Insectivora—Insectivores
Family Soricidae—Shrews
Sorex palustris—Water Shrew

MATERIAL: One mandible, one specimen.

REMARKS: Water shrews are widely distributed in the northern half of Nevada, but are generally found in the vicinity of high elevation mountain streams. The lowest record known to Hall (1946) came from an elevation of 1490 m. (4900 ft.), some 180 m. higher than the top of Eetza Mountain. It is, of course, possible that the Hidden Cave specimen was transported here by a predator from nearby higher elevation habitats.

Order Chiroptera—Bats
Family Vespertilionidae—
Vespertilionid Bats
Myotis sp.—Mouse-eared Bats

MATERIAL: Two mandibles: two specimens.

Myotis yumanensis—Yuma myotis

MATERIAL: Two skull fragments, eight mandibles: 10 specimens.

Plecotus townsendii—Townsend's Big-eared Bat

MATERIAL: One nearly complete desiccated individual: one specimen.

Antrozous pallidus—Pallid Bat

MATERIAL: Two skull fragments, four mandibles: six specimens.

REMARKS: The caves of the Eetza Mountain area support sizable populations of bats. However, I made no attempt to collect bats here and am unaware of which species currently utilize the area. All three species of bats present in the Hidden Cave deposits are known from the Lahontan Basin. *Plecotus townsendii* has been reported from caves in the Eetza Mountain area, and *Antrozous pallidus* is reported to be the most common bat in the Carson Sink; there are published records for *Myotis yumanensis* to the west of, and in the town of, Fallon (Hall, 1946).

The Hidden Cave mandibles and maxillae assigned to *M. yumanensis* are small, comparing with both *M. yumanensis* and *M. lucifugus* in size. M_3 of *M. yumanensis* may be distinguished from that of *M. lucifugus* by the fact that the hypoconid of the former is less rugose and, when compared to the height of the protoconid, relatively low. On M^2, the loph connecting hypocone and metacone is less well developed and shorter in *M. yumanensis* than in *M. lucifugus*. The nearly complete individual of *Plecotus townsendii* was identified as such by Chris Maser.

Order Lagomorpha—Rabbits,
Hares, and Pikas
Family Leporidae—Rabbits and Hares
Sylvilagus sp.—Rabbits

MATERIAL: Twenty-seven skull fragments, eight mandibles, 28 isolated teeth, eight scapulae, 12 humeri, six radii, five ulnae, one metacarpal, five vertebrae, 12 innominates, five femora, six tibiae, one astragalus, one calcaneus, 10 phalanges: 135 specimens.

Sylvilagus idahoensis—Pygmy Rabbit

MATERIAL: One innominate: one specimen.

Sylvilagus cf. *nuttallii*—Nuttall's Cottontail

MATERIAL: Eighty skull fragments, 35 mandibles, 143 isolated teeth, 18 scapulae, 77 humeri, 30 radii, 55 ulnae, two carpals, 60 metacarpals, 68 vertebrae, five sacra, 82 innominates, 96 femora, 122 tibiae, 32 astragali, 58 calcanea, 13 miscellaneous tarsals, 217 metatarsals, one metapodial, 153 phalanges: 1347 specimens.

Sylvilagus nuttallii—Nuttall's Cottontail

MATERIAL: Six skull fragments, 18 mandibles, 60 isolated teeth: 84 specimens.

REMARKS: *Sylvilagus nuttallii* is the only rabbit currently found in the Carson Desert (Hall, 1946), and is also the only large rabbit demonstrably present in the Hidden Cave deposits. The presence of the pygmy rabbit in the Hidden Cave fauna is of much interest. The closest modern record for pygmy rabbits

TABLE 25

Numbers of Identified Mammalian Specimens per Unmixed Stratum, or Which Remain Uncorrelated (N.C.), at Hidden Cave

	Sorex palustris	*Myotis* sp.	*Myotis yumanensis*	*Plecotus townsendii*	*Antrozous pallidus*	*Sylvilagus* sp.	*Sylvilagus idahoensis*	*Sylvilagus* cf. *nuttallii*	*Sylvilagus nuttallii*	*Lepus* sp.	*Lepus californicus*	*Marmota flaviventris*	*Ammospermophilus* cf. *leucurus*	*Ammospermophilus leucurus*	*Spermophilus* sp.	*Spermophilus* cf. *townsendii*	*Spermophilus townsendii*	*Thomomys* sp.	*Thomomys* cf. *bottae*	*Thomomys bottae*	*Perognathus* sp.	*Perognathus longimembris*
Stratum:																						
I	—	—	1	—	2	3	—	21	2	85	1	5	—	—	5	2	2	—	—	—	5	—
II	1	—	—	—	—	2	—	70	1	120	1	10	—	—	1	3	8	2	3	1	1	1
III	—	—	—	—	—	1	—	18	—	65	—	8	—	—	1	2	5	2	—	—	3	1
IV	—	—	1	—	—	24	—	221	9	426	3	140	1	1	5	—	5	9	2	3	12	3
V	—	1	4	—	2	21	—	204	23	255	—	68	—	2	4	—	4	7	1	1	18	3
VI	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
VII	—	—	1	—	—	12	—	106	5	68	—	27	1	—	1	—	1	3	—	1	13	—
VIII	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—
IX	—	—	—	—	—	7	—	40	1	31	—	12	—	—	1	—	—	3	—	—	7	1
X	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
XI	—	—	—	—	—	—	—	2	—	3	—	—	—	—	—	—	—	—	—	—	—	—
XII	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
XIII	—	—	—	—	—	2	—	27	1	16	—	10	1	—	2	—	—	1	—	—	17	—
XIV	—	—	—	—	—	—	—	1	—	1	—	—	—	—	—	—	1	—	—	—	—	—
Totals:	1	1	7	0	4	72	0	710	42	1070	5	280	3	3	20	8	26	27	6	6	76	9
N.C.	0	0	1	1	1	17	1	172	14	270	3	116	0	0	8	0	11	6	6	1	13	0

TABLE 25—(*Continued*)

Stratum:	*Perognathus parvus*	*Perognathus formosus*	*Microdipodops* sp.	*Dipodomys* sp.	*Dipodomys ordii*	*Dipodomys* cf. *microps*	*Dipodomys microps*	*Dipodomys merriami*	*Dipodomys* cf. *deserti*	*Dipodomys deserti*	*Reithrodontomys megalotis*	*Peromyscus* sp.	*Peromyscus maniculatus*	*Peromyscus crinitus*	*Onychomys* sp.	*Onychomys leucogaster*	*Neotoma* sp.	*Neotoma* cf. *lepida*	*Neotoma lepida*	*Neotoma* cf. *cinerea*	*Neotoma cinerea*	*Microtus* sp.
I	—	6	—	26	—	1	5	—	—	—	—	—	—	—	—	—	9	10	6	3	1	4
II	—	—	—	11	—	—	3	—	—	—	2	—	1	—	—	—	12	7	1	6	2	8
III	—	—	—	14	—	3	3	—	—	—	—	—	—	—	—	—	5	15	5	10	6	15
IV	2	7	—	101	1	2	6	—	3	—	—	5	8	—	—	—	55	51	25	95	47	43
V	2	1	1	87	—	1	7	—	3	1	—	5	4	2	—	—	51	51	35	115	34	22
VI	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
VII	—	3	—	32	—	—	2	—	—	—	—	3	3	1	1	1	34	22	7	48	18	6
VIII	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
IX	1	1	—	6	—	—	—	—	—	—	—	—	—	—	—	—	8	10	2	16	7	3
X	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
XI	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	1	1	—
XII	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
XIII	1	1	—	4	—	—	—	—	—	—	—	2	1	—	—	—	5	9	6	23	4	—
XIV	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	1	1	1	—	—
Totals:	6	19	1	281	1	7	26	0	6	1	2	16	17	3	1	1	179	177	88	318	120	101
N.C.	1	3	0	48	0	1	4	1	2	0	0	5	3	1	0	0	44	43	23	60	25	13

TABLE 25—(*Continued*)

	Microtus montanus	*Ondatra zibethicus*	*Canis* cf. *latrans*	*Canis latrans*	*Canis lupus*	*Vulpes vulpes*	*Martes* sp.	*Martes nobilis*	*Mustela* sp.	*Mustela* cf. *frenata*	*Mustela frenata*	*Mustela vison*	*Taxidea taxus*	*Spilogale putorius*	*Mephitis mephitis*	*Lynx* cf. *rufus*	*Equus* sp.	*Camelops* cf. *hesternus*	*Odocoileus* cf. *hemionus*	*Antilocapra americana*	*Bison bison*	Totals
Stratum:																						
I	3	1	—	1	—	—	—	—	—	2	—	—	—	—	—	—	—	—	—	—	—	212
II	—	—	1	2	1	—	—	1	—	—	—	1	1	1	—	—	—	—	—	—	—	286
III	—	—	—	1	—	1	—	—	1	1	—	1	1	—	—	—	—	1	—	—	—	189
IV	4	4	17	2	1	6	—	—	—	3	2	—	10	—	—	1	1	—	2	5	—	1374
V	2	4	3	2	—	10	—	—	—	3	1	—	—	1	1	1	1	—	—	—	—	1069
VI	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0
VII	1	—	—	1	—	1	—	—	—	2	1	—	1	1	—	—	—	—	—	—	—	428
VIII	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1
IX	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	158
X	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0
XI	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	8
XII	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0
XIII	—	—	—	—	—	4	—	—	—	1	—	—	—	—	—	—	1	—	—	6	—	145
XIV	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	7
Totals:	10	9	21	9	2	22	1	1	1	12	4	2	13	3	1	2	3	1	2	11	—	3877
N.C.	2	2	10	4	1	6	0	0	0	9	2	0	6	0	1	1	1	0	0	0	1	964

of which I am aware is from the Reese River Valley, some 125 km. to the east. Given that these animals prefer fairly dense stands of tall sagebrush (*Artemisia tridentata*; Orr, 1940), modern habitats in the Carson Desert seem fully inappropriate for them. The faunal record for the northern half of the Great Basin and the southern reaches of the Plateau demonstrates that pygmy rabbits were much more common here during the early Holocene than they have been since that time (Grayson, 1982, 1983). Although there are extralimital late Pleistocene records for pygmy rabbits from regions well to the south of the modern distribution of this animal (e.g., Harris, 1977), the Hidden Cave specimen is the first extralimital record from an area north of the southern distributional border of *S. idahoensis*. Elsewhere, I have speculated that pygmy rabbits may have been extirpated from the southwest during late Pleistocene or early Holocene times, followed by a mid-Holocene decrease in their abundance in the more northerly Great Basin (Grayson, 1982). Precisely how the Hidden Cave specimen might fit into the developing picture of the biogeographic history of *S. idahoensis* in the arid west cannot be ascertained at the present time, however. Retrieved during the University of California excavations (Thomas, chap. 4, this volume), the specimen (2-57773) cannot be correlated with the Hidden Cave stratigraphic sequence. If my thoughts concerning the late Pleistocene and Holocene history of *S. idahoensis* in the arid west are correct, I would not be surprised to learn that the specimen is late Pleistocene or early Holocene in age, corresponding not only with the presence of pygmy rabbits in the southwest and with greater abundances of pygmy rabbits within the area of their modern distribution, but also with the presence of habitats with greater amounts of *Artemisia* in the Hidden Cave area than is currently the case (Wigand and Mehringer, chap. 9, this volume).

Sylvilagus audubonii, the desert cottontail, is the only other large extant *Sylvilagus* likely to have occupied the Carson Desert during the Holocene. To distinguish fragmentary remains of *S. nuttallii* from those of *S. audubonii* is difficult, but, with the exception of M_3, the mandibular molars and premolars of these species can be securely identified, as can portions of the skull (Orr, 1940; Findley et al., 1975). In addition, edentulous mandibles can be identified by the ratio of the alveolar length of the lower cheekteeth to the height of the mandible at the lateral anterior notch of P_4 (Findley et al., 1975; see table 27). These criteria have been used to identify the large Hidden Cave *Sylvilagus*. Since the desert cottontail is not represented in the identifiable skull fragments, mandibles, and teeth, I have referred all other specimens of large *Sylvilagus* to *S.* cf. *nuttallii.*

The innominate of *Sylvilagus idahoensis* is distinctive. Not only is it smaller than the corresponding element of all other North American leporids, but, as compared with the innominate of *S. nuttallii* and *S. audubonii,* the dorsal border of the acetabulum is rounded, not flattened, and the superior ramus of the pubis is more slender and less rugose.

Lepus sp.—Hares

MATERIAL: One hundred skull fragments, 58 mandibles, 233 isolated teeth, 38 scapulae, 86 humeri, 45 radii, 61 ulnae, three carpals, 98 metacarpals, 52 vertebrae, five sacra, 51 innominates, five patellae, 65 femora, 91 tibiae, 44 astragali, 61 calcanea, 22 miscellaneous tarsals, 312 metatarsals, 329 phalanges: 1759 specimens.

Lepus californicus—Black-tailed Jack Rabbit

MATERIAL: One skull fragment, eight mandibles: nine specimens.

REMARKS: The black-tailed jack rabbit is the only member of the genus *Lepus* currently found in the Carson Desert area. During late Pleistocene and early Holocene times, however, both the snowshoe hare (*L. americanus*) and the white-tailed jack-rabbit (*L. townsendii*) may have been present (Grayson, 1982). Unfortunately, the identification of the species represented in a collection of fragmentary *Lepus* specimens is notoriously difficult. Although Lundelius (1979) has suggested that certain characters of the upper molars allow *L. californicus* to be separated from *L. townsendii,* I do not find that these characters allow consistent identification of the modern material I have available. In addition, the results of my earlier attempt to

TABLE 26

Numbers of Identified Mammalian Specimens per Mixed Stratum at Hidden Cave

Stratum:	*Myotis* sp.	*Myotis yumanensis*	*Antrozous pallidus*	*Sylvilagus* sp.	*Sylvilagus* cf. *nuttallii*	*Sylvilagus nuttallii*	*Lepus* sp.	*Lepus californicus*	*Marmota flaviventris*	*Ammospermophilus* cf. *leucurus*	*Spermophilus* sp.	*Spermophilus* cf. *townsendii*	*Spermophilus townsendii*	*Thomomys* sp.	*Thomomys* cf. *bottae*	*Thomomys bottae*	*Thomomys* cf. *townsendii*	*Perognathus* sp.	*Perognathus longimembris*	*Perognathus parvus*	*Perognathus formosus*	*Microdipodops* sp.	*Microdipodops pallidus*	*Dipodomys* sp.	*Dipodomys* cf. *microps*	*Dipodomys microps*
I–II	–	–	–	–	5	–	21	–	3	–	–	2	–	–	–	–	–	–	–	–	1	–	–	4	–	1
I–V	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
II–III	–	–	–	–	5	–	16	1	1	–	1	–	–	–	–	–	1	–	–	–	–	–	–	6	–	–
II–IV	–	–	–	2	11	2	18	–	8	–	–	–	–	1	1	–	–	2	–	–	–	–	–	5	–	1
III–IV	–	–	–	–	6	1	29	–	4	–	1	–	–	1	–	–	–	1	–	–	–	–	–	8	–	–
IV–V	–	–	–	1	2	–	6	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	1
IV–XIV	–	–	–	–	7	–	7	–	6	–	–	–	–	–	1	–	–	–	–	–	1	–	–	1	–	1
V–VI	–	–	–	2	25	1	23	–	4	–	–	–	–	1	–	–	–	–	–	–	–	–	–	9	1	1
V–VII	–	–	–	–	11	–	4	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
V–XI	–	–	–	–	2	–	3	–	1	–	–	–	–	–	–	–	–	1	–	1	–	–	–	2	–	–
VI–VII	–	1	–	–	28	2	12	–	5	–	–	1	–	–	–	–	–	2	–	–	–	–	–	12	–	–
VII–IX	–	–	–	7	75	3	32	–	12	–	1	–	–	2	1	–	–	10	1	1	1	1	–	14	–	–
VII–X	–	–	–	2	18	2	11	–	7	–	–	–	–	4	–	1	–	1	–	–	–	–	–	6	–	–
VII–XI	–	–	–	–	4	–	10	–	3	–	–	–	–	–	1	–	–	1	–	–	–	–	–	2	–	–
VII–XII	–	–	–	–	1	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
VII–XIV	–	–	–	3	13	2	19	–	9	–	–	–	–	1	–	1	–	–	–	–	–	–	–	3	–	–
VIII–X	–	–	–	1	8	2	7	–	2	–	–	–	–	1	–	–	–	1	–	–	–	–	–	2	–	–
IX–X	–	–	–	3	50	1	40	–	12	1	–	–	–	1	1	–	–	2	–	–	–	–	–	6	–	–
IX–XI	–	–	–	3	23	1	18	–	13	–	–	–	–	–	–	–	–	1	–	–	–	–	–	12	–	–
IX–XII	–	–	–	10	57	3	68	–	29	–	–	–	–	1	–	1	–	24	1	–	7	–	1	26	1	2
IX–XIII	–	1	–	3	49	2	28	–	16	–	–	–	–	1	1	–	–	5	–	–	–	–	–	2	–	–
IX–XIV	–	–	–	–	5	–	2	–	2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
X–XIII	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
X–XIV	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–
XI–XII	1	–	–	–	8	1	11	–	2	–	1	–	1	1	–	–	–	–	–	–	–	–	–	2	–	–
XI–XIII	–	–	–	3	13	2	10	–	2	–	1	–	–	2	–	–	–	–	–	–	–	–	–	2	–	–
XII–XIII	–	–	–	5	23	2	14	–	5	–	–	–	–	–	–	–	–	3	–	–	–	–	–	8	–	–
XII–XIV	–	–	–	–	5	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–
XIII–XIV	–	–	–	1	11	1	9	–	11	–	2	1	–	1	2	–	–	18	1	1	4	–	–	5	–	1
Totals	1	2	1	46	465	28	419	1	159	1	7	4	1	18	8	3	1	73	3	3	14	1	1	139	2	8

TABLE 26—(*Continued*)

Stratum:	*Dipodomys* cf. *merriami*	*Dipodomys* cf. *deserti*	*Dipodomys deserti*	*Peromyscus* sp.	*Peromyscus maniculatus*	*Peromyscus truei*	*Neotoma* sp.	*Neotoma* cf. *lepida*	*Neotoma lepida*	*Neotoma* cf. *cinerea*	*Neotoma cinerea*	*Microtus* sp.	*Microtus montanus*	*Ondatra zibethicus*	*Canis* cf. *latrans*	*Canis latrans*	*Vulpes vulpes*	*Ursus arctos*	*Martes* sp.	*Martes nobilis*	*Mustela* cf. *frenata*	*Taxidea taxus*	*Spilogale putorius*	*Lynx* cf. *rufus*	*Ovis canadensis*	Totals
I–II	—	—	—	—	—	—	1	2	—	1	1	3	—	—	—	—	1	—	—	—	—	—	—	1	—	47
I–V	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1
II–III	—	—	—	—	—	—	2	1	2	4	—	2	—	—	—	—	—	—	—	—	—	1	—	—	—	43
II–IV	—	—	—	1	—	—	3	4	2	8	3	—	—	—	1	—	2	—	—	—	—	—	—	—	—	75
III–IV	—	—	—	—	—	—	3	—	2	5	—	5	1	—	—	—	1	—	—	—	—	1	—	—	—	69
IV–V	—	—	—	1	—	—	—	—	—	1	—	5	—	—	—	—	—	—	—	—	—	—	—	—	—	19
IV–XIV	—	—	—	1	—	—	2	—	—	11	3	—	—	—	—	—	—	—	—	—	—	—	—	—	—	41
V–VI	—	—	1	1	1	—	6	2	2	3	—	2	—	—	—	—	—	—	—	—	1	—	—	—	—	86
V–VII	—	—	—	2	1	—	3	—	1	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	25
V–XI	—	—	—	—	—	—	—	—	—	1	—	1	—	—	—	—	1	—	—	—	—	—	—	—	—	13
VI–VII	—	—	—	—	—	—	3	3	1	8	7	1	—	—	—	—	—	—	—	—	—	—	—	—	—	86
VII–IX	—	1	—	3	1	—	12	6	8	17	3	1	—	—	—	—	—	1	1	—	—	—	—	—	—	215
VII–X	—	—	—	—	1	—	5	1	1	6	—	—	—	—	—	2	—	—	—	—	—	—	—	—	—	68
VII–XI	—	—	—	—	—	—	2	1	1	2	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	28
VII–XII	—	—	—	—	—	—	1	—	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	5
VII–XIV	—	—	—	—	—	—	3	1	2	3	4	—	—	1	—	—	—	—	—	—	—	—	—	—	—	65
VIII–X	—	—	—	—	—	—	2	—	2	6	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	36
IX–X	—	—	—	—	1	—	2	6	—	28	3	—	—	—	1	—	—	—	—	—	—	—	—	—	—	158
IX–XI	—	—	—	—	—	—	8	3	1	12	2	—	—	—	1	—	—	—	—	—	—	—	—	—	1	99
IX–XII	—	—	1	2	2	1	18	15	5	37	26	3	—	—	—	—	1	—	—	—	—	—	1	—	—	343
IX–XIII	—	—	—	5	1	—	12	8	4	11	5	—	—	—	—	1	—	—	—	1	—	—	—	—	—	156
IX–XIV	—	—	—	—	—	—	3	3	3	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	19
X–XIII	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1
X–XIV	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1
XI–XII	—	—	—	—	1	—	2	2	—	5	2	2	—	—	—	—	—	—	—	—	—	—	—	—	—	42
XI–XIII	—	—	—	—	—	—	4	3	1	4	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	47
XII–XIII	—	—	—	4	1	—	6	5	3	19	8	—	—	—	—	—	—	—	—	—	—	—	—	—	—	106
XII–XIV	—	—	—	7	—	—	9	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	22
XIII–XIV	1	—	—	—	—	—	—	—	2	15	8	—	—	—	—	—	—	—	—	—	1	—	—	—	—	96
Totals:	1	1	2	27	10	1	113	66	44	209	79	25	1	1	4	3	6	1	1	1	2	2	1	1	1	2012

TABLE 27
Measurements (in Millimeters) of Edentulous *Sylvilagus* Mandibles[a]

Specimen Number	Alveolar Length		Depth at P_4
	P_3–M_3	P_3–M_1	
2-57799 (1)	12.7		9.3
HC-391	13.8		9.8
HC-2231	13.1		9.1
2-57799 (2)		8.3	9.4
2-57799 (4)		8.4	9.4

[a] See Findley et al. (1975) for measurement definitions.

identify post-cranial remains of *Lepus* through bivariate analysis proved unreasonably time-consuming given the equivocal results obtained (Grayson, 1983). Of the nine specimens assigned to *L. californicus,* one is a fragmentary skull, identified on the basis of the morphology of the supraorbital process (Orr, 1940). The remaining eight specimens were identified by Robert D. Leonard with the use of discriminant function analysis (Leonard, 1980); his use of this technique to identify species of *Lepus* will be discussed elsewhere. All the *Lepus* material from Hidden Cave is commensurate with *L. californicus* in terms of size.

Order Rodentia—Rodents
Family Sciuridae—Squirrels
Marmota flaviventris—Yellow-bellied Marmot

MATERIAL: Ninety skull fragments, 57 mandibles, 199 isolated teeth, three scapulae, 16 humeri, six radii, 13 ulnae, two carpals, 25 metacarpals, 13 vertebrae, one sacrum, 10 innominates, four femora, eight tibiae, 10 astragali, 11 calcanea, 30 metatarsals, 57 phalanges: 555 specimens, plus one nearly complete juvenile skeleton.

REMARKS: There is only one published record for the yellow-bellied marmot in the Carson Desert area: Hall (1946) reports an individual from 26 km. south of Fallon at an elevation of 1370 m. (4500 ft.), a description that indicates that the record is from the northern flank of the Desert Mountains and some 22 km. southwest of Eetza Mountain. Although marmots are well represented in the Hidden Cave fauna and are present in nearly all strata, they do not exist in the Lahontan Mountains today. This absence is not surprising, since the area seems too arid to support them. Nonetheless, the abundance of marmots in the Hidden Cave fauna indicates populations of this animal on Eetza Mountain in the past, as I discuss below.

As Ziegler (1963; see also Guilday and Adam, 1967) has discussed, the hoary marmot, *M. caligata,* may have occurred in the Great Basin during late Pleistocene and early Holocene times. I have assigned the Hidden Cave *Marmota* to the generally smaller *M. flaviventris* because all of that material falls within the modern size range of this marmot. The dental criteria noted by Repenning (1962) as allowing the identification of *M. caligata* and *M. flaviventris* could not be observed on the Hidden Cave mandibles. The nearly entire juvenile comes from mixed Strata XIII–XIV, and is represented by 118 additional specimens.

Ammospermophilus cf. *leucurus*—White-tailed Antelope Squirrel

MATERIAL: Two femora, two tibiae: four specimens.

Ammospermophilus leucurus—White-tailed Antelope Squirrel

MATERIAL: One skull, one mandible, one isolated tooth: three specimens.

REMARKS: The white-tailed antelope squirrel is common in the vicinity of Hidden Cave today, found both on the floor of Lahontan Valley north of the cave in vegetation dominated by black greasewood (*Sarcobatus vermiculatus*), and on Eetza Mountain, in vegetation dominated by little greasewood (*S. baileyi*) and shadscale (*Atriplex confertifolia*); sight and trapping records range from 1195 m. (3920 ft.) to 1240 m. (4070 ft.) elevation. The white-tailed antelope squirrel was the only squirrel active in the vicinity of Hidden Cave during the time of my surveys.

Spermophilus sp.—Ground Squirrels

MATERIAL: One skull fragment, five mandibles, three scapulae, five humeri, one radius, five ulnae, four innominates, six femora, five tibiae: 35 specimens.

Spermophilus cf. *townsendii*—Townsend's Ground Squirrel

MATERIAL: Six skull fragments, six mandibles: 12 specimens.

Spermophilus townsendii—Townsend's Ground Squirrel

MATERIAL: Seven skull fragments, 19 mandibles, 12 isolated teeth: 38 specimens.

REMARKS: Townsend's ground squirrels are abundant in the irrigated fields in the vicinity of Fallon. They appear, however, to be absent today from Eetza Mountain and the immediately adjacent area; at least, I saw none during the summers of 1979, 1980, and 1981. It is possible that they inhabit the well-watered, grassy areas created by the Diagonal Drain approximately 2.5 km. north of Hidden Cave. Even if there were no resident population of *S. townsendii* on Eetza Mountain in the past, they could readily have been transported here by raptors or carnivores from nearby areas.

Family Geomyidae—Pocket Gophers

Thomomys sp.—Smooth-toothed Pocket Gophers

MATERIAL: Three skull fragments, four mandibles, 13 isolated teeth, two scapulae, seven humeri, two radii, one ulna, three innominates, seven femora, seven tibiae, two calcanea: 51 specimens.

Thomomys cf. *bottae*—Botta Pocket Gopher

MATERIAL: Nine skull fragments, seven mandibles, four isolated teeth: 20 specimens.

Thomomys bottae—Botta Pocket Gopher

MATERIAL: Ten mandibles: 10 specimens.

Thomomys cf. *townsendii*—Townsend's Pocket Gopher

MATERIAL: One mandible: one specimen.

REMARKS: Only one species of pocket gopher, *Thomomys bottae,* occurs in the Eetza Mountain area today. Hall (1946) provides a number of records from the vicinity of Fallon, including a single record from the northern edge of Carson Lake. Although I saw no active *Thomomys* mounds during my survey, the owl pellet sample collected from Fallen-in-Cave contained six *T. bottae* skulls and mandibles (see table 28). The animals clearly exist close enough to Hidden Cave today to become incorporated into the deposits of the site.

TABLE 28
Species Represented in the Fallen-in-Cave Owl Pellet Collection

Species	Number of Specimens		
	Skull	Mandible	Total
Thomomys bottae	2	4	6
Perognathus formosus	1	0	1
Dipodomys microps	11	17	28
Dipodomys merriami	18	8	26
Dipodomys deserti	3	0	3
Peromyscus maniculatus	1	1	2
Reithrodontomys megalotis	0	1	1
Microtus montanus	11	0	11
Totals	47	31	78

Although only *T. bottae* is found in the Carson Desert today, two other pocket gophers might be expected to have occurred in this area in the past: the northern pocket gopher, *T. talpoides,* and Townsend's pocket gopher, *T. townsendii.* The nearest populations of *T. talpoides* are currently some 60 km. to the east, in the Clan Alpine Range, whereas the nearest populations of *T. townsendii* are found approximately 70 km. to the north, along the lower reaches of the Humboldt River (Hall, 1946). *Thomomys talpoides* is primarily a high altitude or high latitude animal in the Great Basin today; a much wider lowland distribution in the past is likely (Grayson, 1982). *Thomomys townsendii* has a number of apparently isolated populations in the Great Basin and southern Plateau (Hall and Kelson, 1959), and is known outside of its modern range from the Pleistocene Fossil Lake fauna in south-central Oregon (Allison, 1966; the presence of a robust *Thomomys* in the Fossil Lake fauna is confirmed by specimens housed in the Burke Memorial Museum, University of Washington).

Separation of *Thomomys (Thomomys) talpoides* from *T. (Megascapheus) bottae* and *T.*

TABLE 29
Mandibular Alveolar Lengths (in Millimeters) (P_4-M_2) for Modern *Thomomys bottae* and *Thomomys townsendii*, and for the Hidden Cave *Thomomys*

A. Modern *Thomomys*

	N	Range	$\bar{X}$	s
Thomomys bottae	54	4.7–7.0	5.7	0.48
Thomomys townsendii	67	5.7–7.8	7.1	0.39

B. Hidden Cave *Thomomys*

Specimen Number	Provenience	Alveolar Length	Identification
HC-215	IV	6.4	*T. bottae*
HC-355	VII	6.2	*T. bottae*
HC-404	IX–XII	6.1	*T. bottae*
HC-1026	II–III	7.2	*T.* cf. *townsendii*
HC-1249	None	5.8	*T. bottae*
HC-1339	IV	5.9	*T. bottae*
HC-1608	II	6.4	*T. bottae*
HC-1732	V	6.1	*T. bottae*
HC-1793	VII–XIV	6.1	*T. bottae*
HC-1813	IV	6.0	*T. bottae*
HC-2289	VII–IX	6.3	*T. bottae*

(Megascapheus) townsendii is not difficult. A number of dental and cranial characters, including the morphology of the rostrum and of P_4, allow this separation (Thaeler, 1980), as does the alveolar length of the mandible (Grayson, 1983). The identification of *T. bottae* and *T. townsendii* from fragmentary material is more difficult. As with the Gatecliff *Thomomys* (Grayson, 1983), I have relied on the fact that *T. bottae* tends to be a smaller, less robust animal than *T. townsendii* to identify these species.

Table 29 presents P_4–M_2 alveolar lengths for a modern series of *Thomomys bottae (T. b. laticeps, T. b. leucodon, T. b. mohavensis, T. b. modicus, T. b. nanus,* and *T. b. oreoecus*) and *T. townsendii (T. t. bachmani, T. t. nevadensis, T. t. owyhensis,* and *T. t. townsendii*). I have used P_4–M_2 alveolar lengths because the lingual wall of the alveolus of M_3 is frequently broken in archaeological and paleontological *Thomomys*. Table 29 also displays P_4–M_2 alveolar lengths for the 11 measurable Hidden Cave *Thomomys* mandibles; all of these specimens pertain to the subgenus *Megascapheus*. In all cases but one, t tests indicate assignment to *T. bottae* (unless otherwise stated, all significance tests reported in this chapter employed a significance level of $p = 0.05$). A single specimen from mixed Stratum II–III, however, is significantly larger than my modern sample of *T. bottae* ($t = 3.096$, $p < 0.005$), and exceeds the range of the alveolar lengths in that sample; this specimen does not differ significantly from the modern *T. townsendii* ($t = 0.255$, $p > 0.30$). I have assigned this edentulous mandible to *T.* cf. *townsendii*.

In addition to these measured specimens, 20 skull fragments, mandibles and teeth have been assigned to *T.* cf. *bottae*. All show *T. bottae* or *T. townsendii* P_4 or rostral morphology, but none of the maxillae or mandibles was sufficiently complete to allow alveolar lengths to be measured. I have assigned these specimens to *T.* cf. *bottae* because they appear insufficiently robust to be *T. townsendii*.

Family Heteromyidae—Pocket Mice, Kangaroo Mice, and Kangaroo Rats

Perognathus sp.—Pocket Mice

MATERIALS: Eleven skull fragments, 30 mandibles, seven isolated teeth, 17 humeri, two ulnae, 18 innominates, two sacra, 39 femora, 36 tibiae: 162 specimens.

Perognathus longimembris—Little Pocket Mouse

MATERIAL: Eight mandibles, one innominate, two femora, one tibia: 12 specimens.

Perognathus parvus—Great Basin Pocket Mouse

MATERIAL: Four skull fragments, five mandibles, one isolated tooth: 10 specimens.

Perognathus formosus—Long-tailed Pocket Mouse

MATERIAL: Twelve skull fragments, one complete skull and articulated mandible, 22 mandibles, one isolated tooth: 36 specimens.

REMARKS: Three species of pocket mice occur, or are likely to occur, in the southern Carson Desert: the little pocket mouse, the smallest rodent in Nevada; the Great Basin pocket mouse; and the long-tailed pocket

mouse (Hall, 1946). Alcorn has taken *P. longimembris* in the vicinity of Fallon, but not *P. parvus*. I found *P. formosus* to be common in rocky areas on Eetza Mountain; all specimens were collected in vegetation characterized by *Sarcobatus baileyi* and *Atriplex confertifolia,* and at elevations ranging from 1235 m. (4050 ft.) to 1265 m. (4150 ft.). Only *Perognathus formosus,* and no other pocket mouse, was represented in the Fallen-in-Cave owl pellet collection (table 28).

Perognathus longimembris can be identified by size alone. *P. parvus* and *P. formosus* can be identified on the basis of a number of cranial and dental characters (Hall, 1946, 1980; Wood, 1935). In addition to these described characters, my identification of mandibles, maxillae, and isolated teeth relied on several dental features. In *P. formosus,* P_4 possesses an anterolabial cusp situated more posteriorly than in *P. parvus,* producing a narrower labial valley between metalophid and hypolophid. In contrast, the anterolabial cusp of P_4 of *P. parvus* is situated more anteriorly than in *P. formosus,* producing a broader labial valley between metalophid and hypolophid, whereas the metalophid is, as a result, more closely parallel to the hypolophid. In *P. formosus,* the hypolophid of M_1 and M_2 bulges only at the base of the hypoconid, so that the anterior and posterior walls of the hypolophid are subparallel through much of the wear life of the tooth. In *P. parvus,* the bulge of the hypolophid at the base of the hypoconid is much greater than in *P. formosus* so that at even relatively early stages of wear, the anterior enamel walls of the hypolophid bulge anteriorly. In *P. formosus,* P_4 is wider than M_3; in *P. parvus,* these teeth are subequal in width. Finally, P^4 of *P. parvus* often has an accessory anterolingual cusp that I have not observed on P^4 of *P. formosus.* These characters, as well as those previously described, were used to identify the Hidden Cave pocket mice.

Microdipodops sp.—Kangaroo Mice

MATERIAL: Two femora: two specimens.

Microdipodops pallidus—Pale Kangaroo Mouse

MATERIAL: One mandible: one specimen.
REMARKS: The pale kangaroo mouse, *Microdipodops pallidus,* is currently found in the Lahontan Valley (J. R. Alcorn, personal commun.). I took no kangaroo mice during my collecting, nor were any in the Fallen-in-Cave owl pellet collection, even though the lower reaches of Eetza Mountain and the adjacent valley bottom appear to provide favorable habitat for them. The femora of *Microdipodops* possess a short, stout neck that distinguishes them from other similarly sized heteromyids; the *M. pallidus* mandible retains P_4.

Dipodomys sp.—Kangaroo Rats

MATERIAL: Thirty-five skull fragments, 22 mandibles, 28 isolated teeth, five scapulae, 49 humeri, two radii, 15 ulnae, nine sacra, 53 innominates, 128 femora, 104 tibiae, 18 astragali: 468 specimens.

Dipodomys ordii—Great Basin Kangaroo Rat

MATERIAL: One mandible: one specimen.

Dipodomys cf. *microps*—Chisel-toothed Kangaroo Rat

MATERIAL: One skull fragment, one mandible, eight isolated teeth: 10 specimens.

Dipodomys microps—Chisel-toothed Kangaroo Rat

MATERIAL: Five skull fragments, 28 mandibles, five isolated teeth: 38 specimens.

Dipodomys cf. *merriami*—Merriam's Kangaroo Rat

MATERIAL: One skull fragment: one specimen.

Dipodomys merriami—Merriam's Kangaroo Rat

MATERIAL: One mandible: one specimen.

Dipodomys cf. *deserti*—Desert Kangaroo Rat

MATERIAL: Two skull fragments, one radius, one innominate, one sacrum, four femora: nine specimens.

Dipodomys deserti—Desert Kangaroo Rat

MATERIAL: One skull fragment, two mandibles: three specimens.

REMARKS: All four of the kangaroo rats identified from the Hidden Cave deposits are currently found in the Lahontan Valley (Hall, 1946; Alcorn, personal commun.), but I can document only three from the vicinity of Hidden Cave. Of the 23 kangaroo rats I trapped during 1979 and 1980, 21 were *D. merriami*; only one individual each of *D. microps* and *D. deserti* were taken. The single *D. microps* was trapped on the northern edge of Eetza Mountain just northwest of Hidden Cave in a small sandy hummock surrounded by *Sarcobatus baileyi* and *Atriplex confertifolia* (elev. 1235 m. [4050 ft.]); the same set of traps took three *D. merriami.* The single *D. deserti* was trapped on the sandy flats approximately 0.8 km. north of Hidden Cave in scattered *Sarcobatus vermiculatus* and occasional *Atriplex confertifolia* (elev. 1200 m. [3935 ft.]); this set of traps also took one *D. merriami,* as well as single individuals of *Peromyscus maniculatus* and *Neotoma lepida.* Merriam's kangaroo rat was taken at elevations ranging from 1200 m. (3935 ft.) to 1245 m. (4085 ft.), in substrates ranging from sandy to sand and rock, and in vegetation ranging from primarily *Sarcobatus vermiculatus* through mixed *S. baileyi* and *Atriplex confertifolia* to nearly pure *A. confertifolia.* The only trapped environments that did not take *D. merriami* were those that lacked a significant sandy component in the substrate. The same sets of traps that took *D. merriami* also took *Ammospermophilus leucurus, Perognathus formosus, Dipodomys microps, D. deserti, Peromyscus maniculatus, P. crinitus, Onychomys leucogaster,* and *Neotoma lepida.* While these results would suggest *D. merriami* to be the most abundant kangaroo rat in the immediate vicinity of Hidden Cave, the Fallen-in-Cave owl pellets provided roughly equal number of *D. merriami* and *D. microps* skulls and mandibles, suggesting the owls were sampling environments I did not (table 28). Those environments may have been the better watered ones near the Diagonal Drain some 2.4 km. north of Hidden Cave. As Beatley (1976) has discussed, in at least south-central Nevada, *D. microps* requires greater shrub cover and moister environments than does *D. merriami.* Unlike either the trapped sample or that provided by the owl pellets, the Hidden Cave kangaroo rat fauna is dominated by *D. microps,* although the number of specimens is small.

The skulls, mandibles, and teeth of *Dipodomys* were identified using characters described by Hall (1946) and Wood (1935; see also Lundelius, 1979). Material referred to *Dipodomys* cf. *deserti* was identified on the basis of size alone.

Family Muridae—Murids

Reithrodontomys megalotis—Western Harvest Mouse

MATERIAL: Two mandibles: two specimens.

REMARKS: Western harvest mice are generally found in grassy areas adjacent to water. Although I took none in the Eetza Mountain area, they are present in the Fallon area (J. R. Alcorn, personal commun.), and there is a published record for 13 km. southeast of Fallon (Hall, 1946).

Peromyscus sp.—White-footed Mice

MATERIAL: Ten skull fragments, 38 mandibles: 48 specimens.

Peromyscus maniculatus—Deer Mouse

MATERIAL: Four skull fragments, 24 mandibles, two isolated teeth: 30 specimens.

Peromyscus crinitus—Canyon Mouse

MATERIAL: Three mandibles, one isolated tooth: four specimens.

Peromyscus truei—Piñon Mouse

MATERIAL: One mandible: one specimen.

REMARKS: Only two species of *Peromyscus, P. maniculatus* and *P. crinitus,* are found in the Fallon area today (Alcorn, personal commun.), both of which are represented in the Hidden Cave fauna. The results of my trapping suggest *P. crinitus* to be the most abundant of these two mice on Eetza Mountain now. I took 28 canyon mice, from elevations ranging from 1250 m. (4100 ft.) to 1320 m.

(4330 ft.) and in vegetation characterized either by *Sarcobatus vermiculatus* and *Atriplex confertifolia* (5 individuals) or by *S. baileyi* and *A. confertifolia* (23 individuals). Although canyon mice are generally associated with rocky habitats, I trapped three individuals in the dunes south of Eetza Mountain (elev. 1205 m. [3950 ft.]), some 215 m. south of the nearest rocky areas. The utilization of such environments here by canyon mice may be associated with the lack of *P. maniculatus* in the area during the time I collected. I took only one deer mouse, from the dunes north of Eetza Mountain (elev. 1200 m. [3950 ft.]), in the same set of traps that took *D. deserti.* The owl pellet collection does not shed much light on the relative abundances of *P. maniculatus* and *P. crinitus* in the Eetza Mountain area. Only two identifiable specimens of *Peromyscus* were in that collection, both of which were *P. maniculatus* (table 28). All other specimens of *Peromyscus* in the owl pellet collection were edentulous mandibles.

In addition to *P. maniculatus* and *P. crinitus,* however, Hidden Cave also provided a single specimen of *P. truei.* Although the general distribution of the piñon mouse includes this part of Nevada, it does not exist in the Eetza Mountain area today (Alcorn, personal commun.); the closest modern record of which I am aware is from the vicinity of Lahontan Dam, at an elevation of 1250 m. (4100 ft.), some 40 km. to the west (Hall, 1946). Hall (1946) notes that in Nevada piñon mice are seldom if ever taken in habitats that lack trees, though the trees are not necessarily pinyon pine (*Pinus* spp.). However, *P. truei* is also known to occupy treeless habitats in other parts of its range (Hoffmeister, 1951), and it does not seem wise to place any paleoenvironmental emphasis on the presence of this specimen in the Hidden Cave deposits.

The identification of species of *Peromyscus* from fragmentary skeletal elements is not a simple matter because of the morphological similarity displayed by many of these species, and because of the high variability that characterizes *Peromyscus* dental elements (Hooper, 1957). My identification of the Hidden Cave *Peromyscus maniculatus* and *P. crinitus* maxillae, mandibles, and isolated teeth (M^1 and M_1) depended on previously described taxonomic characters (see especially Grayson, 1983; Hall, 1946; and Miller, 1971). In all cases, measurements of the Hidden Cave mandibles assigned to *P. maniculatus* and *P. crinitus* are consistent with identifications made on qualitative grounds (see figs. 42–44 and table 30). The single specimen of *P. truei* from Hidden Cave is distinguished from other species of *Peromyscus* likely to have been found in the area by the combination of its relatively large size (table 30), a relatively large M_3, and the weak anterointernal inflection of the anteroconid of M_1.

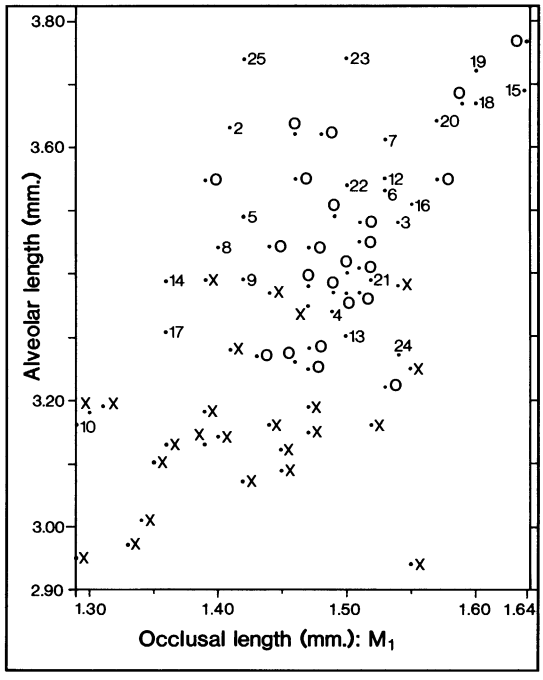

FIG. 42. Relationship between mandibular alveolar length (M_1–M_3) and occlusal length of M_1 in modern *Peromyscus maniculatus* (O), *Peromyscus crinitus* (X), and Hidden Cave *Peromyscus* (numbered specimens) identified as either *P. maniculatus* or *P. crinitus* (numbered specimens keyed to those presented in table 30).

Onychomys sp.—Grasshopper Mice

MATERIAL: One mandible: one specimen.

Onychomys leucogaster—Northern Grasshopper Mouse

MATERIAL: One maxilla: one specimen.

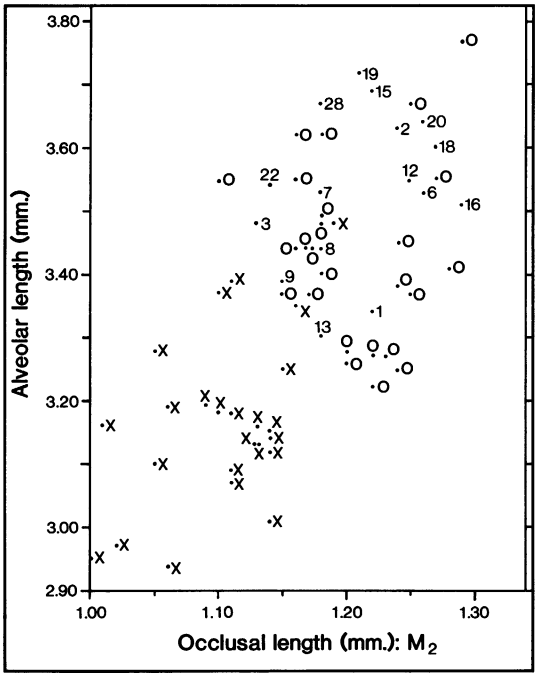

FIG. 43. Relationship between mandibular alveolar length (M_1–M_3) and occlusal length of M_2 in modern *Peromyscus maniculatus* (O), *Peromyscus crinitus* (X), and Hidden Cave *Peromyscus* (numbered specimens) identified as either *P. maniculatus* or *P. crinitus* (numbered specimens keyed to those presented in table 30).

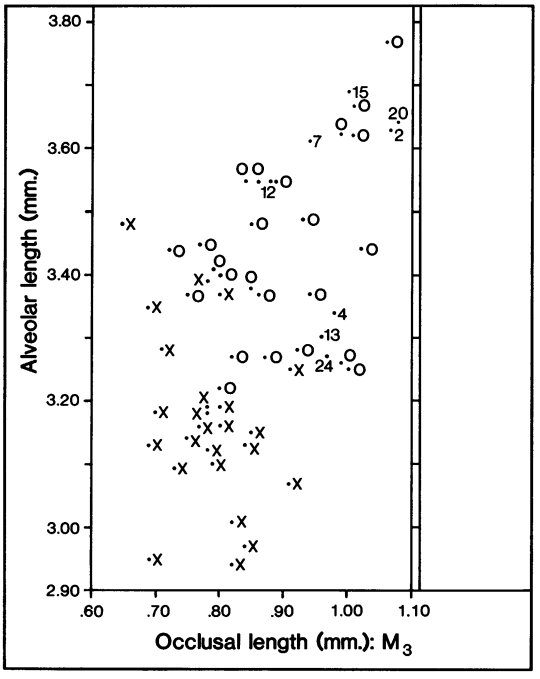

FIG. 44. Relationship between mandibular alveolar length (M_1–M_3) and occlusal length of M_3 in modern *Peromyscus maniculatus* (O), *Peromyscus crinitus* (X), and Hidden Cave *Peromyscus* (numbered specimens) identified as either *P. maniculatus* or *P. crinitus* (numbered specimens keyed to those presented in table 30).

REMARKS: I took a single specimen of the northern grasshopper mouse from the sandy valley bottom approximately 1 km. northeast of Hidden Cave, in scattered *Sarcobatus vermiculatus* and *Atriplex confertifolia* (elev. 1205 m. [3955 ft.]).

Neotoma cf. *lepida*—Desert Wood Rat

MATERIAL: Twenty-eight skull fragments, 14 mandibles, 11 isolated teeth, 10 scapulae, 51 humeri, 4 radii, 19 ulnae, 7 vertebrae, 17 innominates, 3 sacra, 61 femora, 37 tibiae, 1 astragalus, 22 calcanea, 1 metatarsal: 286 specimens.

Neotoma sp.—Wood Rats

MATERIAL: Fifty-four skull fragments, 43 mandibles, 82 isolated teeth, 14 humeri, three radii, six ulnae, 77 vertebrae, three sacra, seven innominates, 31 femora, six tibiae, one astragalus, two calcanea, seven metatarsals: 336 specimens.

Neotoma lepida—Desert Wood Rat

MATERIAL: Thirty-two skull fragments, 33 mandibles, 90 isolated teeth: 155 specimens.

Neotoma cf. *cinerea*—Bushy-Tailed Wood Rat

MATERIAL: Sixty-one skull fragments, 13 mandibles, 33 isolated teeth, 11 scapulae, 83 humeri, 14 radii, 36 ulnae, 50 vertebrae, 13 sacra, 38 innominates, 98 femora, 73 tibiae, 13 astragali, 26 calcanea, 25 metatarsals: 587 specimens.

Neotoma cinerea—Bushy-tailed Wood Rat

MATERIAL: Thirty-three skull fragments, 43 mandibles, 148 isolated teeth: 224 specimens.

TABLE 30
Measurements (in Millimeters) of Hidden Cave *Peromyscus* Mandibles

Specimen Number	Alveolar Length	Occlusal Length			Identification
		M_1	M_2	M_3	
HC-1767 (1)	3.34	—	1.22	—	*P. maniculatus*
HC-1767 (2)	3.63	1.41	1.24	1.07	*P. maniculatus*
HC-164 (3)	3.48	1.54	1.13	—	*P. maniculatus*
HC-302 (4)	3.34	1.49	—	0.98	*P. maniculatus*
HC-355 (5)	3.49	1.42	—	—	*P. maniculatus*
HC-1821 (6)	3.53	1.53	1.26	—	*P. maniculatus*
HC-1799 (7)	3.61	1.53	1.18	0.94	*P. maniculatus*
HC-1716 (8)	3.44	1.40	1.18	—	*P. maniculatus*
HC-1876 (9)	3.39	1.42	1.15	—	*P. maniculatus*
HC-2012 (10)	3.16	1.29	—	—	*P. crinitus*
HC-2302 (12)	3.55	1.53	1.25	0.88	*P. maniculatus*
HC-464 (13)	3.30	1.50	1.18	0.96	*P. maniculatus*
HC-1872 (14)	3.39	1.36	—	—	*P. crinitus*
HC-2006 (15)	3.69	1.64	1.22	1.00	*P. maniculatus*
HC-8 (16)	3.51	1.55	1.29	—	*P. maniculatus*
HC-2020 (17)	3.31	1.36	—	—	*P. crinitus*
HC-2060 (18)	3.67	1.60	1.27	—	*P. maniculatus*
HC-215 (19)	3.72	1.60	1.21	—	*P. maniculatus*
HC-2289 (20)	3.64	1.57	1.26	1.08	*P. maniculatus*
HC-402 (21)	3.39	1.52	—	—	*P. maniculatus*
HC-1345 (22)	3.54	1.50	1.14	—	*P. maniculatus*
HC-364 (23)	3.74	1.50	—	—	*P. maniculatus*
HC-502 (24)	3.27	1.54	—	0.97	*P. maniculatus*
HC-391 (25)	3.74	1.42	—	—	*P. maniculatus*
HC-404 (27)	4.19	1.50	—	1.05	*P. truei*
HC-419 (28)	3.67	—	1.18	—	*P. maniculatus*

REMARKS: Today the only wood rat that lives in the vicinity of Eetza Mountain is *Neotoma lepida,* the desert wood rat. I trapped all rock rims on Eetza Mountain using large Sherman live-traps, taking 14 *N. lepida.* In addition, a single *N. lepida* was taken on the valley floor in the same set of traps that provided *D. deserti* (see above). *Neotoma cinerea* does not exist on Eetza Mountain at present, nor is this surprising, since the area seems too arid for it. The closest published record for *N. cinerea* is from 8 km. west of Fallon (Hall, 1946); I do not know whether this animal exists in the Stillwater Range to the north and east of Eetza Mountain. Even though bushy-tailed wood rats do not exist on Eetza Mountain today, they were the most abundant wood rats in the deposits of Hidden Cave.

The morphology of M^1 allows separation of *N. cinerea* and *N. lepida*: the reentrant angle of the anterior prism of this tooth is deep in *N. cinerea,* but shallow in *N. lepida.* As I have noted elsewhere (Grayson, 1983), many other cranial and postcranial characters allow separation of these two species, but most of these may be a function of size, since *N. lepida* is considerably smaller than *N. cinerea.* Size also played a major role in my assignment of elements of *N.* cf. *lepida* and *N.* cf. *cinerea.*

Size played a role as well in my assignment of maxillae, mandibles, and isolated teeth to *N. lepida* and *N. cinerea.* Whereas all specimens were first identified on the basis of qualitative characters, there seem to be few consistent differences in the teeth of these species that are not related to consistent differences in size. Table 31 presents mandibular alveolar length (M_1–M_3) for 28 modern specimens of *N. lepida (N. l. gilva, N. l. lepida, N. l. nevadensis,* and *N. l. stephensi*), and for 125 modern specimens of *N. cinerea (N. c. alti-*

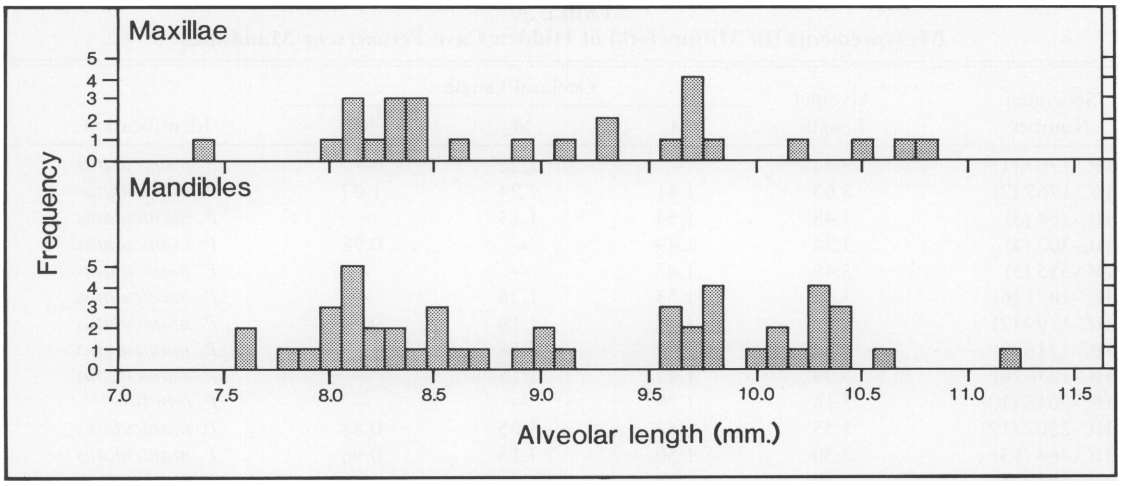

FIG. 45. Alveolar lengths (M^1–M^3 and M_1–M_3) of Hidden Cave *Neotoma* maxillae and mandibles.

cola, N. c. fusca, N. c. occidentalis, N. c. orolestes, N. c. pulla, and *N. c. saxamans*). The distribution of the alveolar lengths of the 49 *Neotoma* mandibles that were sufficiently complete to allow this measurement is shown in figure 45. Specimens with alveolar lengths of 8.6 mm. or less were assigned to *N. lepida*; those with lengths of 9.3 mm. or more were assigned to *N. cinerea*. Of the four specimens that fell between these limits, two retained M_1 and were assigned on that basis (see below); two others, with alveolar lengths of 8.9 and 9.0 mm., were edentulous. These were assigned to *Neotoma* sp. because the results of statistical analysis were ambiguous (for the 8.9 mm. specimen compared with modern *N. cinerea*, $t = -3.02$, $p < 0.01$; with modern *N. lepida*, $t = 2.69$, $p < 0.01$; for the 9.0 mm. specimen, the respective values are $t = -2.76$, $p < 0.01$, and $t = 3.04$, $p < 0.01$).

The same approach was employed for the *Neotoma* maxillae (table 31, fig. 45). Five maxillae fell between the ranges of modern *N. lepida* and *N. cinerea*; four of these retained M^1 and were assigned on the basis of M^1 morphology and tooth size (see below). The remaining specimen, with an alveolar length of 8.9 mm., was edentulous. This specimen was assigned to *Neotoma* sp., since statistical analysis was again ambiguous (with modern *N. cinerea*, $t = -3.12$, $p < 0.01$; with modern *N. lepida*, $t = 1.88$, $0.05 > p > 0.01$).

Occlusal lengths of teeth were employed in the assignment of isolated *Neotoma* teeth, and in the identification of mandibles and maxillae whose assignment on the basis of alveolar length was ambiguous. As table 31 shows, however, there is considerable overlap in the ranges of occlusal lengths between *N. lepida* and *N. cinerea* for all teeth. This overlap is to be expected, even given the lack of overlap in alveolar lengths, since occlusal lengths are affected by wear. As a result, however, specimens could not be assigned simply by observing within which of two size ranges they fell. Instead, *t*-tests were used to identify all specimens; the results are shown in table 32. Of the two mandibles that could not be assigned to species on the basis of alveolar lengths, one, with an alveolar length of 8.7 mm. and an M_1 occlusal length of 3.28 mm., was identified as *N. cinerea*; the other, with an alveolar length of 9.0 mm. and an M_1 occlusal length of 3.11 mm., was identified as *N. lepida*. Of the four maxillae that could not be assigned on the basis of alveolar length, one was assigned to *N. lepida* on the basis of M_1 occlusal length (AL = 9.1 mm.; OL = 3.22 mm.), whereas the remaining three were assigned to *N. cinerea* (AL and OL of these three specimens are, respectively, 9.2 and 3.52, 9.3 and 3.44, and 9.3 and 3.50 mm.). These identifications were consistent with those made on the basis of M^1 morphology alone.

TABLE 31
Alveolar Lengths (M_1-M_3; M^1-M^3) and Occlusal Lengths (in Millimeters) of Upper and Lower Molars of Modern *Neotoma lepida* and *Neotoma cinerea*

A. Alveolar lengths

	Mandible			
	N	Range	$\bar{X}$	s
Neotoma lepida	28	7.6–8.6	8.18	0.37
Neotoma cinerea	125	9.3–11.5	10.07	0.39
	Maxilla			
	N	Range	$\bar{X}$	s
Neotoma lepida	23	7.8–8.6	8.40	0.26
Neotoma cinerea	34	9.4–11.4	10.23	0.42

B. Occlusal lengths

	Neotoma lepida					
	M_1	M_2	M_3	M^1	M^2	M^3
N	26	26	26	26	26	26
Range	2.73–3.33	2.37–2.82	1.33–2.01	2.90–3.46	2.22–2.57	1.43–2.22
$\bar{X}$	3.00	2.63	1.67	3.09	2.38	1.70
s	0.16	0.11	0.18	0.16	0.09	0.20
	Neotoma cinerea					
	M_1	M_2	M_3	M^1	M^2	M^3
N	37	37	37	37	37	37
Range	3.01–4.04	2.75–3.28	1.52–2.57	3.19–4.27	2.48–3.09	1.75–2.73
$\bar{X}$	3.51	3.02	2.15	3.59	2.85	2.30
s	0.23	0.13	0.22	0.19	0.15	0.27

Microtus sp.—Meadow Voles

MATERIAL: Eleven skull fragments, 73 mandibles, 55 teeth: 139 specimens.

Microtus montanus—Montane vole

MATERIAL: Thirteen skull fragments: 13 specimens.

REMARKS: Both the montane vole and the long-tailed vole (*Microtus longicaudus*) occur in the Lahontan Valley (Alcorn, personal commun.). I caught no voles in 1979 and 1980, but *M. montanus* was well represented in the Fallen-in-Cave owl pellet collection (table 28). It is likely that these individuals came from the grassy areas adjacent to the Diagonal Drain north of Hidden Cave. Identifications of *M. montanus* skulls were based primarily on the presence of ridged interorbital regions and constricted incisive foramina (Anderson, 1959; Maser and Storm, 1970).

Ondatra zibethicus—Muskrat

MATERIAL: Three skull fragments, one scapula, one humerus, one radius, four femora, one tibia, one calcaneus: 12 specimens.

REMARKS: Muskrats occupy the Carson River, and are currently found in the Lahontan Valley, where they "are generally distributed in both the irrigated areas and the shallow basins where waste water has accumulated" (Hall, 1946, p. 264).

Order Carnivora—Carnivores
Family Canidae—Coyote, Wolves, Foxes, and Dogs
Canis cf. *latrans*—Coyote

MATERIAL: Two skull fragments, four iso-

TABLE 32
Occlusal Lengths (in Millimeters) of Measurable, Isolated *Neotoma* Molars from Hidden Cave Assigned to Either *Neotoma lepida* or *Neotoma cinerea*[a]

	Neotoma lepida			
	N	Range	$\bar{X}$	*s*
M^1	20	2.57–3.25	2.97	0.18
M^2	5	2.27–2.51	2.39	0.10
M^3	0	—	—	—
M_1	34	2.65–3.11	2.93	0.13
M_2	32	2.43–2.78	2.63	0.11
M_3	—	—	—	—
	Neotoma cinerea			
	N	Range	$\bar{X}$	*s*
M^1	38	3.20–3.70	3.45	0.14
M^2	20	2.59–3.03	2.76	0.11
M^3	5	2.26–2.71	2.52	0.18
M_1	47	3.29–3.97	3.54	0.18
M_2	32	2.83–3.27	2.98	0.14
M_3	1	1.57	—	—

[a] Specimens assigned on the basis of morphology alone are included in the M^1 set.

lated teeth, one scapula, one vertebra, one sacrum, two tarsals, six metapodials, 18 phalanges: 35 specimens.

Canis latrans—Coyote

MATERIAL: One skull fragment, 13 isolated teeth, one humerus, one astragalus: 16 specimens.

Canis lupus—Gray Wolf

MATERIAL: One humerus, two metatarsals: three specimens.

REMARKS: Coyotes occur throughout Nevada; little information is available concerning the early historic distribution of wolves in the state (Hall, 1946).

Vulpes vulpes—Red Fox

MATERIAL: Three skull fragments, three mandibles, 22 isolated teeth, one humerus, two tibiae, three metacarpals: 34 specimens.

REMARKS: There are scattered records of red foxes in Nevada. While I am aware of none for the Carson Desert area, there is a single record for the eastern edge of Fairview Valley, approximately 40 km. southeast of Eetza Mountain (Hall, 1946). The red fox was also represented at Gatecliff Shelter (Grayson, 1983).

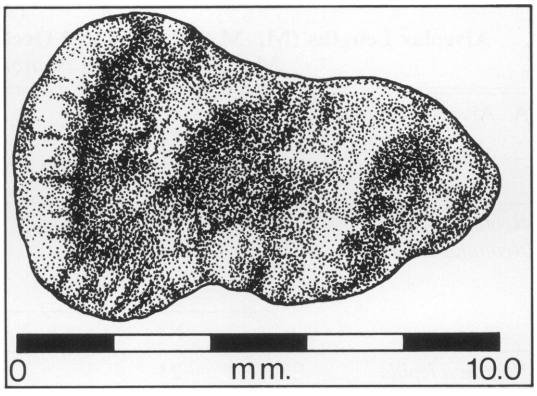

FIG. 46. *Martes nobilis* M^1 (HC–184), Stratum II, Hidden Cave; see table 33 for measurements.

Family Ursidae—Bears

Ursus arctos—Grizzly Bear

MATERIAL: One phalanx: one specimen.

REMARKS: Although there are no historic records for the grizzly bear in Nevada (Hall, 1946, 1981), a single skull is known from the Malheur Lake basin in south-central Oregon, and Bailey (1936) suggested that they may have been widespread in parts of eastern Oregon prior to European settlement. As Kurtén and Anderson (1980) have noted, this bear was much more widely distributed during terminal Pleistocene than during early historic times, and it would not be surprising if small numbers of grizzly bear were present in suitable habitats throughout the Great Basin during the last few thousand years of the Pleistocene and during the early Holocene. The single specimen from Hidden Cave (Strata VII–IX) is a distal phalanx, and is much more massive than the distal phalanges of modern *Ursus americanus* (black bear).

Family Mustelidae—Weasels, Skunks, and Allies

Martes sp.—Martens

MATERIAL: One humerus, one ulna: two specimens.

TABLE 33

M^1 and M_1 Measurements (in Millimeters) for *Martes americana, Martes pennanti,* and *Martes nobilis,* from Anderson (1970), and the Hidden Cave *M. nobilis*[a]

A: M^1

	Martes americana		*Martes pennanti*	
	N	Range	N	Range
WM^1	324	6.1–8.9	70	9.0–12.0
LM^1	323	3.5–5.6	70	5.2–8.7

	Martes nobilis		Hidden Cave
	N	Range	*Martes nobilis*
WM^1	7	9.2–9.9	10.0
LM^1 inner	7	5.7–6.3	6.3
LM^1 mid	7	3.7–4.5	4.4
LM^1 outer	7	3.9–4.5	4.4

B: M_1

	Martes americana		*Martes pennanti*	
	N	Range	N	Range
LM_1	341	6.8–9.4	65	10.4–14.0
LM_1 tr	341	5.0–7.0	65	7.6–10.1
WM_1 tal	—	—	32	4.1–5.7

	Martes nobilis		Hidden Cave
	N	Range	*Martes nobilis*
LM_1	24	9.6–11.3	10.3
LM_1 tr	24	6.5–7.8	7.2
WM_1 tr	23	3.2–4.5	4.0
WM_1 tal	22	3.7–4.6	3.8

[a] See Anderson (1970) for measurement definitions.

Martes nobilis—Noble Marten

MATERIAL: One mandible, one isolated tooth: two specimens.

REMARKS: The extinct noble marten is known from at least 10 late Pleistocene and possibly early Holocene faunas in western North America, including Smith Creek Cave in the Snake Range of eastern Nevada (Kurtén and Anderson, 1980; Miller, 1979). Hidden Cave provides the second Nevada, and the second Great Basin, record for this marten.

Martes nobilis is demonstrably represented at Hidden Cave by a single left M^1 and by a right mandible. The M^1 (HC–184; see fig. 46) is much larger than the corresponding tooth in *Martes americana*; compared with that of *M. pennanti,* the inner lobe is expanded, producing a deeper constriction between inner and outer lobes. These are characters in which the tooth agrees with that of *M. nobilis* (Anderson, 1970). Plotting the length of M^1 against the length of the inner lobe of the tooth on the scattergram provided by Anderson (1970, p. 81) shows the Hidden Cave specimen to lie well above the distribution of *M. americana,* on the lower end of the distribution for *M. pennanti,* and at the upper end of that for *M. nobilis.* As a whole, the measurements of the tooth compare well with those provided by Anderson (1970; see table 33).

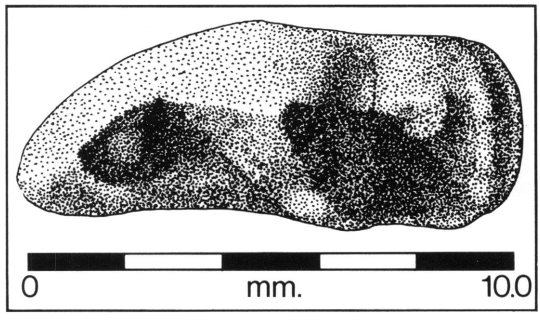

FIG. 47. *Martes nobilis* M_1 (HC–418), Strata IX–XIII, Hidden Cave; see table 33 for measurements.

The mandible of *M. nobilis* from Hidden Cave (HC–418) is from a juvenile individual. Only P_2 and M_1 have been retained; both are in the process of erupting. Anderson (1970) notes that M_1 is the most characteristic tooth of *M. nobilis,* marked by a relatively shorter trigonid than is possessed by either *M. americana* or *M. pennanti,* a condition that also characterizes M_1 of the Hidden Cave mandible (see fig. 47). As with the Hidden Cave *M. nobilis* M^1, the measurements of the M_1 compare well with those provided by Anderson (1970; see table 33). Elaine Anderson has examined both of these specimens, and has confirmed their identification as *M. nobilis.*

In addition to the two undoubted specimens of *M. nobilis,* there is also a distal right humerus (HC–2075) and a complete right ulna with all epiphyses unfused (HC–2007) that pertain to *Martes.* I am unable to distinguish these from *M. americana,* which they match

well in size. I am also unable to provide measurements comparable with those provided by Anderson (1970) because the landmarks used by her are not present on these specimens. Anderson (personal commun.) suggests that these specimens may also be *M. nobilis* and is currently investigating them further.

The significance of the Hidden Cave *Martes nobilis* is discussed below.

Mustela sp.—Weasels, Ferrets, and Minks

MATERIAL: One isolated tooth: one specimen.

Mustela cf. *frenata*—Long-tailed Weasel

MATERIAL: Six humeri, one ulna, one scapula, two innominates, three vertebrae, one sacrum, one femur, four tibiae, one fibula, one astragalus, two calcanea: 23 specimens.

Mustela frenata—Long-tailed Weasel

MATERIAL: One complete skull, five mandibles: six specimens.

Mustela vison—Mink

MATERIAL: One mandible, one radius: two specimens.

REMARKS: Long-tailed weasels are widespread in the northern half of Nevada; Hall (1946) provides a number of records for the Lahontan Valley, including a single specimen from near Eetza Mountain. Hall (1981) provides a record for mink 1.6 km. from Fallon.

Taxidea taxus—Badger

MATERIAL: Four skull fragments, three mandibles, three isolated teeth, one scapula, one ulna, one metacarpal, one tibia, seven phalanges: 21 specimens.

Spilogale putorius—Spotted Skunk

MATERIAL: One mandible, one isolated tooth, one humerus, one radius: four specimens.

Mephitis mephitis—Striped Skunk

MATERIAL: Two isolated teeth: two specimens.

REMARKS: All three of these mustelids are common in the northern half of Nevada.

Family Felidae—Cats and Allies

Lynx cf. *rufus*—Bobcat

MATERIAL: One radius, one astragalus, two phalanges: four specimens.

REMARKS: Bobcats are common throughout Nevada: Hall (1946) records a specimen taken at Carson Lake.

Order Perissodactyla—Perissodactyls

Family Equidae—Horses, Zebras, and Asses

Equus sp.—Horse

MATERIAL: One isolated tooth, two distal sesamoids, one phalanx: four specimens.

REMARKS: The isolated tooth, a left upper molar, is heavily mineralized and lacks precise provenience, having been discovered in fill from earlier excavations. The remaining elements are from Stratum XIII (a second phalanx), Stratum V, and Stratum IV. Stratigraphic disturbance would seem to be indicated.

Order Artiodactyla—Artiodactyls

Family Camelidae—Camels, Llamas, and Allies

Camelops cf. *hesternus*—Yesterday's Camel

MATERIAL: One tarsal: one specimen.

REMARKS: This fragmentary left navicular (HC–1912) was found in Stratum III (*ca.* 3700 B.P.) and is clearly not in primary stratigraphic context. Terminal Pleistocene and early Holocene radiocarbon dates for *Camelops* in the Great Basin range from 8200 to 13,100 B.P. (Grayson, 1982; see also Kurtén and Anderson, 1980), and extinction of this camel by at least 10,000 B.P. seems extremely likely. Hidden Cave provides the fifth published record of Yesterday's Camel from Nevada (Grayson, 1982; Kurtén and Anderson, 1980). Assignment to *Camelops* cf. *hesternus* was based upon the detailed description of this element provided by Webb (1965). Although measurements comparable to those provided by Webb (1965) could not be taken, the specimen clearly matches that of *C. hesternus* in size as well as in general morphology.

TABLE 34
Provenience and Ages of the Hidden Cave *Martes* sp. and *Martes nobilis* Specimens

Specimen Number	Taxon	Element	Stratum	Age
HC-2075	*Martes* sp.	Humerus	VII–IX	10,000–6900 B.P.
HC-2007	*Martes* sp.	Ulna	IX	10,000–7500 B.P.
HC-184	*Martes nobilis*	M^1	II	3700–3600 B.P.
HC-418	*Martes nobilis*	Mandible	IX–XIII	21,000–7500 B.P.

Family Cervidae—Cervids
Odocoileus cf. *hemionus*—
Black-tailed Deer

MATERIAL: One metacarpal, one carpal: two specimens.

Family Antilocapridae—Pronghorns
Antilocapra americana—Pronghorn

MATERIAL: Six tooth fragments, one innominate, four phalanges: 11 specimens.

Family Bovidae—Bovids
Bison bison—Bison

MATERIAL: One distal phalanx: one specimen.

Ovis canadensis—Mountain Sheep

MATERIAL: One carpal: one specimen.

REMARKS: Artiodactyls are quite rare in the Hidden Cave deposits; there are even very few unidentifiable artiodactyl bones and teeth (the six pronghorn tooth fragments pertain to a single left M_3). The lack of these artiodactyls in Hidden Cave is surprising. Morrison (1964) reported the presence of *Bison* sp. in his Unit 7 (Strata IX–X), but I am aware of no other records of *Bison bison* for the Carson Desert. Bison were widespread, but apparently uncommon, throughout much of the Great Basin during the Holocene (Grayson, 1982).

DISCUSSION

There are three aspects of the Hidden Cave birds and mammals that I discuss here in greater detail: the presence of *Martes nobilis*, the contrast between the entire Hidden Cave small mammal fauna and the small mammal fauna of the Eetza Mountain area today, and the information provided by the Hidden Cave birds and mammals concerning long-term environmental change in the southern Carson Desert.

MARTES NOBILIS: ADAPTATION AND TIMING OF EXTINCTION

The noble marten is generally thought to have become extinct at the end of Pleistocene (Kurtén and Anderson, 1980). In this light, the stratigraphic position of the Hidden Cave *Martes nobilis* specimens is noteworthy (see table 34, which also includes information on the two specimens assigned to *Martes* sp.). Whereas the *M. nobilis* mandible came from a mixed stratum that includes material of late Pleistocene age, the *M. nobilis* M^1 came from Stratum II, dated to *ca.* 3600–3700 B.P. As I have observed elsewhere (Grayson, 1984b), either *M. nobilis* survived much longer than has been thought, or the single *M. nobilis* specimen here has been displaced upward from Pleistocene strata. Unfortunately, both options are open.

Part of the unit (Lambda 10, level 3) in which the *M. nobilis* M^1 was found was heavily disturbed by rodent activity. Since the tooth was found during the screening of deposits from that unit, it is not possible to know whether the specimen was originally located in the disturbed area. The presence of specimens of horse in Strata IV and V provides strong evidence for stratigraphic disturbance, although it is unknown whether these specimens represent the bones of extinct horse displaced upward or of modern horse displaced downward. Even more compelling evidence of severe stratigraphic disturbance is, of course, provided by the presence of a *Camelops* cf. *hesternus* navicular in Stratum III. Clearly, we cannot have unquestioning faith in the stratigraphic integrity of the deposits that provided the *M. nobilis* M^1.

Nonetheless, it is also true that Hidden Cave does not provide the first late Holocene record for *Martes nobilis.* Suzanne Miller has identified a single specimen of noble marten from Dry Creek Cave, in the Boise River Valley of southwestern Idaho (Webster, 1978), an identification that has also been confirmed by Elaine Anderson (Anderson, personal commun.). Bone from the level that provided the *M. nobilis* tooth was dated to 3270 ± 110 B.P. (WSU-1574), while a date of 3530 ± 85 B.P. (WSU-1486) is available for the level below. The projectile point styles from these levels are consistent with the radiocarbon dates. Importantly, the level that provided WSU-1486 lies directly on the bedrock floor of the site, so that the *M. nobilis* specimen here could not have been derived from deeper Pleistocene strata within the site (Webster, 1978). The Dry Creek Cave *M. nobilis,* then, seems to provide rather firm support for the survival of this animal into the late Holocene. Given that this is so, the Hidden Cave *M. nobilis* specimen from Stratum II may, in fact, indicate the late survival of the noble marten in western Nevada as well.

Martes nobilis is generally thought to have been a boreal animal (Kurtén and Anderson, 1980). In a number of sites, it has been found associated with boreal taxa: at both Little Box Elder Cave, Wyoming and Jaguar Cave, Idaho, for instance, the collared lemming, *Dicrostonyx* cf. *torquatus,* was apparently contemporary (Anderson, 1968, 1970; Guilday and Adam, 1967). However, as Anderson (1970) has pointed out, no boreal taxa were associated with *M. nobilis* at Samwel and Potter Creek caves in northern California (Furlong, 1904; Sinclair, 1904), and the animals identified from these sites do not imply an environment much different from that which characterizes the area today.

Regardless of the primary stratigraphic context of the Hidden Cave *M. nobilis* specimens, they were not associated with a boreal fauna. Neither Pleistocene nor Holocene strata in the cave contain boreal species of vertebrates. This was also the case at Dry Creek Cave. The Hidden Cave pollen sequence is consistent with this picture: there is no indication that the area surrounding Hidden Cave supported a boreal flora at any time registered in the deposits of the site (Wigand and Mehringer, chap. 9, this volume). When arrayed alongside such sites as Samwel, Potter Creek, Jaguar, and Little Box Elder caves, Hidden Cave suggests that *Martes nobilis* was adapted to a broad variety of settings, and is not a necessary indicator of boreal conditions.

In short, the accumulating information on the noble marten suggests that it was adapted to a wide variety of environmental settings, and that it might not have become extinct until the late Holocene. If both of these hypotheses prove correct, then it must be asked why the animal survived the environmental changes associated with the end of the Pleistocene at about 10,000 B.P. and those associated with the establishment of generally modern conditions in the arid west between about 8000 and 7000 B.P., only to become extinct late in the Holocene.

Hidden Cave and the Modern Eetza Mountain Small Mammal Fauna

Today, the small mammal fauna of Eetza Mountain and immediately adjacent areas is characterized by species adapted to xeric settings. Marmots are absent, the only woodrat is *Neotoma lepida,* the abundant ground squirrel is *Ammospermophilus leucurus,* and Merriam's kangaroo rat (*Dipodomys merriami*) is much more abundant on the mountain itself (trapping data) and apparently about as abundant in the general area (owl pellet data) as the more mesic chisel-toothed kangaroo rat (*D. microps*).

Hidden Cave, however, presents a very different picture. Marmots (*Marmota flaviventris*) are present in every unmixed stratum that has a total of more than eight identified specimens, from Stratum XIII to Stratum I. Bushy-tailed wood rats (*Neotoma* cf. *cinerea* and *Neotoma cinerea*) are present in every unmixed stratum that provided more than a single identified specimen. Ground squirrels are not common in the deposits, but those that are present are primarily Townsend's ground squirrels (*Spermophilus townsendii*), not the more xeric white-tailed antelope squirrels (*Ammospermophilus leucurus*). Kangaroo rats that could be identified to species are uncommon beneath Stratum V,

but Strata I through IV have a *Dipodomys* fauna that is dominated by the chisel-toothed kangaroo rat.

Thus, the modern mammalian fauna of Eetza Mountain and the immediately adjacent area is primarily a xeric one; the mammalian fauna from Hidden Cave is composed of both xeric and mesic taxa, and this is true throughout the history of the site. Although it is likely that some, perhaps many, of the skeletal elements incorporated into the deposits of Hidden Cave were transported some distance by raptors and carnivores, and while it is possible that some of the specimens present in Strata II and IV were transported here by people, the sheer numbers of specimens of *Marmota flaviventris* and *Neotoma cinerea* in the deposits and their presence above and below the archaeological middens strongly implies that these animals were living on Eetza Mountain throughout the history of the site. Assuming that the Stratum I fauna did not result entirely from the movement of skeletal elements upward from deeper strata, it would appear that even the late prehistoric (post-1500 B.P.) small mammal fauna of this area was quite different from that found here today. The prime difference results not from the addition of new taxa to the modern fauna, but from the differential loss of mesic species present in relatively late prehistoric times.

What caused this change? The answer is not at all clear. The loss of mesic mammals from the Eetza Mountain area certainly occurred within the past 1500 years, since those mammals are present in Stratum I and above Mono ash dated to *ca.* 1500 B.P. (Davis, chap. 7, this volume). Unfortunately, further temporal resolution is not currently available. It is possible that the desertification of the Eetza Mountain mammal fauna is related to the decrease in terrestrial pollen influx noted by Wigand and Mehringer (chap. 9, this volume) in the uppermost sample in the Stratum I pollen profile, a change that they suggest may reflect reduced vegetation cover on the slopes surrounding Hidden Cave. It is reasonable to speculate that retreat of Carson Lake sometime during the past 1500 years caused the extirpation of species of mesic mammals here, but it would seem that only a more concerted effort toward understanding the geologic history of this area is likely to shed light on the precise cause of this event. Of the event itself, however, we can be certain.

The Hidden Cave Birds and Mammals and Long-term Environmental Change

The Hidden Cave birds and mammals are less informative about late Pleistocene and Holocene environmental change than might have been expected. Although the nature of the species represented in the deposits suggests more mesic local environments throughout the period of time represented by those deposits, examination of the changing frequencies of those species through time sheds relatively little light on long-term environmental change in this region. There are several reasons why this might be the case.

First, whereas the number of identified bird and mammal specimens is sizable (7835), these specimens are very unequally distributed across the two classes and across the various analytic provenience units (table 22). In particular, only 982 of the identified specimens are bird and, of these, 124 remain uncorrelated with the Hidden Cave stratigraphic sequence. Of the 535 avian specimens that could be assigned to single strata, a full 49 percent (260 specimens) came from Strata IV and V. The sample of identified birds with full provenience, even including those with mixed proveniences, is simply too small to support any meaningful analysis of changing frequencies through time.

Second, 14 percent of the identified mammalian specimens remain uncorrelated. Of these specimens that are correlated, 34 percent came from a mixed context. Of the 3877 specimens that can be assigned to a single stratum within Hidden Cave, 63 percent (2443) came from Strata IV and V, and nearly half (1899) were contributed by *Sylvilagus* and *Lepus*.

Finally, the Hidden Cave faunal sequence stands alone not only in the Lahontan Basin, but in the entire Shadscale vegetation zone (Cronquist et al., 1972) of the western Great Basin. The deep faunal sequences that have shown correlated shifts in the abundances of certain mammalian taxa through time in the Great Basin, and have thus provided some confidence in the reality of those shifts, are

TABLE 35
Relative Abundances of *Lepus* (*Lepus* sp. plus *Lepus californicus*) through Time at Hidden Cave[a]

	NISP		
Stratum	*Lepus* sp.	All Mammals	% *Lepus*
I	86	212	41
II	121	286	42
III	65	189	34
IV	429	1374	31
V	255	1069	24
VII	68	428	16
IX	31	158	20
XIII	16	145	11

[a] All unmixed strata with 145 or more identified specimens.

TABLE 36
Relative Abundances of *Marmota flaviventris* through Time at Hidden Cave[a]

	NISP		
Stratum	*M. flaviventris*	All Mammals	% *Marmota*
I	5	212	02
II	10	286	04
III	8	189	04
IV	140	1374	10
V	68	1069	06
VII	27	428	06
IX	12	158	08
XIII	10	145	07

[a] All unmixed strata with 145 or more identified mammalian specimens.

all from sites located in the Sagebrush and Pinyon-Juniper vegetation zones (Grayson, 1982). Because the Hidden Cave sequence stands alone in this sense, little control is available over the vagaries introduced by the complexity of faunal accumulation mechanisms (Grayson, 1981a, 1983), and the meaning of changing taxonomic frequencies here may be ambiguous as a result.

Given these difficulties, I shall examine only two aspects of changing relative abundances within Hidden Cave: changes in the abundance of *Lepus* through time, and changes in the abundances of the most common indicators of cool and/or moist environments in the fauna, *Marmota flaviventris* and *Neotoma cinerea.*

Changing Abundances of *Lepus*

As I have previously noted (Grayson, 1982, 1983), both Gatecliff Shelter (Toquima Range, Nevada) and the Connley Caves (Fort Rock Basin, Oregon) suggest that *Lepus* was more abundant during the earlier Holocene than during later times in those areas. Does the Hidden Cave fauna, from a very different environment, display the same phenomenon?

Table 35 presents the number of identified *Lepus* specimens, the total number of mammalian specimens, and the percentage of those specimens that are *Lepus* for all unmixed Hidden Cave strata that contained 145 or more identified mammalian specimens. (Eliminated from consideration were Strata VI, X, and XII, which contain no identified mammalian specimens, and Strata VIII, XI, and XIV, which contain one, eight, and seven identified mammalian specimens, respectively.) Elsewhere, I have discussed the relative abundances of the sort presented in table 35 which are often correlated with sample size (Grayson, 1981b, 1983), and that such correlations prevent the straightforward interpretation of relative frequencies. For the Hidden Cave *Lepus,* however, no such problem emerges: the correlation between the total number of identified mammalian specimens per stratum and the percentage of those specimens that is *Lepus* is not significant (Spearman's rho, $r_s = 0.13$, $p \gg 0.10$). It is clear that, quite unlike the situation at either Gatecliff Shelter or the Connley Caves, neither of which are within the Shadscale Zone, the relative abundance of *Lepus* increases steadily from late Pleistocene to late Holocene times. I have no suggestion as to why this might be the case, especially since, with the exception of nine *Lepus californicus* specimens, I am ignorant of the species of *Lepus* involved.

Changing Abundances of *Marmota flaviventris* and *Neotoma cinerea*

Wigand and Mehringer (chap. 9, this volume) suggest that the Hidden Cave pollen sequence may reflect two significant environ-

TABLE 37
Relative Abundances of *Marmota flaviventris* through Time at Hidden Cave[a]

	NISP		
Unit	*M. flaviventris*	All Mammals	% *Marmota*
I–IV	179	2295	08
V–VI	72	1155	06
VII–X	72	1064	07
XI–XIV	30	473	07

[a] Aggregate stratigraphic units.

mental changes during the past 15,000 years. First, they note that the sharp decline in *Pinus* and *Artemisia* pollen at the top of Stratum XI corresponds to the shrinking of Pleistocene lakes and to the replacement of woodland or steppe by shrub-dominated desert vegetation. Second, they note that *Artemisia* pollen remains relatively abundant until about 6500 B.P., at which time it declines again, perhaps reflecting the onset of warmer and/or drier conditions and the establishment of vegetation resembling that of modern times. Such changes are, of course, mirrored elsewhere in the Great Basin, by both the floral (Wigand and Mehringer, chap. 9, this volume) and faunal (Grayson, 1982) records. Are they mirrored by the Hidden Cave mammals?

TABLE 38
Relative Abundances of *Neotoma cinerea* (*Neotoma cinerea* plus *Neotoma* cf. *cinerea*) and *Neotoma lepida* (*Neotoma lepida* plus *Neotoma* cf. *lepida*) through Time at Hidden Cave[a]

	NISP		
Stratum	*N. lepida* + *N. cinerea*	*N. cinerea*	% *N. cinerea*
I	20	4	20
II	16	8	50
III	36	16	44
IV	218	142	65
V	235	149	63
VII	95	66	69
IX	35	23	66
XIII	42	27	64

[a] All unmixed strata with 145 or more identified mammalian specimens.

TABLE 39
Relative Abundances of *Neotoma cinerea* (*Neotoma cinerea* plus *Neotoma* cf. *cinerea*) and *Neotoma lepida* (*Neotoma lepida* plus *Neotoma* cf. *lepida*) through Time at Hidden Cave[a]

	NISP		
Unit	*N. lepida* + *N. cinerea*	*N. cinerea*	% *N. cinerea*
I–IV	325	192	59
V–VI	242	152	63
VII–X	219	154	70
XI–XIV	124	91	73

[a] Aggregate stratigraphic units.

Table 36 presents the number of identified specimens of *Marmota flaviventris* per unmixed stratum with 145 or more identified mammalian specimens, the total number of mammalian specimens for those strata, and the percentage of those specimens that are marmot. The rank order of relative abundance of marmots is not significantly correlated with the rank order of stratum NISP values ($r_s = -0.21$, $p \gg 0.20$). Strata XIII (21,000–16,000 B.P.), IX (10,000–7500 B.P.), VII (7500–6900 B.P.), and V (6900–5400 B.P.) have very similar relative abundances of marmots, while the three most recent strata (3700–0 B.P.) are characterized by lower relative abundances of this animal. These fig-

TABLE 40
Relative Abundances of *Neotoma cinerea* (*Neotoma cinerea* plus *Neotoma* cf. *cinerea*) through Time at Hidden Cave[a]

	NISP		
Stratum	*N. cinerea*	All Mammals	% *N. cinerea*
I	4	212	02
II	8	286	03
III	16	189	09
IV	142	1374	10
V	149	1069	14
VII	66	428	15
IX	23	158	15
XIII	27	145	19

[a] All unmixed strata with 145 or more identified mammalian specimens.

TABLE 41
Relative Abundances of *Neotoma cinerea* (*Neotoma cinerea* plus *Neotoma* cf. *cinerea*) through Time at Hidden Cave[a]

	NISP		
Unit	*N. cinerea*	All Mammals	% *N. cinerea*
I–IV	192	2295	08
V–VI	152	1155	13
VII–X	154	1064	15
XI–XIV	91	473	19

[a] Aggregate stratigraphic units.

ures are not in good accord with the pollen data.

The size of the sample available for analysis can be increased by incorporating the fauna from mixed strata. In order to utilize this material, I have employed four groups of strata as analytic units: I–IV (late Holocene), V–VI (middle Holocene), VII–X (early Holocene), and XI–XIV (late Pleistocene). I have chosen this particular set of units because they allow maximum use of the mixed strata fauna, while preserving meaningful chronological periods that can be compared to the analysis presented by Wigand and Mehringer. Although Davis (chap. 7, this volume) correlates Stratum XIV with the Yarmouthian, the mammals in that stratum differ in no way from those of higher levels. Either the correlation is incorrect, or the Stratum XIV fauna has been derived from late Pleistocene levels. I have, as a result, treated the fauna from this stratum as late Pleistocene in age.

Relative abundances of marmots across these four aggregate stratigraphic units are presented in table 37. The lack of change in those abundances through time is clear. Again, the marmots do not reflect the changes displayed by the pollen sequence.

Table 38 presents the total number of identified *Neotoma lepida (N. lepida* and *N.* cf. *lepida)* and *Neotoma cinerea (N. cinerea* and *N.* cf. *cinerea)* specimens per unmixed stratum with 145 or more identified mammalian specimens, and the percentage of that total that is *N. cinerea.* There is no significant correlation between sample size and *N. cinerea* relative abundances in this data set ($r_s = 0.43$, $p > 0.10$). The ratio of the more mesic *N. cinerea* to *N. lepida* remains remarkably stable from Stratum XIII to Stratum IV, after which it declines. These changes are similar to those shown by the changing relative abundances of marmots, but do not reflect the events suggested by the pollen record.

Table 39 presents the corresponding abundances of *Neotoma* by the four aggregate stratigraphic groups. The total numbers of *N. lepida* and *N. cinerea* are inversely and perfectly correlated with the relative abundances of *N. cinerea.* As a result, these changing abundances do not have interpretable environmental meaning.

Finally, I have also examined the changing relative abundances of *Neotoma cinerea (N. cinerea* plus *N.* cf. *cinerea)* in relationship to all identified mammals. Table 40 presents these abundances for unmixed strata with 145 or more identified mammalian specimens; there is no significant correlation with sample size ($r_s = -0.24$, $p \gg 0.10$). The late Pleistocene Stratum XIII is marked by a higher abundance of *N. cinerea* compared to upper strata, whereas the early and middle Holocene strata have higher abundances of this animal than the late Holocene strata; the decline in abundance of *N. cinerea* in Strata II and I is marked. Table 41 presents the corresponding abundances for the aggregate strata. Here, *N. cinerea* relative abundances are significantly correlated with sample size ($r_s = 0.80, p = 0.05$), and the meaning of those abundances is accordingly unclear.

What do these analyses suggest? Perhaps very little. In only one instance is there clear concordance between the pollen data and changing abundances of the Hidden Cave marmots and wood rats: the decrease in abundance of *N. cinerea* at the end of the Pleistocene. However, it is important to realize that this lack of concordance does not shed any doubt on the hypotheses forwarded by Wigand and Mehringer. There is no reason to believe that the vegetational changes detected by them would necessarily have affected populations of marmots and wood rats on Eetza Mountain. The lack of correlation between changes in the mammalian fauna and the vegetation may simply mean that whatever caused the vegetational shifts affected neither the marmots nor the wood rats; both

species occupy a wide range of mesic environments.

In addition, lacking a faunal sequence from any comparable site with which to compare the changing mammalian abundances through time at Hidden Cave, it is difficult to know whether the changes in taxonomic abundance that I have detected have any meaning outside this particular sample from this particular cave. Until such additional sequences are available, it seems wisest to put little faith in the changing relative abundances of the Hidden Cave mammals. Of the changes that do occur, only one is documented by both species analyzed: Strata I and II, and to some extent III, are characterized by lower relative abundances of marmots and bushy-tailed wood rats than are earlier strata.

CONCLUSIONS

Hidden Cave has provided the first stratified late Pleistocene and Holocene sequence of birds and mammals available from the basin of Pleistocene Lake Lahontan. While to some extent Russell's century-old comments on the dearth of mammalian fossils in this area still apply, it is also true that the Hidden Cave birds and mammals are very instructive. In particular, they document the presence of the noble marten in western Nevada in a non-boreal setting and suggest, with Dry Creek Cave, that this marten may not have become extinct until late in the Holocene. In addition, they document the presence of a more mesic mammalian fauna in the southern Carson Desert than currently exists here and demonstrate as well that the desertification of this fauna occurred within the past 1500 years. Analysis of the changing frequencies of mammals through time within the site does not seem to shed much light on the nature of changing late Pleistocene and Holocene environments in the area, but this may in part be due to the fact that Hidden Cave represents the only mammalian sequence of the region. For the first time, however, such a sequence exists.

CHAPTER 11. PALEONTOLOGY OF HIDDEN CAVE: AMPHIBIANS AND REPTILES

JIM I. MEAD[1]

The Desert West of North America is a vast region containing both hot and cold deserts. During the last glaciation all corners of the Desert West experienced plant and animal community structures different from those that occur at present. Late Pleistocene age fossil localities are being discovered throughout the Desert West and are providing ample remains of past faunal communities. One aspect of faunal reconstruction that has not progressed as rapidly as that of the mammals is the herpetofauna—amphibians and reptiles. Although faunal studies have been fairly progressive in California, Arizona, New Mexico, and somewhat in Utah, the major part of Nevada and sections of western Utah (the Great Basin) have received very little modern stratigraphic excavations.

Only in the last decade or two have cave sediments containing archaeological and paleontological resources been examined. Invariably only mammals and birds have been analyzed. The American Museum of Natural History has been conducting recent excavations in two main cave localities in Nevada. Because these studies have been multidisciplinary in structure, the herpetofauna of the Great Basin is beginning to be unraveled.

This chapter concerns the amphibian and reptile remains excavated from Hidden Cave. Other chapters in this volume discuss in detail the excavating techniques and chronological complexities. It is important for this study that strict control for provenience was maintained throughout the 1979–1980 excavations. As the various sedimentary units were removed, only those with definite provenience and those with no visible bioturbation were given an unmixed provenience designation. This excavation procedure provided a good stratigraphic control of all the fauna recovered. All sediments were screened through 3 mm. (⅛ in.) mesh so that most isolated minute teeth of mammals and diminutive snake vertebrae would be collected. The chronological framework used in this study follows the second hypothesis of Davis (chap. 7, this volume). Stratum XIV is stated to be of Yarmouthian age. This unit predates the deposition in the cave and the development of the cave. Six reptile elements were apparently recovered from this stratum that forms the floor of the cave. The preservation of the bones appears to be identical with that at higher strata; because of this, the three taxa are assumed to be contaminants from Stratum XIII.

A total of 1369 amphibian and reptile remains were recovered from Hidden Cave deposits, of which only 923 (67% of the total) were from unmixed strata. Skeletal remains from mixed proveniences provide no insight to the reconstruction through time of a fauna; therefore, the 446 unprovenienced bones have been eliminated from this study. Only two species (*Sceloporus* cf. *occidentalis,* western fence lizard, and *Phrynosoma douglassi,* short-horned lizard)—one element of each (from mixed strata)—are consequently lost in the unmixed faunal reconstruction.

Disregarding 33 percent of the recovered fauna because of lack of accurate provenience does place a bias on any statistical analysis of the elements. Therefore, only the number of identified skeletal elements (NISP) of each taxon is given in table 42.

DESCRIPTIVE SUMMARY

The following is a systematic account of all amphibians and reptiles recovered from strata of unmixed provenience. Names and ordering of the fauna follow Stebbins (1966). Right and left are referred to as R and L, respectively. Identification characters and a discussion of modern and fossil distributions are provided in Remarks.

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TABLE 42
Amphibians and Reptiles Identified from Unmixed Proveniences in Hidden Cave, Nevada[a]

	I (0–1500)	II (3600–3680)	III (3680–3700)	IV (3700–3800)	V (5400–6900)	VII (6900–7500)	VIII	IX	XI (15,000–18,000)	XIII (18,000–21,000)	XIV Yarmouthian[b]
Scaphiopus intermontanus	—	—	—	2	3	4	—	—	—	1	—
Scaphiopus sp.	—	—	—	1	—	—	—	—	—	1	—
Bufo boreas	—	—	—	1	1	—	—	—	—	—	—
Bufo sp.	1	1	—	2	1	—	—	1	—	—	—
Rana sp.	1	—	—	—	—	—	—	—	—	—	—
Anura	—	—	—	—	2	1	—	—	—	—	—
Crotaphytus collaris	2	—	2	8	2	3	—	1	—	—	—
Crotaphytus sp.	—	1	2	4	4	—	—	—	—	—	—
Sceloporus magister	—	—	—	2	9	4	—	—	—	—	—
Sceloporus sp.	—	—	—	2	—	1	—	—	—	—	—
Uta stansburiana	1	—	—	—	—	—	—	—	—	—	—
Phrynosoma platyrhinos	—	1	—	4	2	5	—	—	—	—	—
Cnemidophorus tigris	—	—	—	1	4	—	—	1	—	—	—
Sauria	11	6	5	29	33	36	1	—	—	2	—
Coluber constrictor	—	—	—	3	—	—	—	—	—	—	—
Masticophis sp.	—	—	—	8	3	—	—	—	—	—	—
Masticophis/Coluber	1	—	—	17	11	1	—	2	—	—	—
Salvadora cf. *hexalepis*	—	—	—	2	—	—	—	—	—	—	—
Pituophis melanoleucus	10	25	8	45	61	10	—	2	1	3	4
Lampropeltis getulus	1	—	3	19	1	—	—	—	—	—	—
L. cf. *zonata*	—	—	—	2	—	—	—	—	—	4	—
L. cf. *pyromelana*	—	—	—	—	1	—	—	—	—	—	—
Lampropeltis sp.	1	—	1	7	5	5	—	—	—	—	1
Rhinocheilus lecontei	—	—	—	56	—	—	—	—	—	—	—
Thamnophis sp.	19	7	13	40	22	21	1	1	—	—	—
Sonora cf. *semiannulata*	—	—	—	—	1	—	—	—	—	—	—
Colubridae	12	12	9	67	56	23	1	4	—	4	1
Crotalus cf. *viridis*	4	1	—	59	5	2	—	1	—	—	—
Total taxa	10	6	4	15	13	9	2	6	1	3	2
Total elements	64	54	43	381	227	116	3	13	1	15	6

[a] Columns refer to excavational strata and their associated ages (second hypothesis; Davis, this volume). Numbers in columns are the quantity of identified skeletal elements.

[b] Questionable association, see text.

AMPHIBIA
Order Salientia
Family Pelobatidae
Scaphiopus cf. *intermontanus* (Great Basin Spadefoot Toad)

MATERIAL: Three urostyles, one radioulna, one sacral vertebra, three tarsi, two tibiofibulae: 10 specimens.

REMARKS: The Great Basin spadefoot toad physically and osteologically resembles the western spadefoot toad (*S. hammondi*). Some characters of the sacral vertebra can be used to separate the two closely related species.

I am not sure if *S. intermontanus* presently lives near Hidden Cave, although it is known to occur within the confines of the arid Lake Lahontan Basin. This spadefoot toad was recovered throughout the strata at Gatecliff Shelter and occurred in an 11,600 B.P. age wood rat midden and cave sediments dating 12,000 B.P. at Smith Creek Cave, eastern Nevada (Mead, Thompson, and Van Devender, 1982). Brattstrom (1976) reports re-

covering *S.* cf. *hammondi* from an unprovenienced level in Smith Creek Cave.

Scaphiopus sp. (Spadefoot Toad)

MATERIAL: One radioulna, one vertebra: two specimens.

Family Bufonidae
Bufo boreas (Western Toad)

MATERIAL: One sacral vertebra, one vertebra: two specimens.

REMARKS: The western toad presently occurs throughout most of the Great Basin except the drier eastern region of the Lake Bonneville Basin. The toad lives in a variety of habitats from sea level up to high, mountainous elevations. It frequents dry and humid areas, such as lakes, marshes, springs, streams, and open valleys. Brues (1932) found the toad in the saline waters of Pyramid Lake which is surrounded by a dry, sparsely vegetated playa.

Bufo boreas has been recovered in the 12,000 B.P. sediments of Smith Creek Cave, eastern Nevada (Mead, Thompson, and Van Devender, 1982).

Bufo sp. (Toad)

MATERIAL: One sacral vertebra, five vertebrae: six specimens.

Family Ranidae
Rana sp. (Frog)

MATERIAL: One tibiofibula: one specimen.

REMARKS: I am unable to assign the specimen to a species. Presently *R. pretiosa* (spotted frog) and *R. pipiens* (leopard frog) occur within the Great Basin. *Rana* sp. was recovered from Late Pleistocene age sediments at Smith Creek Cave, eastern Nevada (Mead, Thompson, and Van Devender, 1982).

Family, Genus, and Species
Indeterminate

MATERIAL: Two humeri, one vertebra: three specimens.

REMARKS: These elements could not be identified to family or below because of their incomplete preservation state.

REPTILIA
Order Squamata
Suborder Sauria
Family Iguanidae
Crotaphytus collaris (Collared Lizard)

MATERIAL: Five R dentaries, eight L dentaries, one R maxilla, one frontal, one parietal, one pelvis, one femur: 18 specimens.

REMARKS: The collared and leopard lizard (*C. wislizenii*) can be separated from other iguanid lizards by their larger size and dental characters. Individual teeth of *C. collaris* are relatively wide anteroposteriorly as compared with those of *C. wislizenii,* the posterior teeth are strongly tricuspid, the anterior one-quarter tending toward blunt spikes, some with a slight posterior curve.

The collared lizard at present can be found at Hidden Cave among the rocky outcrops but it avoids the flat, sparsely vegetated regions of the playa. Although this diurnal predator is common throughout the Great Basin today, it is not known for sure how long it has been an inhabitant. One element of the collared lizard was recovered from Gatecliff Shelter (Strata 26–30). Other remains have been recovered at Smith Creek Cave, eastern Nevada, in a unit dating sometime before 12,000 B.P. (Mead, Thompson, and Van Devender, 1982). South of the basin, in the northern Mojave Desert, this lizard has been recovered in undated association at Gypsum Cave, Nevada (Brattstrom, 1954) and within the Grand Canyon dating as early as 22,000 B.P. (Mead, 1981).

Crotaphytus sp.
(Collared or Leopard Lizard)

MATERIAL: Three R dentaries, one L maxilla, one parietal, one basioccipital, two pelves, three femora: 11 specimens.

REMARKS: These skeletal elements could not be unequivocally identified as *C. collaris* or *C. wislizenii*; fragmentation was usually the problem. Although all *Crotaphytus* remains identified to species are of the collared lizard, it is possible that some of the above elements are from the leopard lizard.

Sceloporus magister
(Desert Spiny Lizard)

MATERIAL: One R dentary, four L dentaries, three R maxillae, two L maxillae, one

basioccipital, one pelvis, three femora: 15 specimens.

REMARKS: The spiny desert lizard can be differentiated from other sceloporine lizards of the Great Basin by its larger size and dental characters. It presently lives in the southern and southwestern Great Basin which may correspond to the 120 minimum days per year 32°F. isogram (Houghton, Sakamoto, and Gifford, 1975). Pyramid Lake is just about its northernmost distribution. The lizard lives in a variety of habitats including arboreal, terrestrial, and saxicolous (among rocks) but avoids the open desert.

Sceloporus magister was common in the upper levels of Gatecliff Shelter but very rare in the 12,000 B.P. cave sediments at Smith Creek Cave, eastern Nevada (Mead, Thompson, and Van Devender, 1982). In the Grand Canyon it is known from wood rat middens dating less than 15,000 B.P. (Mead, 1981).

Sceloporus sp. (Spiny Lizard)

MATERIAL: One basioccipital, one humerus, one femur: three specimens.

REMARKS: These skeletal elements could not be identified to species although they appeared to be from a large species of *Sceloporus (S. magister*?) and not the medium-sized *S. occidentalis* (western fence lizard) which occurs in the Hidden Cave region today. A few skeletal remains of this latter species were identified from Hidden Cave but unfortunately they have an ill-defined provenience (Strata IX–XI) and therefore have not been included in this report.

Uta stansburiana (Side-blotched Lizard)

MATERIAL: One vertebral column with skin: one specimen.

REMARKS: The single fossil was identified as *Uta stansburiana* based on the scale-color pattern of the adhering hide.

Phrynosoma platyrhinos
(Desert Horned Lizard)

MATERIAL: Two R dentaries, one L maxilla, one skull, one frontal, five parietals, two squamosals: 12 specimens.

REMARKS: In cranial bone and dental characters *P. platyrhinos* can be easily distinguished from *P. douglassi* (short-horned lizard), the only other horned lizard presently inhabiting the northern Great Basin. The desert horned lizard is by far more common and widespread throughout the arid valleys than the short-horned lizard which occurs in grassland and woodland vegetation zones up into the conifer forest. Only *P. platyrhinos* occurs in the Carson Sink region.

The fossil history from the Great Basin for *P. platyrhinos* is inadequately understood. Its remains were recovered from Strata 19, 20, and 26–30 at Gatecliff Shelter, and from the cave sediments dating about 12,000 B.P. at Smith Creek Cave, eastern Nevada (Mead, Thompson, and Van Devender, 1982).

A single squamosal was identified as *P. douglassi*; unfortunately it has no provenience and therefore cannot be considered here.

Family Teiidae
Cnemidophorus tigris (Western Whiptail)

MATERIAL: Two R dentaries, one L dentary, one L maxilla, two femora: six specimens.

REMARKS: Osteological characters of the pelvis, long bones, mandible, and cranial bones, including dental criteria, easily distinguish *Cnemidophorus* from iguanids. Only the large species, *C. tigris,* presently lives in the Great Basin, although smaller species do occur to the east and south. The nearest whiptail lizard of size comparable to *C. tigris* is *C. burti* (giant spotted whiptail) which lives in southeastern Arizona (Stebbins, 1966).

The western whiptail was recovered in sediments dating 12,000 B.P. at Smith Creek Cave, eastern Nevada (Mead, Thompson, and Van Devender, 1982). South of the Great Basin it is found in wood rat middens dating less than 13,000 B.P. in the Grand Canyon (Mead, 1981) and in the Sonoran Desert unequivocally dating 11,000 B.P. (Van Devender and Mead, 1978).

Sauria
Genus and Species Indeterminate

MATERIAL: One hundred twenty-three entire and fragmented postcranial remains.

Suborder Serpentes
Family Colubridae
Coluber constrictor (Racer)

MATERIAL: Three vertebrae: three specimens.

REMARKS: Vertebrae of *Coluber* are very similar to *Masticophis.* The PR-PR/PR-PO (pre and postzygapophyses) ratio in *Coluber* is 0.98–1.25 and 0.87–1.00 in *Masticophis.* There are other differentiating criteria (Auffenberg, 1963; Rogers, 1976). The racer is today found in the vicinity of Hidden Cave and has been recovered from an upper stratum in Gatecliff Shelter. Remains of unknown age were recovered from Smith Creek Cave, eastern Nevada (Brattstrom, 1976).

Masticophis sp.
(Coachwhip and Whipsnake)

MATERIAL: Eleven vertebrae: 11 specimens.

REMARKS: Two species of *Masticophis (M. flagellum,* coachwhip, and *M. taeniatus,* striped whipsnake), very similar osteologically, live in the Lake Lahontan region. Because of their similarities, the remains from Hidden Cave are taken only to the generic level (see Van Devender and Mead, 1978).

Masticophis or *Coluber*
(Coachwhip, Whipsnake, or Racer)

MATERIAL: Thirty-two vertebrae: 32 specimens.

REMARKS: These vertebrae were either somewhat eroded by digestive juices (raptor) or had a PR-PR/PR-PO ratio between 0.98 and 1.00; therefore no generic identification could be conferred.

Salvadora cf. *hexalepis*
(Western Patch-nosed Snake)

MATERIAL: Two vertebrae: two specimens.

REMARKS: There do not appear to be any skeletal characters to differentiate *S. hexalepis* from *S. grahamiae* (mountain patch-nosed snake) although the latter does not occur today near the Great Basin. This crepuscular or nocturnal small snake is a burrower that presently lives in the Lake Lahontan region.

Its remains have been recovered in the middle and lower strata at Gatecliff Shelter and in a late Holocene age wood rat midden in the Grand Canyon (Mead and Phillips, 1981).

Pituophis melanoleucus (Gopher Snake)

MATERIAL: One hundred sixty-nine vertebrae: 169 specimens.

REMARKS: Vertebrae of the gopher snake are most similar to *Elaphe* (rat snakes), which do not live within the Great Basin. At present the gopher snake is widespread over North America and lives in a variety of habitats. It is also a common fossil, having been recovered at Gatecliff Shelter, Smith Creek Cave, eastern Nevada (Mead, Thompson, and Van Devender, 1982), Gypsum Cave, Nevada (Brattstrom, 1954, 1958), and from the Grand Canyon (Van Devender, Phillips, and Mead, 1977).

Lampropeltis getulus
(Common Kingsnake)

MATERIAL: Twenty-four vertebrae: 24 specimens.

REMARKS: Vertebral characters to identify this medium-to-large kingsnake are discussed in Van Devender and Mead (1978). Usually this snake inhabits riparian areas within desert regions. I do not believe that *L. getulus* has been located in the Lake Lahontan region but it is common in eastern Nevada.

Lampropeltis getulus was recovered from lower strata at Gatecliff Shelter and from wood rat middens dating 15,000 B.P. in the Grand Canyon (Mead, 1981) and 11,000 B.P. in the Sonoran Desert (Van Devender and Mead, 1978).

Lampropeltis cf. *zonata*
(California Mountain Kingsnake)

MATERIAL: Six vertebrae: six specimens.

REMARKS: *Lampropeltis zonata* is very similar to *L. pyromelana* (Sonora Mountain kingsnake). I did not have a large series of *L. zonata* to compare with the collection of *L. pyromelana*; however, a few possible distinguishing characteristics appear and are used here with caution. From an anterior view of

vertebrae from *L. zonata* the prezygapophyses are oriented more horizontally and have relatively longer, more pointed accessory processes. In contrast, the same view of vertebrae of *L. pyromelana,* shows the prezygapophyses to be oriented more dorsally and have shorter, more blunt accessory processes. A large series of skeletons from both species should be examined to unequivocally identify either species from the central Great Basin.

Neither species lives in the central basin region today. *Lampropeltis zonata* lives only in the mountainous regions of California and Oregon—there is no record to my knowledge of its occurring in the Great Basin. *Lampropeltis pyromelana* occurs mainly on the southern and eastern margins of the Great Basin, and there is a relict population in the Snake Range, eastern Nevada (Stebbins, 1962).

There are no known fossils of *L. zonata* (Zweifel, 1974). There are, however, remains of *L. pyromelana* at Smith Creek Cave, eastern Nevada (Mead, Thompson, and Van Devender, 1982). All the kingsnake remains recovered from archaeological and paleontological sites in the Great Basin should be thoroughly re-examined to determine which taxon or taxa of small kingsnake has lived within the arid desert.

Lampropeltis cf. *pyromelana*
(Sonora Mountain Kingsnake)

MATERIAL: One vertebra: one specimen.
REMARKS: See remarks under *L.* cf. *zonata.*

Lampropeltis sp. (Kingsnake)

MATERIAL: Twenty vertebrae: 20 specimens.

REMARKS: These vertebrae could not be identified either as *L. zonata* or *L. pyromelana*; however, they do seem to belong to a medium-sized kingsnake such as those species. The vertebrae were also compared with *L. triangulum* (milksnake). Although this latter species occurs no closer to Hidden Cave than the Wasatch Mountains and southern Utah, it was identified (one vertebra) from the Late Pleistocene sediments in Smith Creek Cave, eastern Nevada (Mead, Thompson, and Van Devender, 1982).

Rhinocheilus lecontei
(Long-nosed Snake)

MATERIAL: Fifty-six vertebrae: 56 specimens.

REMARKS: The vertebrae of *Rhinocheilus* and *Lampropeltis getulus* resemble each other more than those of the smaller species of *Lampropeltis* discussed above. Identifying characteristics are listed in Van Devender and Mead (1978) and Auffenberg (1963).

Rhinocheilus lecontei is common in the Great Basin although I am not sure if it has been collected in the Carson Sink area.

Fossil and subfossil remains of *R. lecontei* are fairly common in western North America. Vertebral remains were recovered in Smith Creek Cave sediments dating to 12,000 years B.P. No remains of this snake were identified from Gatecliff Shelter. South of the Great Basin, *R. lecontei* is known from the Late Pleistocene of the Grand Canyon (Mead, 1981) and the Sonoran Desert (Van Devender and Mead, 1978).

Thamnophis sp. (Garter Snake)

MATERIAL: One hundred twenty-four vertebrae: 124 specimens.

REMARKS: Vertebrae of the genus *Thamnophis* are typical of natricine snakes in having a short S-shaped haemal keel. I have not been able to satisfactorily separate *T. elegans* (western terrestrial garter snake) from *T. sirtalis* (common garter snake) using characters of the vertebrae. *Thamnophis elegans* is common in wet to moist areas throughout the Great Basin. *Thamnophis sirtalis* occurs along the western, northern, and northeastern periphery of the Great Basin.

Thamnophis sp. was identified from one stratum at Gatecliff Shelter and from cave sediments at Smith Creek Cave, eastern Nevada (Mead, Thompson, and Van Devender, 1982).

Sonora cf. *semiannulata*
(Western Ground Snake)

MATERIAL: One vertebra: one specimen.

REMARKS: The vertebrae of *Sonora* can be differentiated from other small colubrids by the characters listed below. Several other genera are similar (*Chionactis,* shovel-nosed

snake; *Chilomeniscus,* sand snake; *Hypsiglena,* night snake). Vertebral characters for *S. semiannulata* are: (1) size: cl = 1.35–1.80 mm.; (2) shape: cl/naw = 1.07–1.30 mm.; (3) neural spine very low and thick; (4) zygosphene concave or slightly convex viewed from above; (5) accessory processes short, blunt; and (6) anterior zygapophysial surfaces more oblique to anterior than in *Hypsiglena* (Van Devender and Mead, 1978).

The western ground snake lives today throughout the Great Basin. Fossils of the snake are found in wood rat middens in the Grand Canyon (Van Devender, Phillips, and Mead, 1977) and in the Sonoran Desert (Van Devender and Mead, 1978).

Colubridae
Genus and Species Indeterminate

MATERIAL: One hundred eighty-nine vertebrae: 189 specimens.

REMARKS: These vertebrae were not identifiable to either a genus or species because of fragmentation (physical breakage), digestive erosion (probably from a raptor), or extreme caudal or cervical position on the vertebral column. Only mid-column vertebrae were identified to genus and species.

Family Viperidae
Crotalus cf. *viridis*
(Western Rattlesnake)

MATERIAL: Seventy-two vertebrae: 72 specimens.

REMARKS: I believe there are at present no reliable osteological characters for separating *C. viridis* from *C. mitchelli* (speckled rattlesnake). A sufficiently large sample of modern *C. viridis* and *C. mitchelli* and all fossil *Crotalus* from the Great Basin may determine which rattlesnake occurred there in the Late Pleistocene. Only *C. viridis* lives in the central Great Basin today. *C. mitchelli* lives in the southernmost limits of the basin.

Crotalus cf. *viridis* has been identified from many strata at Gatecliff Shelter and from Late Pleistocene cave sediments at Smith Creek Cave, eastern Nevada (Mead, Thompson, and Van Devender, 1982).

DISCUSSION AND CONCLUSIONS

Nine hundred twenty-three skeletal elements were recovered from unmixed strata, of which the following were identified: 24 anurans (3%), 189 lizards (20%), and 710 snakes (77%). The modern herpetofauna of northern Nevada is provided in table 43.

Five anurans occur in northern Nevada, four actually within the confines of the Lake Lahontan Basin. Three of these anurans were recovered in Hidden Cave. Both *Scaphiopus intermontanus* and *Bufo boreas* are hardy animals not necessarily requiring abundant, flowing, perennial water. The absence of *Rana pretiosa* (spotted frog) or *R. pipiens* (leopard frog) until Stratum I may be indicating a lack of open, ponding water with pondside vegetation near Hidden Cave.

Eleven lizards are known from northern Nevada, and five of these were recovered in Hidden Cave (*Crotaphytus collaris, Sceloporus magister, Uta stansburiana, Phrynosoma platyrhinos,* and *Cnemidophorus tigris*). These five species were expected as they are common at the cave today. *Sceloporus* cf. *occidentalis* was expected in greater abundance, at least in enough quantities to be recovered from unmixed provenience. The single occurrence of *Phrynosoma douglassi* (mixed provenience) might have been expected; it does not occur near the cave today but lives in the higher elevations of the mountains in other areas of northern Nevada. I expected to find the remains of *Crotaphytus wislizenii, Callisaurus draconoides* (zebra-tailed lizard), and a greater abundance of *Uta stansburiana* (side-blotched lizard) since they occur in the region today. *Crotaphytus wislizenii* is known to have occurred in the eastern Great Basin during the Late Pleistocene (Mead, Thompson, and Van Devender, 1982). Late Pleistocene occurrences of *Uta stansburiana* and *Callisaurus draconoides* are very poorly understood; it is not known when they entered the Great Basin.

Twelve species of snakes are known to live in the northern Great Basin. Of these *Hypsiglena torquata* (night snake) and *Charina bottae* (rubber boa) are very small snakes and are consistently lacking from the Hidden Cave fauna. As mentioned above, the screening of

TABLE 43
Geographic Distributions of the Modern Amphibians and Reptiles of Northern Nevada (North of 39°) Including Those Animals Recovered from Hidden Cave[a]

	Hidden Cave Sediments	Present at Hidden Cave	Within Carson Sink	Within Lake Lahontan Basin	Northern Nevada	Not in Great Basin
Scaphiopus intermontanus	X	–	–	X	X	–
Bufo boreas	X	–	–	X	X	–
Hyla regilla	–	–	–	X	X	–
Rana pretiosa	!b	–	–	–	X	–
Rana pipiens	!	X	X	X	X	–
Crotaphytus collaris	X	X	X	X	X	–
Crotaphytus wislizenii	–	–	X	X	X	–
Callisaurus draconoides	–	X	X	X	X	–
Uta stansburiana	X	X	X	X	X	–
Sceloporus graciosus	–	–	–	X	X	–
Sceloporus magister	X	X	X	X	X	–
Sceloporus occidentalis	!	–	X	X	X	–
Phrynosoma douglassi	!	–	–	–	X	–
Phrynosoma platyrhinos	X	X	X	X	X	–
Cnemidophorus tigris	X	X	X	X	X	–
Eumeces skiltonianus	–	–	–	–	X	–
Charina bottae	–	–	X	X	X	–
Coluber constrictor	X	–	X	X	X	–
Masticophis flagellum	!	–	X	X	X	–
Masticophis taeniatus	!	–	X	X	X	–
Salvadora hexalepis	X	–	X	X	X	–
Pituophis melanoleucus	X	X	X	X	X	–
Lampropeltis getulus	X	–	–	?	X	–
Lampropeltis zonata	!	–	–	–	–	X
Lampropeltis pyromelana	!	–	–	–	X	–
Lampropeltis triangulum	!	–	–	–	–	X
Rhinocheilus lecontei	X	–	–	–	X	–
Hypsiglena torquata	–	–	–	–	X	–
Sonora semiannulata	X	–	X	X	X	–
Thamnophis elegans	!	X	X	X	X	–
Crotalus viridis	X	–	X	X	X	–

[a] Distributions from Linsdale (1940), Smith (1946), Wright and Wright (1957), and personal observations.
[b] ! = see text.

the cave sediments would have been sufficient to recover these small snakes had they been present in the deposit. Nine species of snakes recovered in Hidden Cave live today in the northern Great Basin. One of the fossil kingsnakes (*Lampropeltis* cf. *zonata*) presently lives not far away in the Sierra Nevada, whereas the other species (*L.* cf. *pyromelana*) is a relict only in the Snake Range, eastern Nevada, but common farther east in the Wasatch Mountains of Utah. The remains of these small kingsnakes from Great Basin cave sites need to be re-examined in conjunction with larger series of modern specimens of the three species of *Lampropeltis* involved (*L. zonata, L. pyromelana,* and *L. triangulum*).

Three major factors appear to be involved in the deposition of these faunal remains at Hidden Cave:

1. The most important factor is that the interior of the cave appears to have been a raptor roost. Birds of prey (see chap. 10, this volume), could have introduced much of the fauna recovered during the excavations. Rap-

tor roosting in the cave might have produced clustering of faunal remains in areas not excavated. Roosting outside the entrance to the cave would have been similar, in which case periodic thunderstorms could have washed these faunal remains into the cave.

2. There is no question that man has utilized the cave, as evidenced especially by the cultural middens (Strata II and IV). The quantity of animal remains appears highest in units showing cultural use (chap. 10, this volume).

3. Small mammalian prey may have been deposited as either dead troglophylls (those animals frequently in the cave) or as food bones left by larger predators. Deposition within the cave was probably altered by the periodic inflooding.

In essence, the Hidden Cave herpetofauna is depauperate in comparison to the present-day fauna. The diversity of the Holocene and Late Pleistocene fauna from the Lake Lahontan Basin, as viewed from Hidden Cave, may be real in that other species now present are very recent arrivals. An alternative is that the Hidden Cave fauna is representative only of the immediate community, one that is biased in terms of the entire fauna possible for the Lake Lahontan Basin.

I am not sure that the amphibians and reptiles from Hidden Cave can be used, by themselves, to reconstruct the basin-wide environment, or the entire local herpetofauna through time. The value of this cave fauna will be fully understood when additional herpetofaunas from other cave deposits and wood rat middens of the Lake Lahontan Basin can be amassed for a complete reconstruction of the local fauna.

CHAPTER 12. PALEONTOLOGY OF HIDDEN CAVE: FISH

GERALD R. SMITH[1]

Fish remains are reported from numerous caves in the Lahontan region of Nevada and northeastern California, including the Falcon Hill sites (Follett, 1963; see also Hattori, 1982), Lovelock Cave (Follett, 1967, 1970; Heizer and Napton, 1969), NV-Wa-197 (Follett, 1974), Thea Heye Cave (Follett, 1977), Karlo (Follett, 1980), and several others, including Hidden Cave (as summarized by Heizer and Napton, 1969, fig. 1).

These sites contain a nearly uniform list of fish species common to the central part of the Lahontan Basin (La Rivers, 1962): cutthroat trout, cui-ui or kuyui (a large lake sucker), Tahoe sucker, and tui chub. Each of these is thought to have been an important prehistoric food item, large and abundant enough to be a significant source of protein. Two smaller species, Lahontan redside shiner and speckled dace, are less commonly encountered in midden deposits. All but the speckled dace have been identified from Hidden Cave.

Bones of several of the above species were identified in coprolites from Lovelock Cave by Follett (1970) and discussed by Heizer and Napton (1969). Coprolite samples from five of seven sites in the area (including Hidden Cave) contained fish bones, representing approximately 5–20 percent of the food items identified (Heizer and Napton, 1969).

This chapter describes fish remains recovered during the 1979–1980 excavations at Hidden Cave. A total of 9591 fish bones (derived from 815 provenience units) were identified into five species. Identification and estimation of original size were conducted through comparison with osteological reference collections in the Division of Fishes, Museum of Zoology, University of Michigan.

FISH SPECIES

Lahontan Cutthroat Trout
Salmo clarki henshawi

This large trout of Lake Lahontan and its remnant waters is represented in Hidden Cave samples by skeletal remains of individuals that ranged from 20 to 60 cm. in length. The minimum number of individuals is 64. These bones constitute about 1 percent of the total number of fish bones, representing about 4 percent of the original fish biomass in the Hidden Cave sample (table 46). Specimens from lower stratigraphic levels were probably deposited either during episodes of inundation by high lake levels, or they may have been dragged there from the nearby shore by carnivores during times of lower lake levels.

The small number of trout in the upper, obviously cultural Strata I–IV (table 46) suggests infrequent fishing, perhaps only during the winter and spring spawning runs into creeks (Fowler and Bath, 1981).

Virtually all the bones are vertebrae; for some reason skull bones are rarely found in Hidden Cave. Trout bones are never charred or stained, but are sometimes slightly etched, perhaps by lake waters (as in the lacustrine subfossil bones of *Gila bicolor* shown in fig. 49 top). The bones are always disarticulated and somewhat abraded (fig. 48a).

Cui-ui (or Kuyui)
Chasmistes cujus

These large planktivorous fish were endemic to Lake Lahontan and are now restricted to Pyramid Lake. Cui-ui breed in tributaries, and the spring spawning run in the lower Truckee River supplied a significant portion of the protein in the diet of certain Northern Paiute groups (Frémont, 1845; Snyder, 1917; Follett, 1980). This species accounts for about 2 percent numerically (and about 9% by weight) of the total Hidden Cave fish sample (table 46). The skeletal remains represent fish that ranged in length from 30 to 50 cm. and averaged about 2 kg. in weight.

Most specimens seem to have been deposited when the lake inundated the cave, or they may have washed up on the beach and been dragged to the cave by carnivores. Nearly all cui-ui bones were recovered from Strata V–XIV, where both vertebrae and skull bones appear (table 46).

[1] Curator, Museum of Paleontology, University of Michigan, Ann Arbor.

The scarcity of *Chasmistes cujus* in the midden samples is noteworthy, particularly since this species is known to have been exploited by later inhabitants of caves across the valley to the northwest, closer to the Truckee River. Frémont (1845) implied that certain local groups of Indians were excluded from access to the spring spawning runs of these fishes in the mouth of the Truckee River.

Tahoe Sucker
Catostomus tahoensis

This species is abundant in the lakes and streams of the Lahontan drainage. But remains of Tahoe sucker are surprisingly rare in Hidden Cave, accounting for only about 1 percent (both numerically and by weight) of fish biomass represented in the sample. Hidden Cave specimens ranged from about 7 to 20 cm. in length and up to about 200 grams in weight.

Tahoe sucker are bony fish, usually not highly preferred as food (La Rivers, 1962), but their oil content makes them easily preserved (Fowler and Bath, 1981). Their relative rarity in the deposits might also be accounted for by their benthic habits and small mouths (which allowed them to remain unaffected by hooks and nets that could not reach their bottom habitat). Net sinkers are not known from the area (Rostlund, 1952; Fowler and Bath, 1981).

Tui Chub
Gila bicolor obesus and
G. b. pectinifer

These two subspecies inhabit large lakes of the Lahontan Basin; *Gila bicolor obesus* also inhabits streams and marshes. *Gila bicolor pectinifer* is a large minnow, reaching lengths of 20 to 40 cm.; *G. b. obesus* is usually smaller, reaching lengths of 10 to 30 cm. These two subspecies are roughly identifiable by the presence of four (*obesus*) or five (*pectinifer*) teeth on the right pharyngeal arch (fig. 48b), both forms having five teeth on the left arch (fig. 48c). In all, tui chub constitute 96 percent numerically, and 86 percent by weight, of the Hidden Cave fish samples. The live fish ranged in weight from about 100 to 300 grams.

Lahontan Redside
Richardsonius egregius

This small species is abundant in lakes and streams of the Hidden Cave area, but not common at Hidden Cave (having been identified with certainty only from Stratum IV). Perhaps these small fish escaped the coarse mesh of the nets, weirs, or basket traps normally used (see Stewart, 1941; Loud and Harrington, 1929).

ECOLOGICAL AND SUBSISTENCE INFERENCES

Interest in the diversity and abundance of fish remains in Hidden Cave centers on two questions: (1) Through what processes did fish enter the cave? and (2) How far from the cave did the fish live during the time of deposition? Answers to these questions would permit us to know which fish remains represent human food, and where and how they were obtained.

The fishes found in Stratum XIII (table 46) include lake species, *Chasmistes cujus* and *Gila bicolor pectinifer,* as well as species that inhabit both lakes and streams. The same can be said of Strata IX and VII. These bones are usually large, clean except for silt in the foramina, pale in color, not etched by acid, and not abundant.

Stratum V, deposited approximately 6900 to 5400 years ago, marks a transition in the fish fauna at Hidden Cave. The lake species and subspecies virtually disappear at this point in the sequence, as might be expected given the recession of lake waters from the vicinity. Specimens bearing obvious evidence of human use (see below) also appear for the first time. Burnt fish bones (in sample HC-1101) also appear initially in Stratum V.

Stratum IV, the 32 Inch Midden, contained more than one-third of the fish bones in the 1979–1980 Hidden Cave sample; 93 percent are small *Gila bicolor obesus.* Most of these bones bear circumstantial evidence of having been digested. A few large trout bones are also present.

Fish bones showing evidence of human use appear also in Strata I, II, and III, though in much reduced numbers (table 46).

The stratigraphic pattern in Hidden Cave

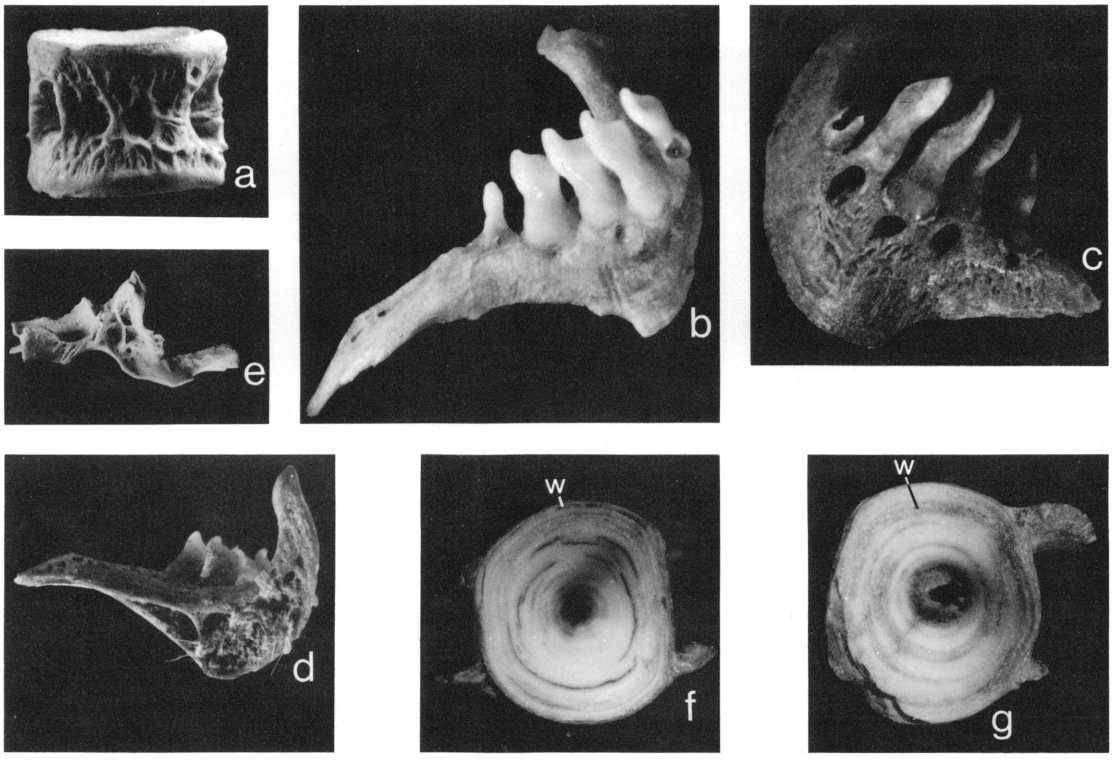

FIG. 48. (a) *Salmo clarki* vertebra showing diagnostic sculpturing of lateral aspect, 2.4×. (b) *Gila bicolor pectinifer,* right pharyngeal, unstained, 4×. (c) *Gila bicolor,* left pharyngeal, stained, 4×. (d) *Gila bicolor* pharyngeal with matted clay, hair, and feather, 4.8×. (e) *Gila bicolor* basioccipital, 1.6×. (f) *Gila bicolor* vertebra showing winter line, "w," and narrow band of spring growth, 8×. (g) *Gila bicolor* vertebra showing winter line, "w," and broad band of spring-to-fall growth, 8×. All specimens from HC-1767.

indicates roughly constant background levels of fish abundance, with two notable exceptions: Stratum IV is associated with good evidence of human use of fish, and Stratum VII, which lacks direct evidence of human exploitation of fish, but shows suggestively high frequencies of taxa characteristically used by humans.

EVIDENCE OF HUMAN EXPLOITATION OF FISH

The condition of fish bones found in the upper strata of Hidden Cave (i.e., above Stratum V) is quite different from the large, pale vertebrae that occur in the lower strata. Although fish bones from the middens are not directly associated with coprolites, a number of distinctive characteristics of the bones themselves indicate ingestion, digestion, and defecation:

1. Dark stain throughout the bone, macroscopically gray, but reddish under microscopic examination, suggestive of iron oxide (fig. 48c).
2. Acid-etched bone and (often) tooth enamel (fig. 49 bottom) usually coincident with the stain.
3. Adhering matrix of organic-rich claylike substance, usually gray but often with yellow pigment; sometimes including bits of charcoal, hair, and a variety of other organic fragments and fibers (fig. 48d).
4. Bones of roughly uniform small size compared with the rest of the Hidden Cave sample, usually less than 5 mm., and representing fishes 10–14 cm. long. Fossils

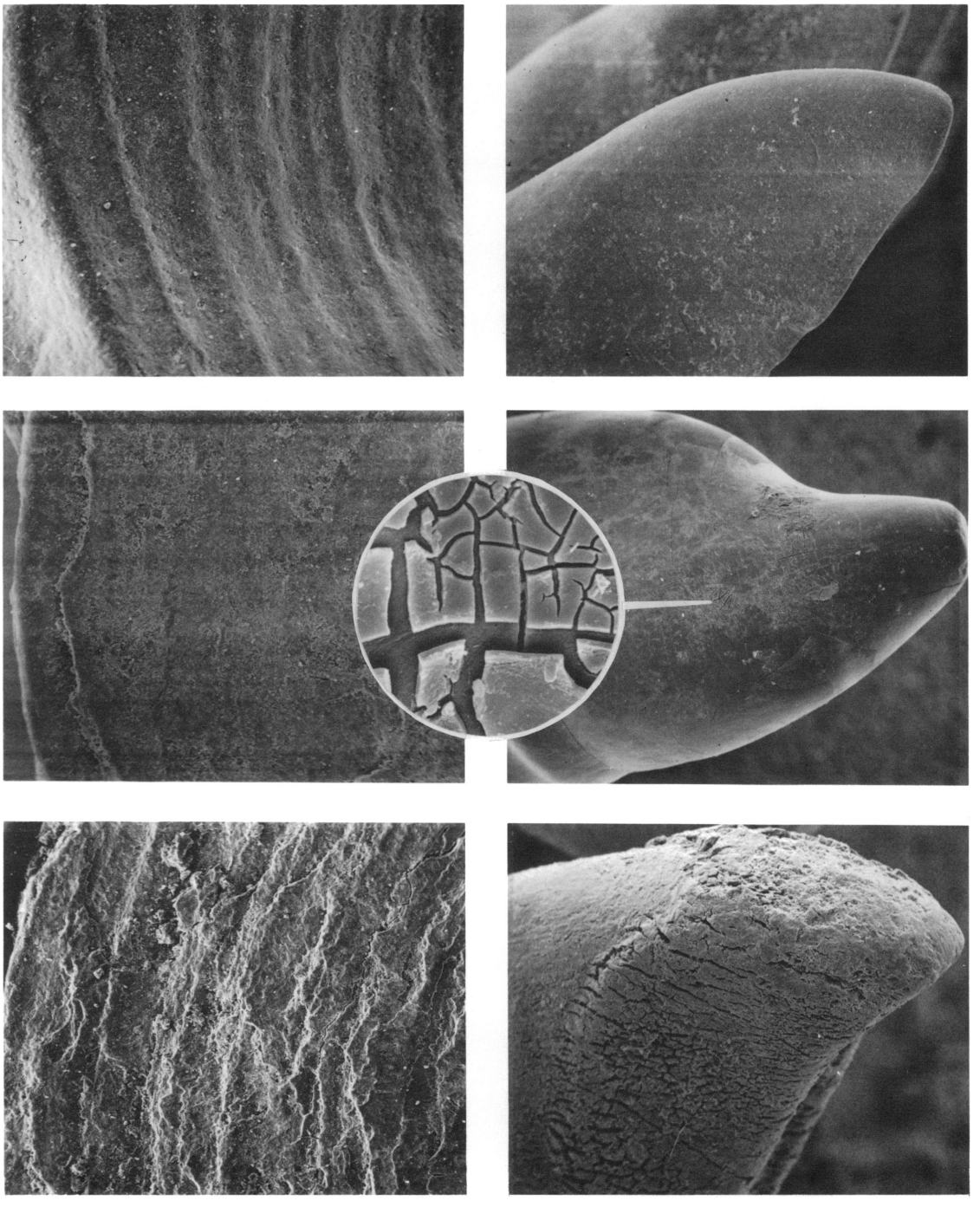

FIG. 49. Texture of vertebrae (left) and teeth (right) of *Gila bicolor* exposed to different conditions. (Top) Subfossil vertebra and teeth from Pyramid Lake beach (61×). (Middle) Vertebra and tooth dried on Hidden Cave floor (48×); inset showing desiccation cracks on tooth enamel (1014×). (Bottom) Vertebra and tooth etched by acid, presumably during digestion (48×).

larger than 11 mm. are never stained. Stained bones, 5–11 mm. in size, show frequent signs of original breakage; smaller bones are less often broken. The bones usually represent fishes no more than 2 cm. in cross sectional diameter.

5. Overrepresentation of internal bones, especially vertebrae, pharyngeal teeth, and basioccipitals (fig. 48e); flat, external bones are uncommon.

The Stratum IV sample includes about 2000 such bones, and a few are found in Strata II, III, and V, as well. A large sample (HC-1767) from Stratum V contains both dark and light bones, therefore we may conclude that the stain and etching are not diagenetic.

High correlation of dark staining, nearly homogeneous small size, acid etching, and heterogeneous organic claylike matrix, suggest that the fishes were ingested, slightly chewed when large, and digested (except for massive internal bones, which were defecated nearly whole).

After developing this hypothesis, known coprolitic material was examined (in sample HC-100); all the above characteristics were observed on the six fish bones contained in these coprolites. We think it likely that the isolated fish bones in Stratum IV were probably deposited originally in coprolites, which then deteriorated prior to burial by later sediments.

The cause of this staining is of some importance to the understanding of human use of the fishes. The correlation with size indicates that small fish were chewed only slightly before being swallowed. Large bones in Stratum IV, especially those too large to have been part of items swallowed whole, remained pale and were never stained.

Because the dark red-brown color is suggestive of iron-oxide stain, vertebrae with different levels of stain were compared by atomic absorption spectrometry to determine their iron content. Selected fish bones from Hidden Cave were divided into three categories (dark, medium, and light) and then dissolved in nitric acid.

Results of atomic absorption spectrometry, shown in table 44, show that the degree of staining is indeed correlated with iron content. Since bile pigments do not contain iron, but muscle and blood are rich in undigestible iron, we hypothesize that stained vertebrae are iron-rich because they were part of episodes of heavy fish ingestion. Although digestion seems correlated with the staining, actual oxidation probably occurs after defecation (but this has not been experimentally confirmed).

TABLE 44
Iron Content of Light, Medium, and Dark-Stained Vertebrae[a]

Stain	Sample Size	Parts per Thousand Fe
Light	7	0.48 ± 0.01
Medium	4	0.62 ± 0.01
Dark	5	1.42 ± 0.11

[a] Vertebrae were dissolved in nitric acid and analyzed in an atomic absorption spectrometer.

Seasonality of Fish Capture

Growth rings form in fish bones when peripheral layers of bone are added to certain skeletal parts, such as scales and vertebrae. Rate of production of this peripheral bone is a function of food supply, temperature, metabolic rate, and amount of energy devoted to growth rather than reproduction. The result is seasonal variance reflected in the apparent width of growth rings. In high latitudes, winter is usually a season of little or negative growth, and winter lines are often observable on fish bones. If one knows the expected normal growth for each year in the life of a fish of a given species, it is readily possible to estimate the time of death for fossil fish as just before or just after the winter season.[2]

We began the seasonality study by establishing expected pattern of growth and ring widths in modern samples of *Gila bicolor* collected in spring and fall in Nevada. Using these control data as a baseline, we then studied three samples of fish vertebrae from Hid-

[2] Because the color of the Hidden Cave fish bones might represent differential utilization, I attempted to determine the season of capture for both colors of specimens.

TABLE 45
Season of Mortality of Fish, As Estimated by Width of Last Growth Ring on Vertebrae[a]

Sample	Stratum	Stain	Number of Vertebrae for each Season of Mortality		
			Spring	Summer	Fall
HC-1767	V	light	32	5	8
HC-1767	V	dark	27	2	19
HC-68	IV	dark	20	5	5

[a] Criterion for spring: small fraction of expected yearly growth beyond last winter line (fig. 48f). Fall: most of expected yearly growth in band outside last winter line (fig. 48g).

den Cave in order to obtain an estimate for season of death.[3]

Results shown on table 45 indicate a predominance of spring mortality (fig. 48f) in all samples, although the dark specimens of HC-1767 seemed to include almost as many fall vertebrae (fig. 48g). Summer vertebrae appear to be less represented, although the distinction between summer and fall vertebrae may be blurred by variability between good and bad growth years.

DISCUSSION

We have circumstantial evidence, based on correlations noted for fish bones from Stratum IV, that bones stained by iron oxide and etched by acid were ingested by humans. These bones represent small fishes, 10–14 cm. long, that were bitten into segments smaller than 15 or 20 mm. in diameter, chewed in proportion to their size, and swallowed. Dark-stained bone possibly represents episodes of high fish intake, especially in the spring. Feces were left somewhere on the cave floor, but the bones are not usually associated with coprolites.

During the time represented by Stratum V, lake fishes such as *Chasmistes cujus* probably became unavailable within the catchment of Hidden Cave. The fish and geological data suggest that during the time of deposition of Stratum IV, roughly 3800 years ago, the nearest lake habitat had receded to a distance of at least 5–10 km. from the cave, perhaps to Carson Lake, to the southwest. Fish, primarily *Gila bicolor obesus,* were obtained from sloughs tributary to the Carson River, probably about 3 km. to the west and north. The dominance of *Gila bicolor obesus* and the surprising absence of normally abundant benthic forms such as mountain suckers (*Catostomus platyrhynchus*) and dace (*Rhinichthys osculus*), suggests that available local aquatic habitat (from which fish were obtained) were sloughlike.

Fish were probably procured with poorly weighted nets that did not effectively reach the bottom. Rostlund (1952) indicates that a wide range of aboriginal fishing methods was used in this area historically, although net weights are not known (see also Fowler and Bath, 1981). The absence of fish less than 15 mm. in diameter is difficult to explain.[4] Certainly fish of this small size would have been most abundant and most easily caught.

Some trout were captured, and these were evidently carried to the cave after removal of the head. Small fish were probably eaten directly at the site of capture as well as being carried back to the dwelling (I have observed this behavior among children and adults in several places in the Amazon drainage in Ecuador).

The fish bones in Stratum IV average slightly smaller (and correspondingly younger) than those in Stratum V, possibly indicating heavier cropping of the resource at the time of deposition of Stratum IV.

Heizer and Napton (1969) reported seeing

[3] Vertebrae are best observed wet under a dissecting microscope. Some staining with alizarin red [calciphilic] dye is often helpful. Examination of daily growth rings in thin section under 200× magnification is useful to establish the underlying structure of the pattern of variation in growth.

[4] The netting actually recovered from Hidden Cave (Goodman, chap. 19, this volume) includes 65 pieces, several of which may be fishing nets. Mesh sizes range from 5.5 mm. to 90 mm. (square mesh), with the average mesh size approximately 25 mm. The technology represented at Hidden Cave includes netting sufficiently small to procure rather small fish. Perhaps their vertebrae, which would be only about 1–1.5 mm. in diameter, were destroyed by ingestion and digestion, or passed through the screens.

TABLE 46
Tabulation of Numbers of Identified Bones of Each Fish Species in Each Stratum or in Each Category of Mixed Strata

Unmixed Stratum	*Gila bicolor* Vertebrae Small	*Gila bicolor* Vertebrae Large	*Gila bicolor* Skull Bones Small	*Gila bicolor* Skull Bones Large	*Richardsonius egregius*	*Catostomus tahoensis*	*Salmo clarki* Small	*Salmo clarki* Large	*Chasmistes cujus* Skull	*Chasmistes cujus* Vertebrae	Row Totals
I	54	7	58	16	—	1	—	—	—	—	136
II	4	23	57	7	—	2	—	1	—	1	95
III	219	17	34	2	—	1	—	—	—	—	273
IV	2111	130	1114	29	34	2	1	12	—	—	3433
V	274	300	81	31	—	—	—	1	1	5	693
VI	—	—	—	—	—	—	—	—	—	—	—
VII	543	78	23	9	—	—	6	11	1	11	682
VIII	—	—	—	—	—	—	—	—	—	10	10
IX	269	67	23	4	—	1	—	6	2	16	388
X	—	—	—	—	—	—	—	—	—	—	—
XI	8	1	—	—	—	—	—	—	—	—	9
XIII	103	57	6	2	—	—	3	4	3	14	192
XIV	23	13	2	1	—	—	—	—	—	—	39
Totals (w/prov.)	3590[a]	693[a]	1382	101	34	7	10	35	7	57	5950
Species totals	5800				34	7	45		64		

Mixed Strata	*Gila bicolor* Vertebrae Small	*Gila bicolor* Vertebrae Large	*Gila bicolor* Skull Bones Small	*Gila bicolor* Skull Bones Large	*Richardsonius egregius*	*Catostomus tahoensis*	*Salmo clarki* Small	*Salmo clarki* Large	*Chasmistes cujus* Skull	*Chasmistes cujus* Vertebrae	Row Totals
IX–XIII	364	37	18	7	—	—	—	8	1	2	437
IX–XIV	6	—	—	—	—	2	—	—	—	—	8
X–XIII	26	10	—	—	—	—	—	—	—	—	36
XI–XII	44	14	3	2	—	—	—	4	—	12	79
XI–XIII	13	6	3	—	—	—	—	1	—	9	32
XII–XIII	108	37	3	—	—	1	1	3	1	17	171
XII–XIV	19	5	2	1	—	—	—	—	—	—	27
XIII–XIV	116	72	6	5	—	1	2	5	—	15	222
Totals, mixed strata	1848	366	122	37	—	4	5	34	2	86	2504
	2214		159				39		88		
No provenience	500	92	450	65	—	2	1	3	1	57	1171
	592		515				4		58		
Grand total	9280[a]				34	13	88		210		9625

[a] Totals for vertebrae for *Gila bicolor* include an estimated 0.006 misidentified vertebrae of *Catostomus tahoensis*.

Charcot-Leyden crystals, possibly indicative of dysentery, in coprolites from Lovelock Cave. Although several kinds of crystals are on the fish bones from Hidden Cave, none fitting the description of Charcot-Leyden crystals were seen.

CONCLUSIONS

The following conclusions seem justified on the basis of fish remains recovered from Hidden Cave:

1. Sometime during the deposition of Stratum V, lake waters receded from the vicinity of Hidden Cave, and thereafter lake fishes such as *Gila bicolor pectinifer* and *Chasmistes cujus* were rarely carried into the cave.

2. At about the same time, small, iron oxide-stained, and acid-etched bones—primarily of *Gila bicolor obesus*—became abundant. By Stratum IV times, such bones became the predominant fish remains found in the cave. These bones are interpreted as evidence of

human ingestion of tui chubs, the smaller individuals of which were eaten nearly whole.

3. Both stained and unstained fish bones decrease in abundance through Strata III and II. An intermediate number of fish remains was found in Stratum I.

4. Analysis of growth rings in small samples of vertebrae suggest that most of them were taken in the springtime.

5. The species composition of the sample—conspicuously lacking small and benthic species—suggests that fishing technology involved rather coarse-meshed, poorly-weighted nets.

CHAPTER 13. HUMAN REMAINS FROM HIDDEN CAVE

CLARK SPENCER LARSEN[1]

Beginning with the 1940 excavation of Hidden Cave by S. M. Wheeler, a number of human remains, consisting of 44 bone fragments, more than seven isolated teeth, and 39 hair samples, have been recovered. For the most part, this material comprises fragmentary, isolated specimens scattered haphazardly throughout the cave deposits. Most of the skeletal and dental materials are from the midden strata (II and IV). The hair samples are primarily associated with the upper midden (II). Nearly all strata, however, include one or all three types of remains (table 47). Metric observations—cranial, dental, and postcranial—are listed on tables 47–49.

Prior to the 1979 and 1980 excavations of this site by the American Museum of Natural History, two sets of human skeletal remains had been recovered, one by Wheeler in 1940 and one by Roust and Grosscup in 1951. The former—consisting of one pair of adult left and right clavicles, tooth fragments, and a mandible (Roust and Grosscup, n.d.)—was lost following excavation. The latter comprised an adult male right mandible with an associated first molar, one phalanx, one fourth metacarpal, one rib fragment, one fibula fragment, and one incisor (Roust and Grosscup, n.d.). All of these materials were recovered from the 32 Inch Midden. In addition, Roust and Grosscup located several cranial fragments from the Mud Flow Gravels. Of the materials recovered by Roust and Grosscup, only an incisor and fibula and rib fragments were available for study. The most recently excavated materials, those collected by the American Museum, include the following:

20.4/1272: left half of an adult female mandible with the lateral incisor, canine, first molar, third molar, and roots for the third and fourth premolars. Loss of the remainder of the dentition is due to postmortem factors. Although the mandible is small, the attachments for the temporalis and masseter muscles are well defined, particularly on the anterior-superior margin of the coronoid process and the medial surface of the gonial angle. Inferior to the alveolus separating the third and fourth premolar tooth sockets is a moderately developed *torus mandibularis*. Two small occlusal carious lesions are present on the third molar. Occlusal wear is extreme on all teeth. In addition, these teeth show extensive premortem enamel chipping in association with multiple occlusal wear planes.

20.4/1308: adult maxillary central incisor represented only by a fragment of labial enamel.

20.4/1426: adult mandibular left premolar.

20.4/1604: complete left infant femur. The maximum length (table 49) suggests that it is from an individual aged six months to one year at death (cf. Ubelaker, 1978).

20.4/1605: complete left adult metatarsal.

HC-76: adult right mandibular lateral incisor.

HC-137: adult terminal hand phalanx.

HC-141: adult radius head fragment.

HC-148: adult mandibular premolar.

HC-164: unidentifiable fragment.

HC-209: adult tibia diaphysis segment.

HC-263: adult metacarpal, proximal end.

HC-325: adult male radius with distal end missing. The bone is markedly robust and the head exhibits a recent line of epiphyseal fusion.

HC-364: adult proximal hand phalanx.

HC-448: fragment of tooth enamel.

HC-1054: tooth enamel fragment.

HC-1081: adult left patella.

HC-1204: adult terminal foot phalanx.

HC-1313: adult first rib fragment.

HC-1617: adult metacarpal or metatarsal diaphysis.

HC-1964: child proximal hand phalanx.

HC-2279: adult proximal hand phalanx.

The following skeletal materials recovered by the American Museum of Natural History consist of remains that are virtually identical

[1] Research Associate, American Museum of Natural History; Assistant Professor and Director, The Anthropology Museum, Northern Illinois University, De Kalb.

TABLE 47
Human Remains from Hidden Cave[a]

Catalog No.	Provenience[b] Unit	Stratum
Skeletal/dental		
20.4/1272	Lambda 9	IV
20.4/1308	Lambda 9	V
20.4/1426	Mu 8	III
20.4/1604	Omicron 7	IV
20.4/1605	Nu 7	V
HC-76	Kappa 6	III
HC-137	Kappa 9	IV
HC-141	Kappa 8	IV
HC-148	Kappa 12	IV
HC-164	backfill trench II	N.C.
HC-206	Nu 10	IV
HC-209	Lambda 13	V
HC-263	Lambda 10	IV
HC-325	Nu 9	N.C.
HC-351	Mu 12	V
HC-364	Omicron 9	IV
HC-448	Lambda 9	I
HC-537	Eta 13 (Feature 105)	II
HC-551	Zeta 12	IV
HC-775	Lambda 7	III
HC-938	Nu 9	II, III
HC-1054	Lambda 9	II, III
HC-1081	Lambda 5	V
HC-1204	Nu 6	N.C.
HC-1313	Mu 8	III
HC-1617	Feature 113	IV
HC-1964	Rho Sigma 3.7	IV
HC-2024	Eta 10 (wall fall)	N.C.
Lowie-2-57746	—	N.C.
Lowie-2-57860	K5	N.C.
Lowie-2-32418	L6	N.C.
Hair		
20.3/9867	trench P (Feature 100)	N.C.
HC-37	Kappa 10	I
HC-38	Kappa 10	II
HC-39	Mu 12	II
HC-40	Nu 12	II
HC-41	Kappa 6	II
HC-42	Kappa 9	I
HC-43	Kappa 6	II
HC-46	Pi 14	N.C.
HC-49	Kappa 12	II, III
HC-70	Omicron 12	IV
HC-91	Omicron 10	II
HC-101	Nu 10	II
HC-106	Omicron 9	N.C.
HC-107	Nu 10	III
HC-108	Lambda 13	I, II
HC-109	Lambda 13	II
HC-129	Nu 13	I
HC-143	Pi 14	N.C.
HC-169	Iota 13	II
HC-170	Lambda 5	I
HC-220	Rho 10	N.C.
HC-244	Iota 13	IV
HC-291	Omicron 9	N.C.
HC-379	Iota 12	XIII
HC-396	Nu 12	V
HC-408	Iota 12	XIII
HC-430	Eta 11	II
HC-433	Iota 8	V
HC-437	Lambda 9	I
HC-469	Lambda 9	II
HC-470	Eta 13	III
HC-487	Eta 13	III
HC-505	Zeta 11	I
HC-520	Lambda 8	II, III
HC-521	Eta 9-Zeta 9	I
HC-522	Eta 13 (Feature 105)	II
HC-523	Eta 13 (Feature 107)	II
—	Mu 12	I

[a] Includes materials of known provenience.

[b] With the exception of Lowie Museum of Anthropology catalog numbers (2-57860, 2-32418), all provenience designations—unit and stratum—refer to the American Museum site plan (this volume). The Lowie Museum catalog proveniences refer to the Roust and Grosscup (1957) site plan. N.C. = no correlation.

in robusticity, color, and texture. These specimens seem to represent scattered bones from one individual, a robust adult male.

HC-141: nearly complete right radius.

HC-206: clavicle, sternal aspect.

HC-351: left humerus, distal aspect.

HC-537: humerus head.

HC-551: humerus diaphysis fragment.

HC-775: tibia fragment, proximal aspect.

HC-938: two rib fragments.

HC-1313: right rib, dorsal aspect.

HC-2024: right rib, dorsal aspect.

TABLE 48
Dental and Mandibular Dimensions (in Millimeters) of Human Elements from Hidden Cave

Specimen 20.4/1272	
L. Mandibular I_2 breadth	*[a]
L. Mandibular C length	*
L. Mandibular C breadth	*
L. Mandibular M_1 length	*
L. Mandibular M_1 breadth	*
L. Mandibular M_3 length	*
L. Mandibular M_3 breadth	10.0
Condylar breadth	17.9
Ascending ramus height, coranoid process	63.8
Ascending ramus height, condyle	56.6
Ascending ramus, minimum breadth	34.3
Symphysis height	36.7
Symphysis thickness	15.2
Mandibular length	106.9
Miscellaneous Specimens	
R. Mandibular I_2 breadth	5.2
L. Mandibular P_3 length	7.4
R. Mandibular P_3 length	7.1
L. Mandibular P_3 breadth	8.0
R. Mandibular P_3 breadth	7.4

[a] Asterisk denotes occlusal surface too worn for accurate measurement.

TABLE 49
Postcranial Measurements (in Millimeters) of Human Elements from Hidden Cave

L. Femur: maximum length (20.4/1604)	86.0
L. Tibia: maximum length (2)	61.1
L. Humerus: biepicondylar breadth (HC-351)	61.4
R. Radius: maximum length (HC-141)	(235)[a]
L. Radius: head diameter (HC-325)	23.8
L. Radius: maximum diameter, crest (HC-325)	15.4
R. Radius: maximum diameter, crest (HC-141)	16.5
L. Radius: minimum diameter, crest (HC-325)	11.2
R. Radius: minimum diameter, crest (HC-141)	11.9

[a] ( ) denotes estimated measurement.

A number of skeletal specimens recovered by Roust and Grosscup (1957) were not originally recognized as representing human material. Reanalysis indicates that the following are, in fact, human and not nonhuman remains:

1. Adult femoral diaphysis segment.

2. Infant tibia showing extensive expansion of the cortex (osteomyelitis) with multiple plaque-like lesions covering most of the periosteum. The maximum length of the bone (table 49) suggests that the individual died at the time of birth or shortly thereafter (cf. Ubelaker, 1978).

3. Infant fibula showing same pathological bone remodeling as in the above infant tibia and, therefore, probably from the same individual.

4. Two fragments of either femoral or tibial diaphysis of an adult. Both fragments show advanced degrees of mineralization.

2-57746: adult proximal hand phalanx.

2-57860: adult rib fragment.

2-32418: right corpus of an adult mandible with anterior aspect of ascending ramus. Tooth sockets present for right canine; tooth roots of third and fourth premolars present in sockets; first molar present; second molar missing postmortem; third molar missing premortem (agenesis). Wear on the first molar is extreme; only a ring of enamel is present along the margin of the occlusal surface of the tooth. Most of the mesial-lingual quadrant is missing as a result of extreme premortem chipping.

In sum, then, some three to four dozen skeletal and dental specimens have been collected from Hidden Cave. Most bones and teeth are represented by this sample. Given the scattered nature of these materials in the site, we really have no way of knowing the exact number of individuals represented by these materials. There are at least three adults: two showing advanced stages of dental wear (20.4/1272; 2-32418) and another represented by less severe wear (20.4/1426). There are at least two preadults present: one showing the long bone development of birth to six months and the other, long bone development of six months to one year (20.4/1604).

A number of hair strands were recovered in Hidden Cave by the American Museum of Natural History. In total, 39 samples of hair were collected (table 47). With two exceptions, all samples consist of under five separate strands. The two exceptions, HC-522 and HC-41, consist of about a dozen strands each. Initial field inspection showed that all the hair samples are uniform in both color and texture: black and coarse. One strand of hair was submitted for identifica-

tion to the laboratories of the Federal Bureau of Investigation, Washington, D.C. Gross and microscopic examination of the submitted sample indicated that the hair is human.

This is the extent of the meager human remains recovered from Hidden Cave. We refrain, at this point, from offering even preliminary interpretations until we present the additional information on human skeletal material from the Carson Sink (Appendix B, this volume).

CHAPTER 14. MATERIAL CULTURE: ARTIFACTS OF STONE

LORANN S. A. PENDLETON[1]

This is the first of several chapters discussing artifacts from Hidden Cave. As outlined earlier, material culture recovered from all three excavations—1940, 1951 and 1979–1980—has been combined into a single body of data. All items were analyzed firsthand by us. The limited references to these artifacts in the literature are considered later in this volume.

All Hidden Cave artifacts were correlated into the 1979–1980 American Museum excavation units, according to specific criteria discussed in chapter 8. We reiterate that when a question arose regarding the stratigraphic placement of a given artifact, it was termed "N.C.," meaning not correlated. Thus in this context, the term "no provenience" has no meaning, since all artifacts discussed herein are known to have come from Hidden Cave (although, in some cases, we might not be able to determine from which stratum). See table 50 for provenience summary data.

The various descriptive chapters are presented according to material; this chapter discusses the lithic artifacts, the next presents artifacts of horn and bone, the subsequent chapter describes artifacts of shell, and so forth. These discussions attempt to provide a clear set of descriptive statements about the artifacts recovered from Hidden Cave. In later chapters we consider additional aspects of functional, settlement, and subsistence significance in this data set.

PROJECTILE POINTS

Recovered from Hidden Cave were 201 typable projectile points.[2] This section describes the typable artifacts as well as various projectile point fragments. The provenience and metric attributes of the typable projectile points are listed on table 53, at the end of this chapter.

Hidden Cave projectile points were classified into the Monitor Valley typology (Thomas, 1981a), a scheme which chronologically orders points based on a series of metric attributes. Although the metric data adequately define chronological types, we also discuss additional technological attributes which will further refine the typology.

The large sample of Gatecliff series points from Hidden Cave affords an opportunity to analyze the stylistic and functional integrity of this series. These points have similar technological attributes and consequently can be considered distinct as both a *temporal and technological type.*

The lithic assemblage at Hidden Cave is highly unusual because finished projectile points vastly outnumber unfinished points or production stage bifaces. Because this collection offers virtually no data on projectile point manufacture, production stages were examined through a series of replicative experiments.

The term *projectile point* and similar terms employed in the descriptive sections (drill, scraper, knife, ground stone, etc.) are used in a strict morphological sense. These are purely descriptive categories, based on artifact shape. At this level, the types are neither functional nor temporal; those distributions are derived from ancillary analyses.

All chipped stone artifacts from Hidden Cave were examined for microscopic (7–30×) traces of edge damage. Several specimens were further examined with a SEM (20–400×) and these results are discussed below. Attribute definitions in this chapter are derived from Binford (1963), Crabtree (1972, 1973), and Tixier (1974).

GATECLIFF SERIES

Hidden Cave contained 153 Gatecliff series projectile points. This large sample size

[1] Material Culture Analyst, Department of Anthropology, American Museum of Natural History.

[2] Projectile points 1-1B-27, 1-1B-29, 1-1B-31, 1-1B-33, 1-1B-245, 1-1B-412, 1-1B-663, 1-1B-877, 1-1B-888 (Nevada State Museum) and 2/25561, 2/32383, 2/32436, 2/32748, 2/32376, 2/46171 (Lowie Museum) were unavailable for study and are not included in this analysis.

TABLE 50
Provenience of Stone Artifacts from Hidden Cave

Type	*n*	Surface	I	I/II	II	II/III	III	III/IV	IV	IV/V	V	VII	IX/X	N.C.
Projectile Points														
Gatecliff Split Stem	90	12	3	1	16	2	8	1	17	1	3	—	—	26[a]
Gatecliff Contracting Stem	63	5	2	3	19	1	3	4	4	1	—	—	—	21
Elko Corner-notched	7	1	—	—	2	—	1	—	—	—	1	—	—	2
Elko Eared	6	1	—	1	—	—	—	—	1	—	—	—	—	3
Rosegate	8	—	4	—	2	—	—	—	—	—	—	—	—	2
Humboldt Basal-notched	19	1	2	1	13	—	—	—	—	—	—	—	—	2
Humboldt series	8	1	—	—	1	—	—	1	1	—	—	—	2	2
Residual Concave Base	17	3	2	—	2	—	1	—	4	—	—	—	2	3
Projectile point preforms	2	—	—	—	1	—	—	—	—	—	—	—	1	—
Miscellaneous projectile points	8	—	—	—	2	1	1	—	1	—	—	—	—	3
Projectile point fragments	56	1	9	—	9	2	9	1	2	—	3	—	—	20
Fine percussion bifaces	8	—	—	—	—	—	1	—	2	—	—	1	—	4
Pressure flaked bifaces	24	—	4	—	5	—	1	—	6	—	1	—	—	7
Scrap	7	—	—	—	1	—	3	—	1	—	—	—	—	2
Drills	7	—	1	—	3	—	—	—	1	—	—	—	—	2
Utilized flakes	26	1	3	—	6	—	6	2	2	—	—	—	—	6
Chippage & cores	57	—	5	—	13	—	3	—	11	—	2	—	1	22
Crystals & prisms	4	1	—	—	—	—	—	—	—	—	2	—	—	1
Ground stone	21	1	2	—	2	—	3	—	9	—	—	—	—	6
Ochre	2	—	—	—	—	—	—	—	2	—	—	—	—	—
Stone bead	1	—	—	—	—	—	—	—	—	—	—	1	—	—
Totals	441	29	36	6	97	6	39	9	64	1	12	2	7	134

[a] One found in Strata V–IX.

affords an excellent data base for a thorough technological analysis.

GATECLIFF SPLIT STEM (figs. 50–54)

NUMBER OF SPECIMENS: Ninety.

PROVENIENCE: Table 53. Surface, 12; Stratum I, three; mixed Strata I/II, one; Stratum II, 16; mixed Strata II/III, two; Stratum III, eight; mixed Strata III/IV, one; Stratum IV, 17; mixed Strata IV/V, one; Stratum V, three; Strata V–IX, one; not correlated, 25.

MATERIALS: Obsidian, 62; chert, 23; basalt, four; quartzite, one.

DIMENSIONS: Table 53.

CONDITION: Complete, 72; lateral fractures, 16; crenated fractures, one; perverse fractures, base, one.

One point (2/32761, fig. 53e) was fractured from an incipient hertzian cone, which could have been present within the material for some time and was activated by some unknown process, resulting in a lateral fracture.

One finished chert point (20.4/677, fig. 53m) was reconstructed for illustrative purposes. It had been destroyed by a crenated fracture, and potlid fractures cover its face. Both fractures are typically associated with thermal alteration. While heat treatment cannot improve finished lithic artifacts, it does improve the "flakability" of unfinished artifacts. Since thermal alteration would have served no function for this finished artifact, we conclude that the crenated and potlid fractures resulted from unintentional thermal alteration, such as a midden fire. A similar circumstance may account for the potlid and crenated fractures noted on several other points from Hidden Cave.

Four points (20.3/9921, fig. 54m; 20.4/371, fig. 54p; 20.4/705, fig. 54u; and 20.4/1619, fig. 54n) were broken by perverse fractures. Apparently, most of the perverse fractures resulted from resharpening, but one projectile point (20.4/705) was broken during man-

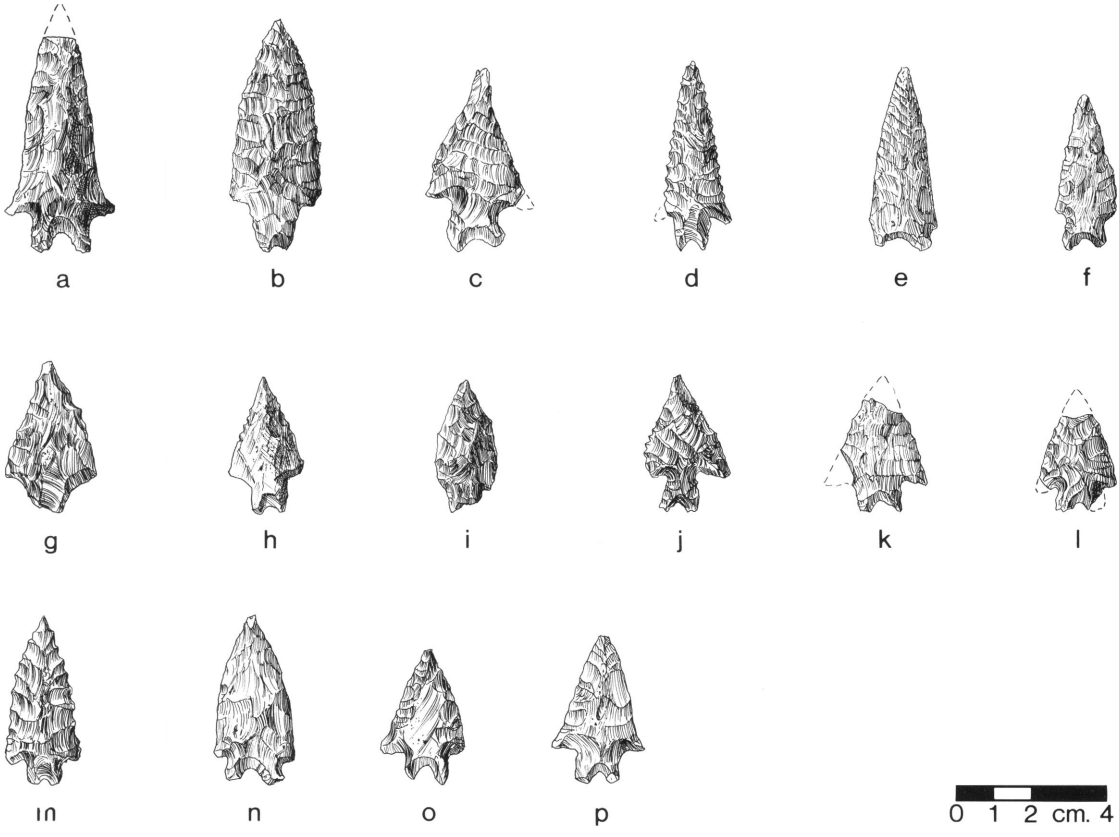

FIG. 50. Gatecliff Split Stem points from Surface and Stratum I deposits at Hidden Cave. a. 1-1B-883; b. 1-1B-878; c. 1-1B-130; d. 1-1B-249; e. 1-1B-59; f. 1-1B-131; g. 1-1B-145; h. 1-1B-259; i. 1-1B-958; j. 1-1B-128; k. 1-1B-76; l. 1-1B-884; m. 2/32584; n. 20.4/472; o. 2/32481; p. 20.4/909. Provenience: Surface, a–l; Stratum I, m–o; mixed Strata I/II, p.

ufacture of the basal notch. The base could have been reworked with some minor pressure retouch.

Several other fractures resulted in snapped tips. Some broken points have twisted end shock fractures, typically associated with drilling, but also commonly caused by an oblique impact. The remainder of the broken tips had lateral hinged or slightly stepped terminations, again typical of impact fractures.

PLAN VIEW: Blade shapes in our sample of Gatecliff Split Stem points vary: triangular, 34 percent; excurvate, eight percent; incurvate, 27 percent; incurvate-excurvate, 13 percent; ovate, 12 percent. Resharpening of tips resulted in the bulk of incurvate-excurvate forms; some points were repeatedly resharpened. Several points were resharpened into drills (as indicated by bilateral crushing and rounding on the tips). The proximal blade section, which forms the shoulder, tends to be straight, with a mean distal shoulder angle of 172° ± 22°.

Shoulders are formed by a combination of bilateral lever notches and pressure flaking. Fifty-one percent of the points were lever-notched; notches are bilateral on 26 percent of the points. The opposite face usually (62%) was pressure flaked. Occasionally, lever notches were deepened with overlying pressure flakes on the same face.

Shoulder notches are deep, forming right

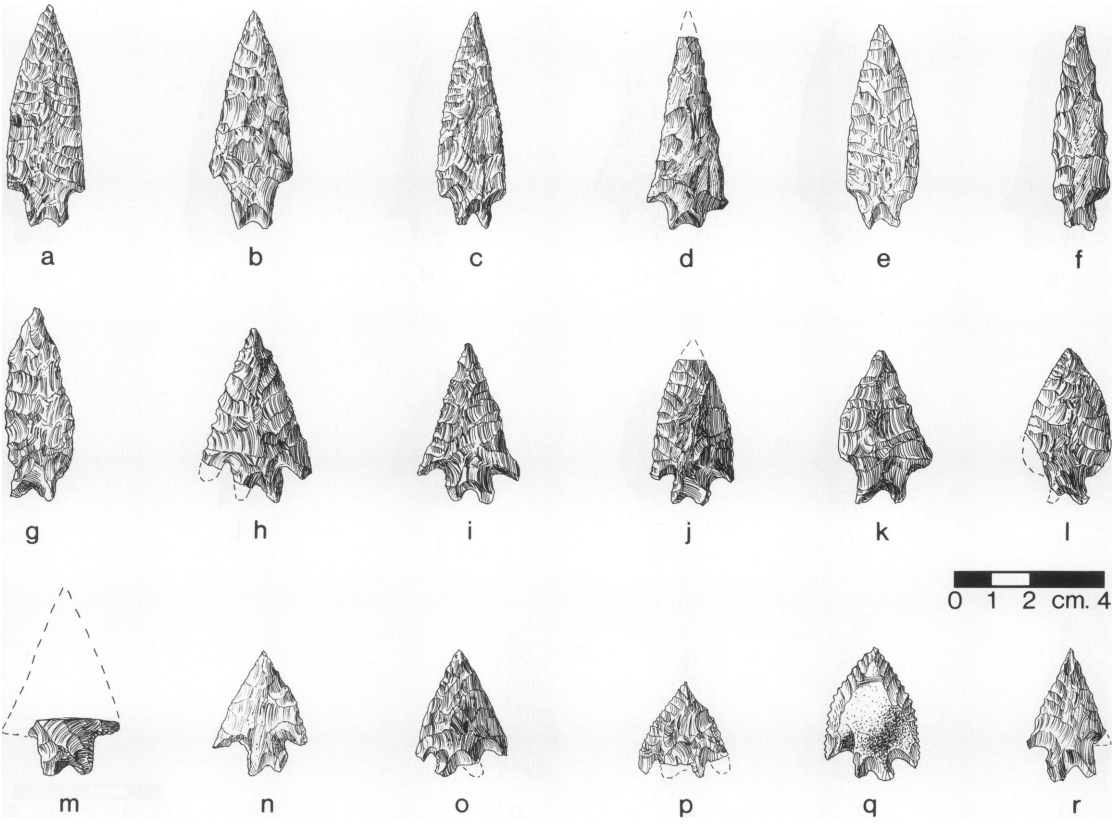

FIG. 51. Gatecliff Split Stem points from Stratum II (and II/III) at Hidden Cave. a. 1-1B-586; b. 1-1B-378; c. 1-1B-365; d. 1-1B-30; e. 1-1B-430; f. 1-1B-620; g. 1-1B-456; h. 2/32750; i. 1-1B-399; j. 20.4/572; k. 2/32660; l. 1-1B-706; m. 2/32463; n. 1-1B-32; o. 20.4/653; p. 2/32749; q. 20.4/1613; r. 20.4/1211.

Provenience: Stratum II, a–p; mixed Strata II/III, q–r.

angles between the blade and base ($\bar{X}$ NOI = 83°). Only 10 percent of the shoulders are ground. Initially, many shoulder concavities appeared to be purposely abraded, but replicative experiments suggest that the crushing probably resulted from notching the point, rather than intentional dulling.

Most Gatecliff Split Stem points have slightly constricted ($\bar{X}$ PSA = 89° ± 9°), deep concave ($\bar{X}$ BIR = 0.94 ± 0.02) bases. Basal concavities are generally (70%) formed by unifacial or bifacial lever notches, although 13 percent of the bases were formed by a combination of notching and vertical pressure flaking. About one-third of the concavities were produced solely by pressure flaking. Virtually none (2%) of the basal concavities are ground.

LONGITUDINAL SECTION: Plano-convex, 17 percent; lenticular, 14 percent; ovate, 9 percent; concavo-convex, 6 percent. Although the longitudinal profiles do not appear particularly definitive, well over 50 percent of the profiles were thickest over the shoulder.

CROSS SECTION: Plano-convex, 43 percent; ovate, 28 percent; lenticular, 15 percent; diamond, 6 percent; triangular, 2 percent. The cross and longitudinal sections probably resulted from the selection of wide side-struck or end-struck flakes. The bulb was retouched into the lower shoulder/base portion of the point, producing a low, thick basal section.

FLAKE SCAR PATTERN: Oblique parallel pressure, 37 percent; unpatterned pressure, 34 percent; double oblique, 14 percent; less regular parallel, 13 percent; parallel pressure, 5 percent. Flaking on 42 percent of the points meets or overlaps the midline. Four points are retouched with small serration notches along the margins.

FLAKE SCAR MORPHOLOGY: The bulk of flakes are parallel, thin, flat, and ribbon-like, with shallow bulbs and numerous compression rings. The widest flake scars are 2.5 mm. but usually cluster around 1.5 mm. Flake scars overlap (reducing their visible width and giving them their parallel appearance) thus creating even, thin margins on the blades.

COMMENTS: Thirty-four percent of the Gatecliff Split Stem points were resharpened several times. Artifacts 1-1B-130 and 20.3/9920 (figs. 50c, 54w) were resharpened into drills. Use wear patterns on these points consist of bilateral crushing and rounding on the margins near the tip; a twisted fracture, typical of drills, broke the tip on 1-1B-130.

Over half of the Gatecliff Split Stem points (66%) were used strictly as projectile points; 12 percent have cutting use wear, and another 4 percent were used as scrapers subsequent to use as projectile points.

Margins of 13 of the points are fresh, but four of those points had been resharpened, which probably obliterated any use wear on the margins.

Haft wear—dulled and polished areas on the face in line with the shoulders—was found in 42 percent of the split stem points. Artifact 20.4/1336 (fig. 54j) contains the remnants of pitch and sinew hafting material on the base and basal notch of its dorsal face.

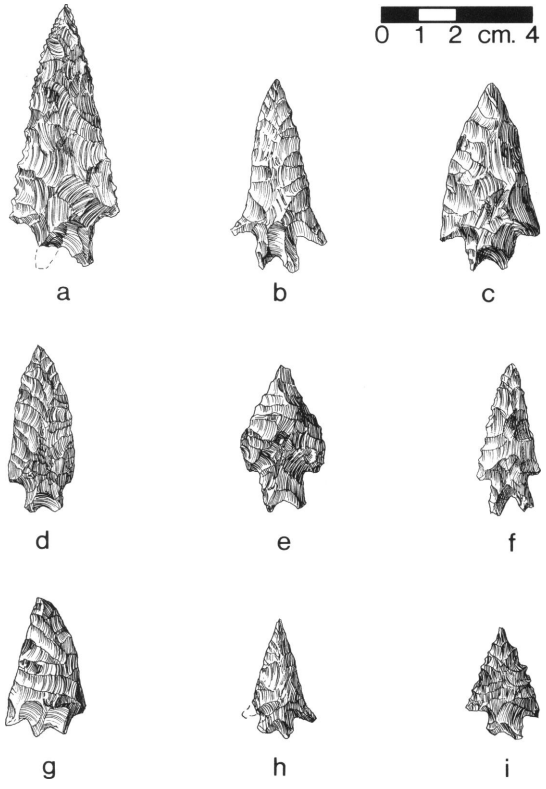

FIG. 52. Gatecliff Split Stem points from Stratum III (and Strata III/IV) at Hidden Cave. a. 20.4/1312; b. 20.4/831; c. 20.4/555; d. 20.4/1641; e. 20.4/1651; f. 20.4/1642; g. 20.4/1194; h. 20.4/828; i. 20.4/864.

Provenience: Stratum III, a–h; mixed Strata III/IV, i.

GATECLIFF CONTRACTING STEM (figs. 55–57)

NUMBER OF SPECIMENS: Sixty-three.

PROVENIENCE: Table 53. Surface, five; Stratum I, two; Strata I/II, three; Stratum II, 19; Strata II/III, one; Stratum III, three; Strata III/IV, four; Stratum IV, four; Strata IV/V, one; not correlated, 21.

MATERIALS: Obsidian, 41; chert, 14; quartzite, one; basalt, seven.

DIMENSIONS: Table 53.

CONDITION: Complete, 54; lateral fractures, nine.

A small part of the base of artifact 1-1B-273 (fig. 55p) was broken by a clean lateral fracture, either during manufacture, or after deposition in the cave. Impact probably caused the lateral lipped fractures on the other eight point tips.

Artifacts 20.4/696 and 20.4/704 (fig. 57q) are the midsection and base, respectively, of the same obsidian point. The midsection was found on the hill below Hidden Cave; the base was recovered inside the cave, in the backdirt of the 1940 trench. The specimen was broken into thirds, probably by impact fractures, although it is equally possible that

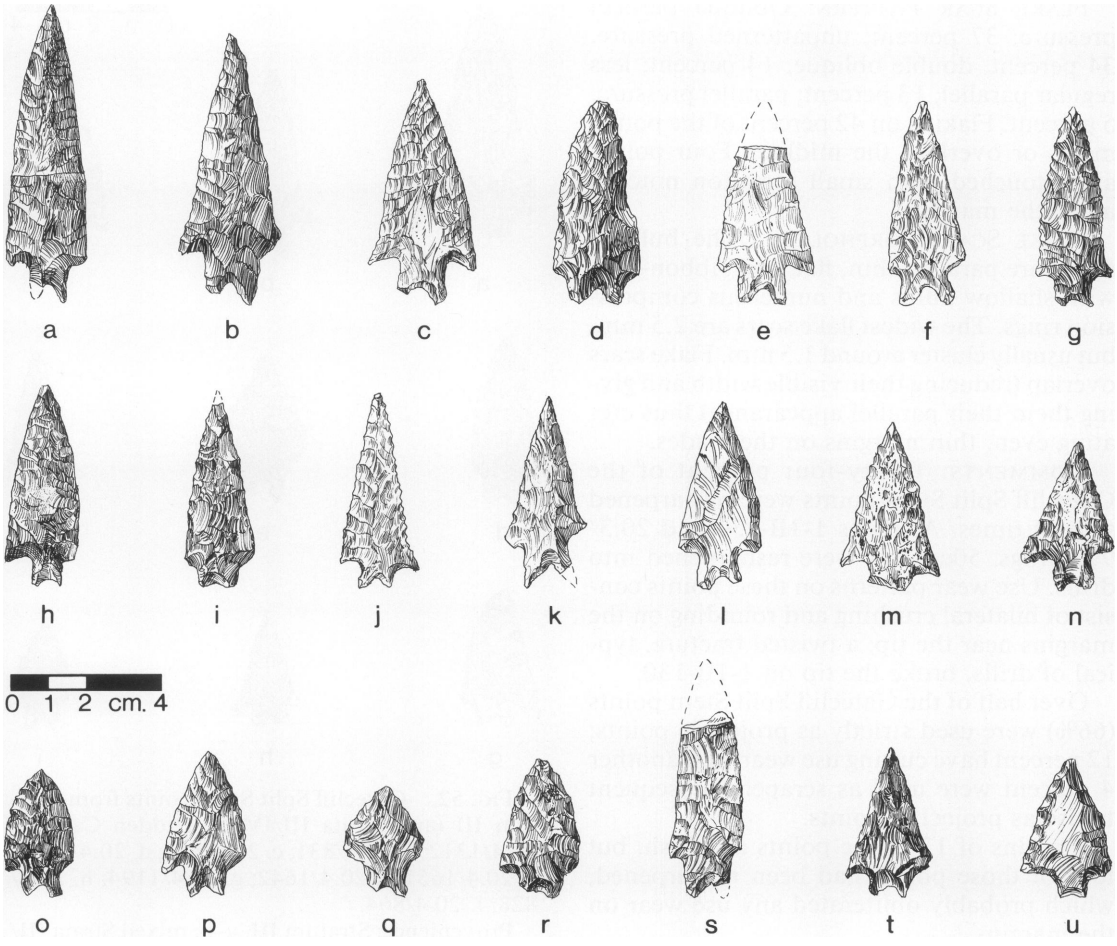

FIG. 53. Gatecliff Split Stem points from Strata IV–V at Hidden Cave. a. 20.4/833; b. 20.4/852; c. 20.4/936; d. 1-1B-307; e. 2/32761; f. 20.4/680; g. 2/32655; h. 20.4/1564; i. 20.4/1552; j. 1-1B-326; k. 20.4/1593; l. 20.4/678; m. 20.4/677; n. 20.4/1567; o. 20.4/1233; p. 20.4/681; q. 2/32442; r. 2/32403; s. 20.4/1253; t. 20.4/1708; u. 20.4/955.

Provenience: Stratum IV, a–q; mixed Strata IV/V, r; Stratum V, s–u.

the point broke after deposition, perhaps during Wheeler's excavation.

Artifact 20.4/865 is the tip of point 20.4/905 (fig. 56f). A diagonal lateral fracture broke the point; both parts were recovered in the same stratum from adjacent units. The point was probably broken after deposition.

PLAN VIEW: Triangular, 61 percent; incurvate, 16 percent; incurvate-excurvate, 11 percent; ovate, 11 percent. Some 34 percent of the points were resharpened, and 11 percent were resharpened repeatedly, as indicated by their incurvate-excurvate blades. Unlike the split stem points, few contracting stem points were resharpened into drills.

The shoulders are nearly straight ($\bar{X}$ DSA = 169° ± 25°). Both pressure lever notching and pressure flaking were used to manufacture most (34%) of the shoulders: 78 percent of the points have flaked shoulders, whereas 48 percent are notched. Many shoulders on lever notched points were deepened with overlying pressure flaking. Eleven points (17%) were ground inside the shoulder concavity. The shoulders generally form a right angle to the basal margin ($\bar{X}$ NOI = 92° ± 28°).

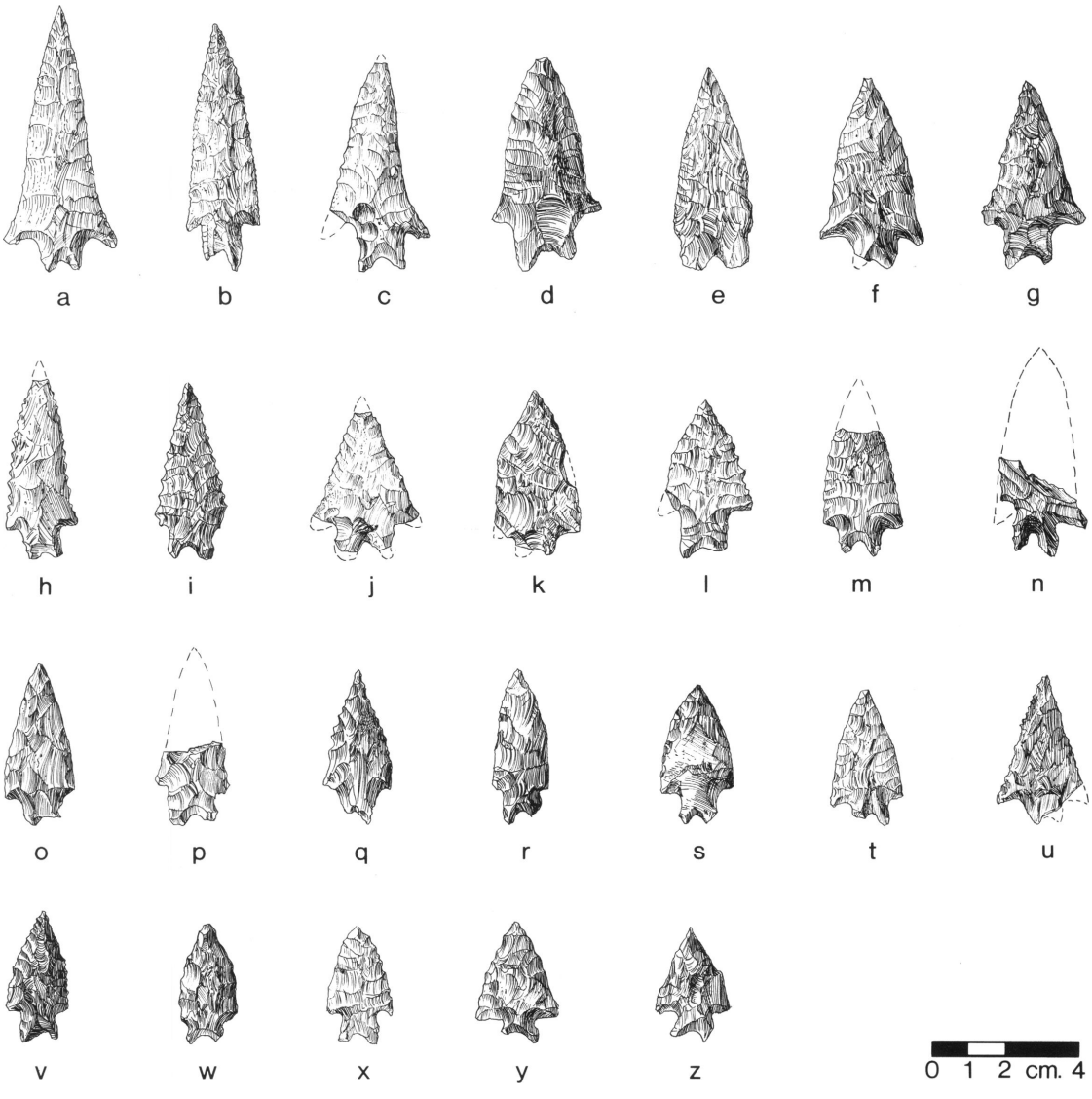

FIG. 54. Gatecliff Split Stem points from uncorrelated contexts (N.C.) at Hidden Cave. a. 1-1B-683; b. 2/21905; c. 2/21906; d. 2/32639; e. 20.3/9923; f. 20.4/396; g. 20.4/1618; h. 20.4/757; i. 2/32638; j. 20.4/1336; k. 20.3/9784; l. 20.4/756; m. 20.3/9921; n. 20.4/1619; o. 20.4/479; p. 20.4/371; q. 20.4/583; r. 20.4/386; s. 20.4/1429; t. 2/32506; u. 20.4/705; v. 20.4/1706; w. 20.3/9920; x. 20.4/960; y. 2/32509; z. 20.3/9929.

Provenience: Strata V–IX, a; not correlated (N.C.), b–z.

Gatecliff Contracting Stem points usually have convex (63%) or straight (25%) bases, but several (14%) bases are slightly concave ($\bar{X}$ BIR = 0.996 ± 0.001).

Basal margins (PSA ≤ 100°) vary from straight to contracting ($\bar{X}$ PSA = 77° ± 11°). One base has a shallow lever notch, but most bases (94%) were formed by oblique, bilateral pressure flaking. Eight bases were ground, usually to flatten the basal termination, but in rare instances to dull the basal margins.

LONGITUDINAL SECTION: Lenticular, 14

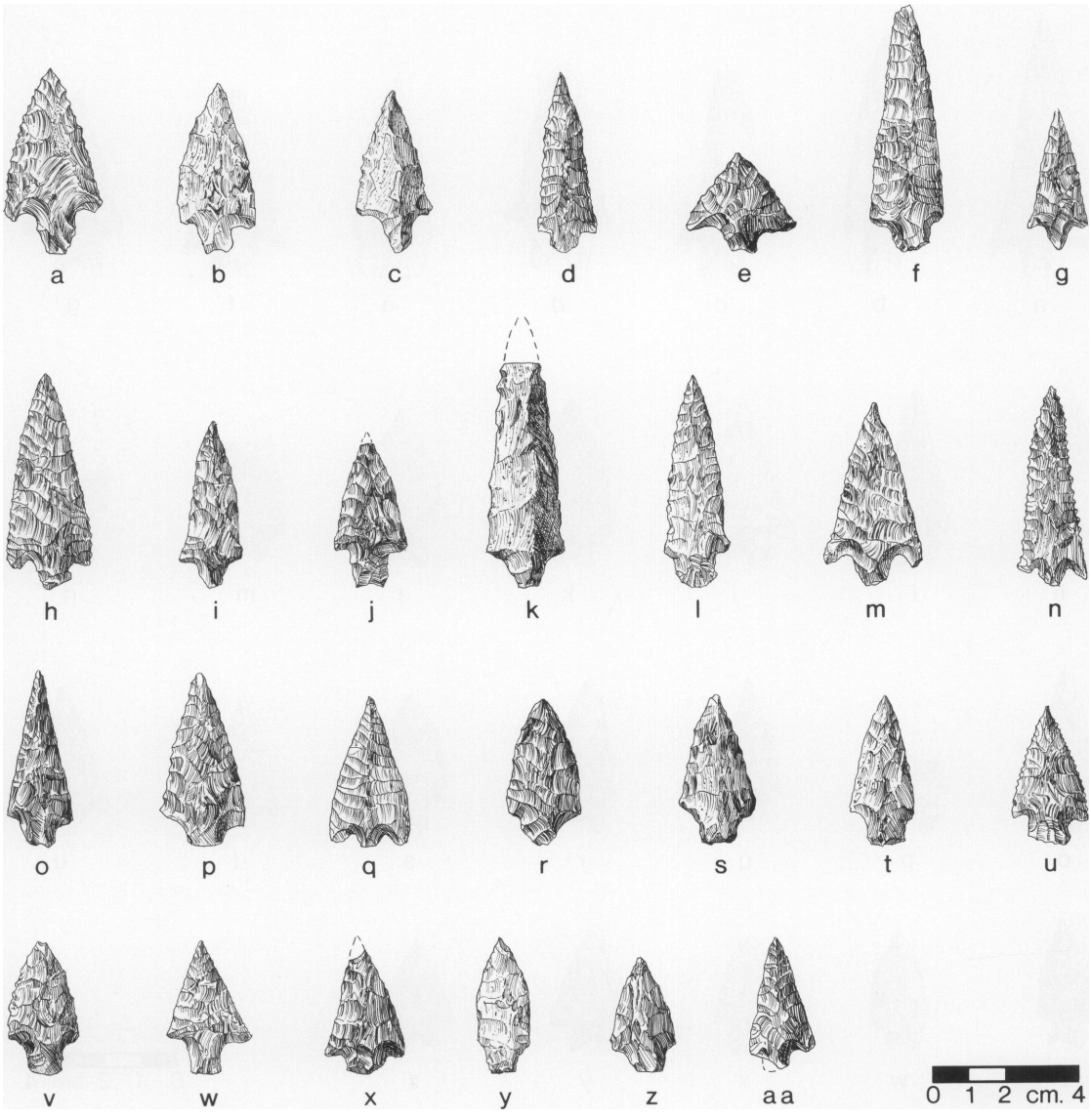

FIG. 55. Gatecliff Contracting Stem points from Surface to Stratum II at Hidden Cave. (Artifacts 1-1B-214a and 1-1B-214b [Stratum II], on display at the Nevada State Museum, are not illustrated.) a. 1-1B-874; b. 1-1B-243; c. 1-1B-244; d. 1-1B-873; e. 1-1B-880; f. 2/32357; g. 20.4/398; h. 2/32387; i. 20.4/1245; j. 20.4/1291; k. 2/32752; l. 1-1B-436; m. 20.4/1005; n. 20.4/549; o. 1-1B-366; p. 1-1B-273; q. 2/32485; r. 2/32747; s. 1-1B-342; t. 20.4/836; u. 2/32359; v. 1-1B-466; w. 1-1B-664; x. 20.4/434; y. 2/32725; z. 1-1B-429; aa. 1-1B-534.

Provenience: Surface, a–e; Stratum I, f, g; Strata I/II, h–j; Stratum II, k–aa.

percent; ovate, 13 percent; plano-convex, 13 percent; concavo-convex, 9 percent. Well over half the points are thickest over the shoulder.

CROSS SECTION: Plano-convex, 45 percent; lenticular, 27 percent; ovate, 20 percent; diamond, 3 percent. The cross and longitudinal sections appear to have resulted from the use of long, flat, end-struck flakes, with no pronounced bulb in the basal/shoulder area.

FLAKE SCAR PATTERN: Unpatterned, 39

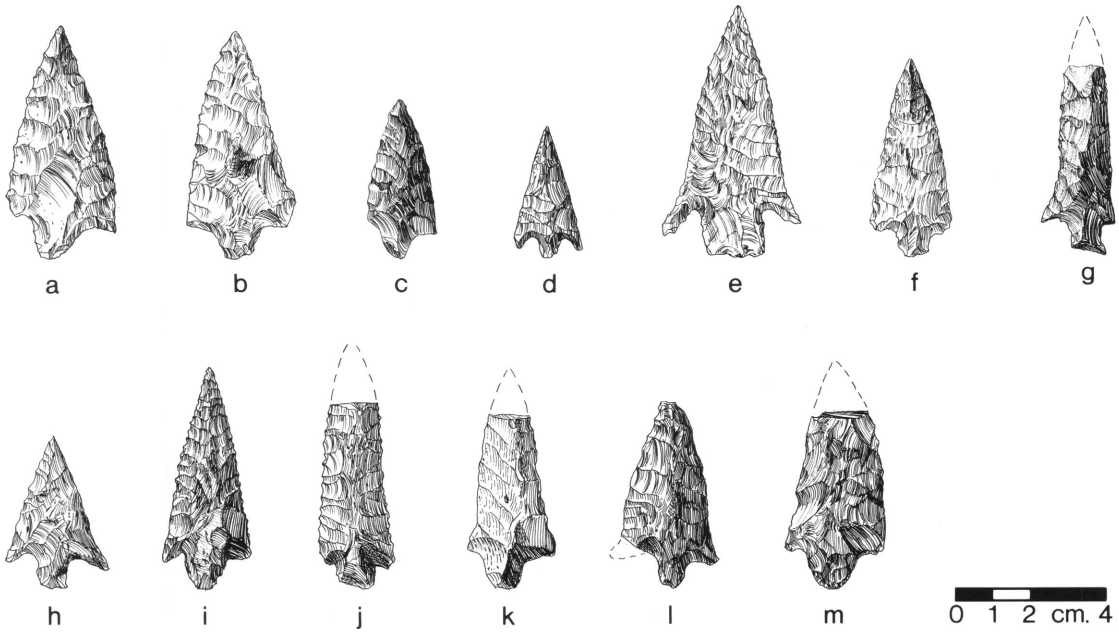

FIG. 56. Gatecliff Contracting Stem points from Strata III–V at Hidden Cave. a. 20.4/1623; b. 1-1B-865; c. 20.4/1648; d. 20.4/557; e. 20.4/863; f. 20.4/865 & 20.4/905; g. 20.4/1678; h. 20.4/441; i. 20.4/1689; j. 20.4/928; k. 20.4/856; l. 2/32758; m. 20.4/1501.
Provenience: Strata II/III, a; Stratum III, b–d; Strata III/IV, e–h; Stratum IV, i–l; Strata IV/V, m. (20.4/905 was found in Stratum III.)

percent; oblique parallel, 28 percent; less regular parallel, 23 percent; double oblique, 16 percent; parallel, 2 percent.[3] Twelve of the points were purposefully serrated; flaking was restricted to the margins on eight points—sufficient to shape, but not to thin the points. As mentioned above, 22 of the points were resharpened—typically through bilateral margin retouch with short overlapping pressure flakes. Most flakes met, or slightly overlapped, the midline.

FLAKE SCAR MORPHOLOGY: The parallel pressure flake scars were produced by well-controlled, thin, shallow, overlapping ribbon flakes. The flake margins are usually parallel or slightly constricting toward feathered terminations. Remnants of percussion scars from a previous production stage are visible on several points. Pressure flake widths range from over 4.0 mm. to 1.5 mm., generally clustering around 3.0 mm. Flake scars overlap, so flake widths are assumed to be somewhat larger than indicated above.

COMMENTS: Twenty-three percent of the Gatecliff Contracting Stem points have been resharpened, but only 20.4/1678 (fig. 56g) was resharpened repeatedly (bifacial resharpening on both margins).

Artifacts 1-1B-366 and 20.3/9922 (figs. 55o, 57b) were reworked into drills; 2/32641 (fig. 69c) is a drill which may once have been a Gatecliff Contracting Stem point. Drilling wear patterns on the tips of these points consist of bilateral crushing and rounding on the lateral margins. Clear evidence of haft wear is present on the AMNH specimen.

Most contracting stem points (74%) were used strictly as projectile points. But, in addition to the drills mentioned above, three were also used for cutting, and another three were also used for scraping.

Margins of six (10%) of the points are fresh; but two of these were resharpened, probably obliterating any previous signs of use wear.

Artifact 1-1B-466 (fig. 55v) is a curated point which was subjected to fairly severe

[3] Occasionally, projectile points are manufactured with more than one flaking pattern; both styles are included in this summary.

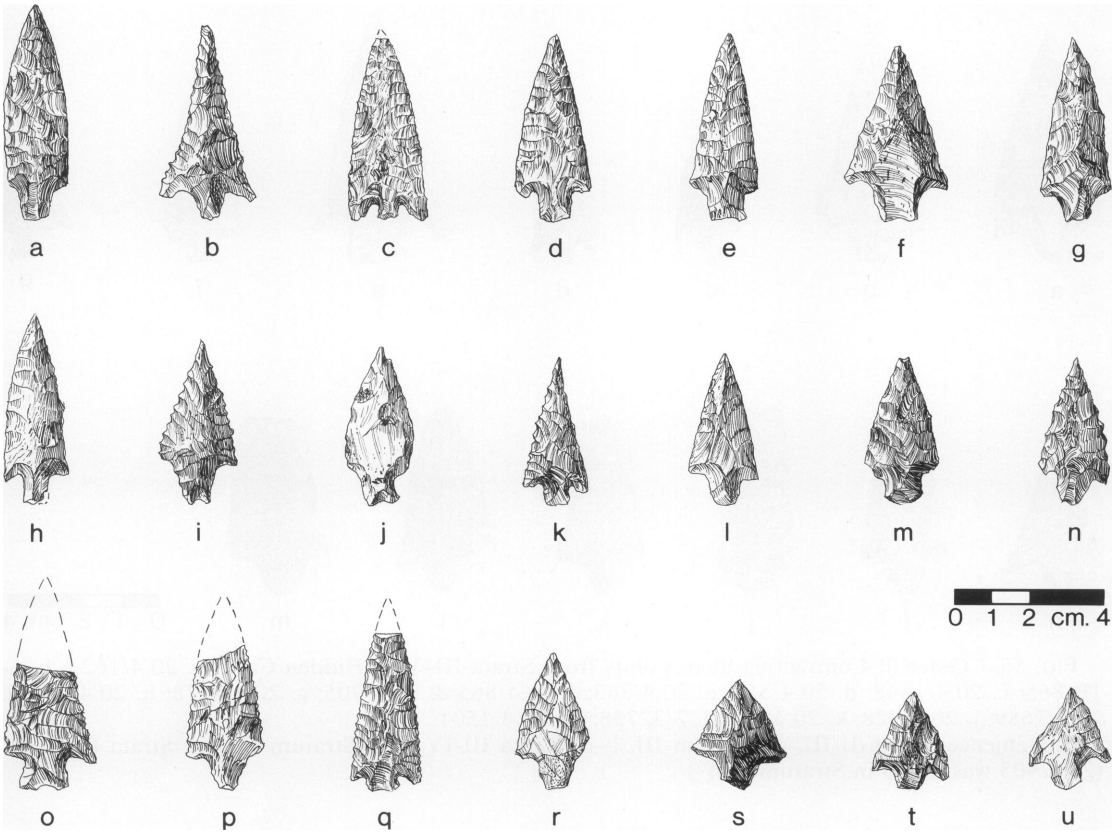

FIG. 57. Gatecliff Contracting Stem points from uncorrelated contexts (N.C.) at Hidden Cave. a. 20.4/685; b. 20.3/9922; c. 20.4/687; d. 20.4/686; e. 20.4/766; f. 20.4/958; g. 20.3/9926; h. 20.4/765; i. 20.4/1430; j. 20.4/959; k. 20.4/382; l. 20.4/767; m. 20.4/1431; n. 20.3/9925; o. 20.4/768; p. 20.4/480; q. 20.4/704 & 20.4/696; r. 20.4/507; s. 20.4/1523; t. 20.4/328; u. 20.4/658.

surface alteration (patination) prior to resharpening.

Haft wear was observed on one or both faces of 25 percent of the contracting stem points. The lateral margins on 2/32485 (fig. 55q) were dulled near the base—perhaps to protect the hafting material. A microscopic quantity of what appears to be pitch was observed inside the base and shoulder notches of 20.4/958 (fig. 57f).

GATECLIFF SERIES TECHNOLOGY: The Gatecliff series points recovered from Hidden Cave are all "finished"; therefore manufacturing data from these artifacts are limited. Nevertheless, one is struck by the homogeneity of these Gatecliff series points and the apparent consistency in production techniques. Both contracting and split stem forms are narrow triangular points with constricted bases. The points are relatively thick ($\bar{X} = 6.0 \pm 1.3$ mm.) and over twice as long as they are wide (length $\bar{X} = 45.8$ mm.; width $\bar{X} = 20.7$ mm.).

Gatecliff points are generally fashioned from long, thick flakes. Several remnant scars suggest initial bifacial reduction by direct percussion. Fine ribbon pressure flaking generally covers both faces, producing straight margins which are often serrated.

A modest replicative experiment was conducted by Steve Carter (a lithic technologist from Ramona, California) and the author to investigate possible production methods for Gatecliff series points. The results suggest that Gatecliff points were manufactured in at least five stages.

Stage I: A primary flake blank was struck

from the core by direct percussion using a semihard hammerstone (e.g., limestone or sandstone). Harder hammerstones (such as quartz or basalt) tend to shatter obsidian. Softer hammerstones produce large flakes on obsidian with fewer end shocks and less shatter. The flake blank, somewhat concavo-convex, was selected for adequate thickness and size (comparable metric attributes are discussed with the Humboldt Basal-notched bifaces).

Stage II: The knapper switched to an antler billet and began random bifacial percussion, creating a thin even surface that was prepared for pressure flaking. The resultant fine percussion blank was an elongated oval in plan view.

Stage III: This stage consisted of heavy pressure retouch with a large pressure flaker (an antler tine with a tip ground to a flat bevel). The objective was to orient the pressure ridges for stylized light pressure retouch.

Because the flint knapper was attempting to replicate an oblique parallel pressure flaked point, heavy retouch was initiated at the tip, overlapping toward the base. This retouch created large oblique parallel scars that terminated beyond the midline on the dorsal face of the biface. Margins were then crushed, using the side of the pressure flaker. The same process was repeated on the ventral face; the flakes carried across the midline, removing the previously unflaked portion of the dorsal face.

This stage produced a pressure flaked blank with smooth, ovate margins. Margins were crushed again with the flaker and abraded more severely with sandstone.

Stage IV: A narrow pressure flaker (a sharply pointed antler tine) was used for final retouch. Once again, the scars were initiated at the tip on the dorsal face, and proceeded toward the base. The ventral face was similarly flaked. Irregular and unflaked surfaces were quickly retouched, producing a triangular pressure flaked blank.

Two or three rows of light pressure flaking were initiated on each face, based on the thickness and regularity of the blank. This stage produced an even, straight, sharp edge for efficient penetration.

Stage V: The final stage required another tool change to an extremely narrow antler flaker (the width of a small nail) to produce the shoulders and base. Rows of bifacial oblique pressure flakes were removed from the biface approximately 10 mm. from the basal ends running toward the opposite tip margin, resulting in curved shoulders and a constricted base. The base had been thinned previously by oblique pressure; the basal concavity was produced by crushing out the center of the base and running narrow vertical thinning flakes up toward the tip. One shoulder was initiated by a unifacial lever notch, but because the knapper felt this technique was not easily controllable, he relied instead on carefully applied pressure retouch to manufacture the other shoulder.

Hattori (1982, p. 172) has noted similar manufacturing details on finished and preform specimens of Gatecliff points from Kramer Cave.

Elko Series

Elko series points are generally restricted to the upper levels of Hidden Cave, although a few isolates were recovered in Strata IV and V.

Elko corner-notched (fig. 58)

Number of Specimens: Seven.

Provenience: Table 53.

Materials: Chert, four; quartzite, one; obsidian, two.

Dimensions: Table 53.

Condition: Complete, six; tip broken, one.

A lateral fracture on artifact 2/32607 (fig. 58e) removed the tip; this fracture was apparently precipitated by an incipient hertzian cone (a remnant survived on the fracture surface) created during a previous manufacturing stage. The fracture scar produced by the errant flake is retained on the left dorsal margin at the point of impact.

Plan View: Most blade elements (58%) are triangular to excurvate. Over 80 percent of the distal shoulder angles are greater than 160°; in other words, the shoulders are fairly straight.

Most of the bases (86%) are concave, with a mean basal indention ratio of 0.97 ± 0.0017; one basal concavity is ground.

Shoulders on most of the points (86%) are formed by lever notches, varying from uni-

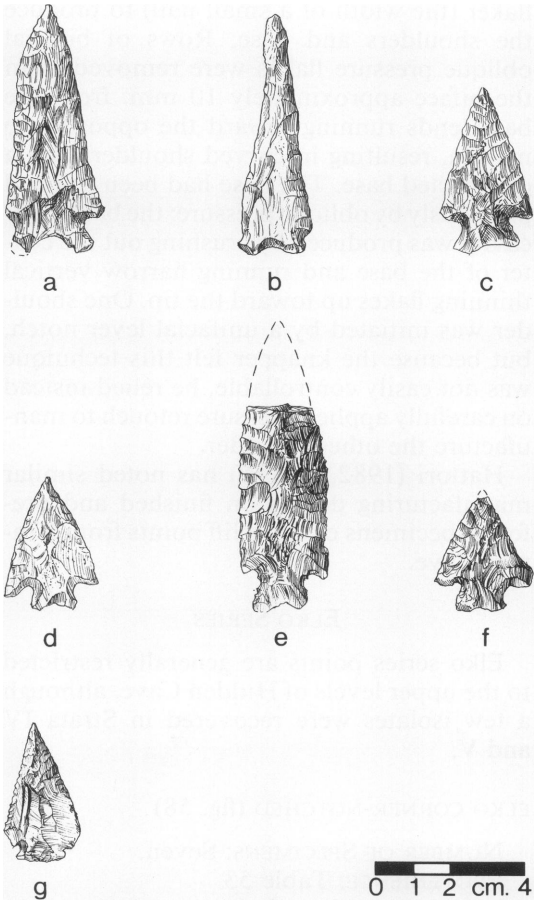

FIG. 58. Elko Corner-notched points from Hidden Cave. a. 1-1B-28; b. 2/32440; c. 20.4/435; d. 2/32526; e. 2/32607; f. 20.3/9924; g. 20.4/1546.

Provenience: Surface, a; Stratum II, b–d; Stratum V, e; not correlated (N.C.), f–g.

facial and bilateral to bifacial placement. The shoulder concavity is crushed on 2/32607 (fig. 58e). The notch opening indices are moderate, clustering at 50°.

LONGITUDINAL SECTION: Most are ovate, with the position of maximum thickness over the shoulder.

CROSS SECTION: No distinctive patterns emerge.

FLAKE SCAR PATTERN: Finish flaking is equally divided between unpatterned and less regular parallel pressure.

FLAKE SCAR MORPHOLOGY: Flaking tends to be wide, with the largest flake scars approaching 6.0 mm. or wider. Flakes tend to overlap the midline, although retouch is restricted to short pressure flakes immediately adjacent to the margins on several specimens.

COMMENTS: Hidden Cave Elko Corner-notched points are manufactured from relatively poor quality materials, including coarse-grained chert and quartzite (probably local materials). This distinguishes these points from most of the rest of the Hidden Cave projectile points. One artifact (1-1B-28) may have been heat treated to facilitate flaking, but determination of heat treatment is equivocal without replicative experimentation.

Manufacturing data are minimal. These Elko points do seem to have been manufactured with relatively little consistency or care in comparison with other points from the cave.

Several points were resharpened; 2/32440 (fig. 58b) appears to have been resharpened several times and may have been reworked into a drill.

Projectile point wear was observed on only two of the seven Elko Corner-notched points. It should be noted, however, that wear patterns are less evident on chert than on obsidian, and the majority of Elko points are made of chert. A similar shadowing effect may account for the relative absence of observable haft wear. Artifact 1-1B-28 (fig. 58a) has high point polish on the dorsal face, perhaps the amorphous remnants of haft wear.

ELKO EARED (fig. 59)

NUMBER OF SPECIMENS: Six.

PROVENIENCE: Table 53.

MATERIALS: Chert, one; obsidian, five.

DIMENSIONS: Table 53.

CONDITION: Complete, six.

PLAN VIEW: Elko Eared blade elements are generally triangular (34%) or incurvate (34%); one specimen is ovate. The shoulders tend to be straight, with distal shoulder angles ranging from 140° to 200°. Notch opening indices vary from 20° to 90°, with a mean of 52° ± 25°.

Basal margins tend to expand slightly ($\bar{X}$ PSA = 112° ± 4°) and have deep concavities ($\bar{X}$ BIR = 0.91 ± 0.002) with eared projections. Half of the basal concavities are formed

by lever notch flakes; the other half are shaped by vertical pressure, and none are ground. Most shoulders (83%) are formed by pressure flakes rather than short notches.

LONGITUDINAL SECTION: The profiles are usually ovate, with maximum thickness over the shoulder.

CROSS SECTION: Half of the thick cross sections are plano-convex, the other half are ovate.

FLAKE SCAR PATTERN: Unpatterned pressure, three; oblique, three. Most flake scars terminate short of the midline.

FLAKE SCAR MORPHOLOGY: Flake scars are long, overlapping, and ribbon-like. The pressure tips were of moderate width, producing flake scars about 3.5 mm. or less.

COMMENTS: Most Elko Eared points (66%) were resharpened, but repeated resharpening was absent. Artifact 1-1B-129 (fig. 59a) had been reworked bilaterally into a drill.

Five Elko Eared points were used as projectile points, and haft wear was observed on three of these. One margin of 20.3/9777 (fig. 59d) is heavily crushed, and this artifact may have been used as a knife subsequent to its use as a projectile point.

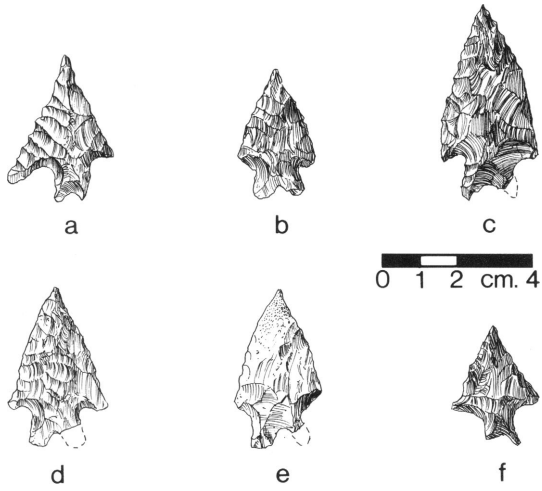

FIG. 59. Elko Eared points from Hidden Cave. a. 1-1B-129; b. 2/32629; c. 20.4/1238; d. 20.3/9777; e. 20.4/597; f. 20.4/329.

Provenience: Surface, a; Strata I/II, b; Stratum IV, c; not correlated (N.C.), d–f.

ROSEGATE SERIES

NUMBER OF SPECIMENS: Eight (fig. 60).

PROVENIENCE: Table 53.

Rosegate points occur only in the top strata of Hidden Cave (Strata I and II).

MATERIALS: Chert, three; obsidian, five.

DIMENSIONS: Table 53.

CONDITION: Complete, seven; tip broken, one.

The broken Rosegate point resulted from an incipient hertzian cone, which produced a lateral fracture.

PLAN VIEW: Blade elements tend (50%) to be triangular; those that are not are equally divided between excurvate and incurvate blades. The proximal blade elements which form the shoulder tend to slope downward ($\bar{X}$ DSA = 121° ± 21°). Ninety percent of the points have notch opening indices of less than 40°. Most shoulders (68%) are formed by lever notch flakes, and the remainder result from bifacial pressure flakes.

Rosegate bases are thinned by vertical thinning flakes. Approximately 30 percent of the bases are straight, 25 percent are convex, and 38 percent are slightly concave ($\bar{X}$ BIR = 0.99 ± 0.01). The basal margins are straight to slightly expanding ($\bar{X}$ PSA = 101° ± 7°).

LONGITUDINAL SECTION: Profiles range from concavo-convex or (biplano) lenticular (25%) to slightly plano-convex (13%). The position of maximum thickness is slightly above the shoulder.

CROSS SECTION: Half of the Rosegate points have plano-convex cross sections; several (38%) are lenticular (biplano), and only one is biconvex. The longitudinal and cross sections probably reflect the selection of thin, moderately curved primary flakes for the manufacture of these points.

FLAKE SCAR PATTERN: Unpatterned pressure predominates (68%); 25 percent are finished with oblique parallel flaking, and one artifact has chevron or double oblique flaking.

FLAKE SCAR MORPHOLOGY: The oblique flaking is generally thin, meeting at the midline. Flaking is restricted to the margins on several specimens and appears to have been a quick attempt to shape an unusually thin flake.

COMMENTS: Few details of the manufacturing process were retained on the Rosegate

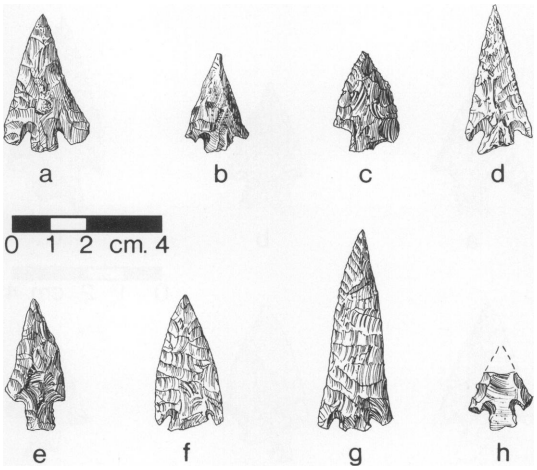

FIG. 60. Rosegate series points from Hidden Cave. a. 1-1B-872; b. 1-1B-114; c. 1-1B-890; d. 20.4/1182; e. 2/32557; f. 2/32640; g. 20.3/9782; h. 20.3/9930.

Provenience: Surface, a–c; Stratum I, d; Stratum II, e, f; not correlated (N.C.), g–h.

points. One specimen seems to have been made from an end struck flake. Another example was probably manufactured from a side struck flake that required relatively minor modification.

The relative position of flake scars on specimens 20.3/9782 and 20.4/1182 (fig. 60g, d) indicates that the lateral margins were flaked before the base, which was then thinned by small vertical pressure flakes. Shoulder notches cross-cut the margin and basal flaking; this suggests that shoulders were manufactured in the final flaking stage.

Although Rosegate points were considerably scarcer than Elko points at Hidden Cave, general patterns of material choice and flaking style are similar. Both series are occasionally flaked into a diagonal parallel pattern on the dorsal face. These flakes are usually overlaid by vertical basal thinning or notch flakes, partially obliterated by subsequent shoulder flaking. The flat or concave sections of the face are typically unretouched. Bilateral resharpening predominates, although there is considerable variation in the positioning of the resharpening flakes. In any case, the small sample size of these series tends to amplify the apparent variability.

Rosegate series use wear is restricted to light bifacial dulling on the serrated margins—indicative of projectile point wear.

HUMBOLDT BASAL-NOTCHED

Humboldt Basal-notched bifaces are not considered in the Monitor Valley typology (Thomas, 1981a). The category is based on a W_B/W_M ratio of 1.0 which exceeds the Humboldt series ratio of ≤ 0.90. We think that Humboldt Basal-notched bifaces deserve separate typological status, and the Hidden Cave series assists in this redefinition.

Humboldt Basal-notched bifaces can be defined as large (weight > 3.0 grams, length ≥ 30.0 mm., thickness ≥ 4.0 mm.), triangular ($W_B/W_M > 0.95$, MWP $\bar{X} < 10\%$) bifaces, with distinctly concave bases (BIR ≤ 0.96).

Distribution of Humboldt Basal-notched bifaces is restricted to Strata I and II in Hidden Cave. Two hafted bifaces, probably Humboldt Basal-notched, were also found (as discussed below).

Humboldt Basal-notched bifaces are the most homogeneous lithic category found at Hidden Cave; this homogeneity is reflected in outline, metric attributes, wear pattern, stratigraphic association, raw material, and even the source of that raw material (see chap. 23, this volume).

HUMBOLDT BASAL-NOTCHED BIFACES (fig. 61)

NUMBER OF SPECIMENS: Nineteen.

MATERIAL: All obsidian.

PROVENIENCE: Table 53. Surface, one; Stratum I, two; Strata I/II, one; Stratum II, 13; not correlated, two.

DIMENSIONS: Table 53.

CONDITION: Complete, nine; lateral fracture tip, seven; lateral fracture midsection, one; lateral fracture base, one; perverse fracture base, one.

PLAN VIEW: Humboldt Basal-notched bifaces have distinctly triangular outlines ($W_B/W_M \bar{X} = 1.0$), which range from wide equilateral, to shallow isosceles triangles.

The deep concave bases (BIR $\bar{X} = 0.91 \pm$

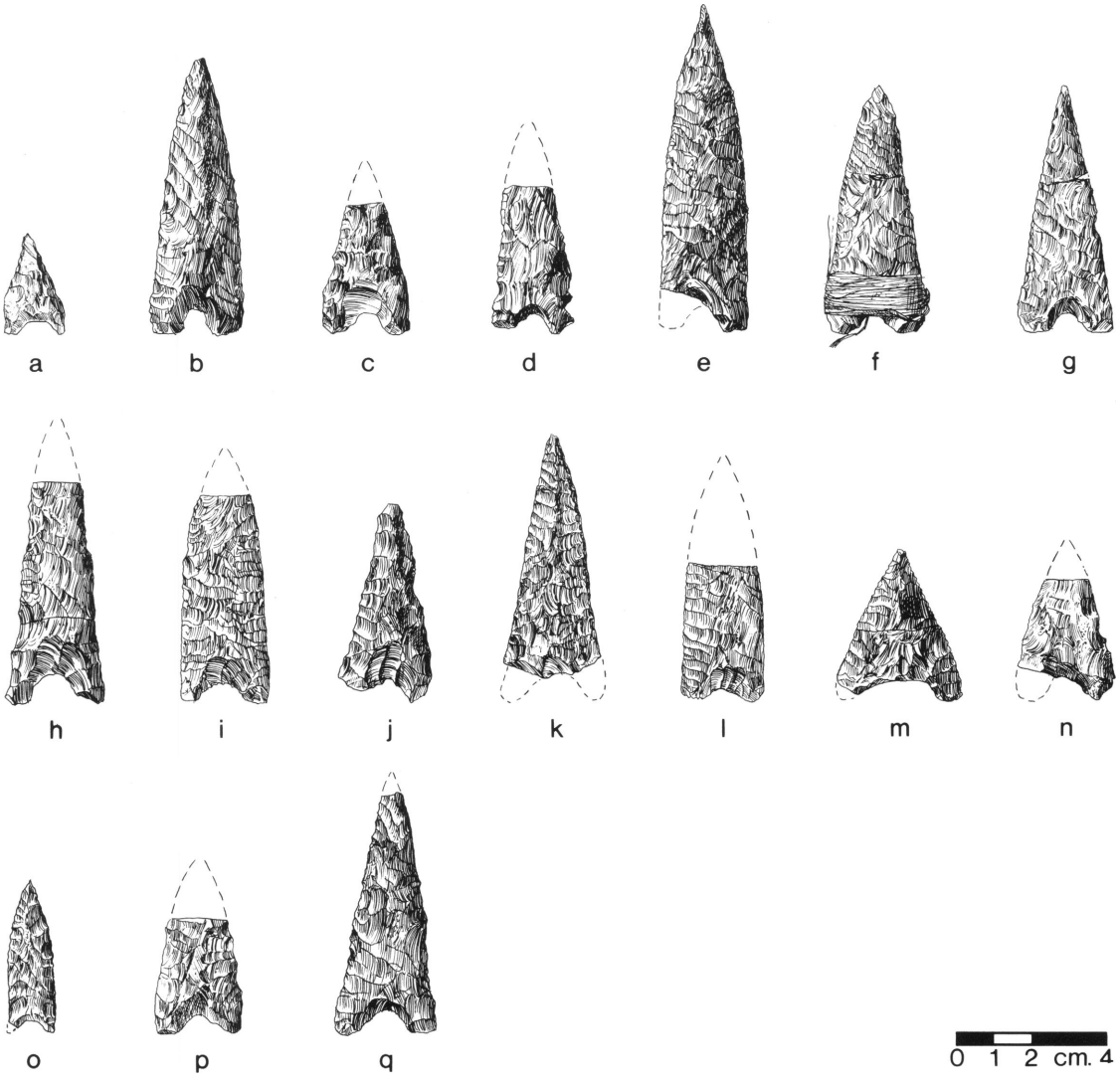

FIG. 61. Humboldt Basal-notched bifaces from Hidden Cave. (Artifact 1-1B-296 [Stratum II] is on display at the Nevada State Museum and is not illustrated.) a. 1-1B-885; b. 20.4/813; c. 20.4/908; d. 20.4/985; e. 2/32734; f. 2/32611; g. 1-1B-286; h. 1-1B-216; i. 1-1B-313; j. 2/32751; k. 20.4/1201; l. 2/32408; m. 20.4/827; n. 1-1B-341; o. 1-1B-615; p. 1-1B-290; q. 20.3/9775.
Provenience: Surface, a; Stratum I, b, d; Strata I/II, c; Stratum II, e–p; not correlated (N.C.), q.

0.001) are made by unifacial basal thinning flakes that typically co-occur with unifacial notch flakes on the reverse face. Basal bifacial thinning flakes also form the bases of several of the bifaces. Two specimens have ground basal concavities and nine of the bifaces have ground basal margins.

LONGITUDINAL SECTION: Twelve bifaces are lenticular, thickest over the base; five others are ovate, with maximum thickness at the base; two bifaces are thickest across the midpoint.

CROSS SECTION: Cross sections intergrade from ovate to lenticular; the final form is dependent on the extent of edge grinding and/or resharpening on the artifact.

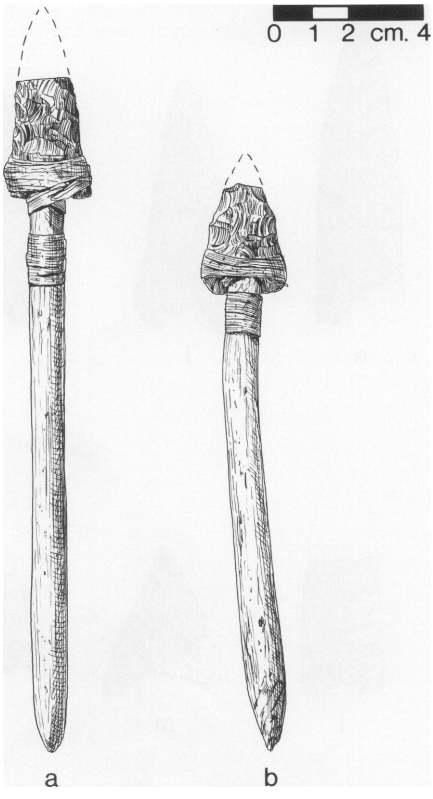

FIG. 62. Hafted bifaces from Hidden Cave (probably Humboldt Basal-notched). a. 20.3/9933; b. 1-1B-7.
Provenience: not correlated (N.C.).

FLAKE SCAR PATTERN: Oblique parallel, 14; less regular parallel, two; unpatterned, two; double oblique, one.

FLAKE SCAR MORPHOLOGY: Most flake terminations are finely feathered, with parallel to slightly contracting overlapping margins.

HAFTED HUMBOLDT BASAL-NOTCHED BIFACES

Two Humboldt Basal-notched bifaces are wrapped with sinew around their basal margins. Artifact 1-1B-7 is still in the haft (fig. 62b), and it appears that the other, 2/32611, (fig. 61f) was once hafted in a similar fashion. Artifact 20.3/9933 (fig. 62a) is a hafted midsection which was once probably part of a Humboldt Basal-notched biface.

Basal margin grinding on nine unhafted Humboldt Basal-notched bifaces from Hidden Cave corresponds to the sinew position on the two hafted Humboldt points, suggesting that basal grinding was a dulling technique to protect the sinew lashing. Hattori (1982, pp. 177–181, fig. 44) reports similarly lashed points from a twined cache bag excavated at Shinners Site C near Winnemucca Lake, Nevada.

Artifact 1-1B-7 is lashed on the dorsal surface at the juncture of the biface and the foreshaft. The sinew strand is wrapped diagonally across the face of the biface and then overwrapped, covering the diagonal strand and extending down onto the foreshaft. The wrap reverses direction on the foreshaft to cover the initial wrap and secure the haft. Unlike previously reported hafted bifaces (Hester, 1970) no pitch or other resinous substances were used to secure the haft.

The haft, probably made of *Sarcobatus vermiculatus,* was smoothed and straightened by longitudinal whittling. The pointed end was formed by diagonal cuts and surface smoothing; the U-shaped notch was probably cut with a flake. Sollberger's (1969) comparison of the efficiency of various tool types suggests that unmodified flakes serve as an efficient tool for notching shafts.

Artifact 20.3/9933 (fig. 62a) is an oblique pressure flaked obsidian biface midsection, probably from a Gatecliff or Humboldt Basal-notched point. The midsection is hafted without a base; the tip, which is now missing, probably broke after hafting.

This midsection is hafted into a notched *Sarcobatus* foreshaft that was pared longitudinally, leaving striations along the length of the shaft. The pointed end was formed by diagonal cuts into a smooth taper similar to the foreshaft of the hafted Humboldt Basal-notched point. The sinew lashing which fastens the midsection to the foreshaft is also similar.

Both hafted bifaces are attached to large foreshafts, which could have served as knife handles. Observation of use wear traces on 1-1B-7 may be somewhat misleading because the point was resharpened, effectively obliterating most of the previous use wear. But microscopic examination (7–400×) revealed small oblique striations on the flake ridges. These striations and light nibbling on the margins and near the tip probably resulted

from short-term cutting of soft material such as meat. Coincidentally, Hester (1970, p. 46) reports lighter use wear on hafted than unhafted bifaces recovered from Lahontan area caves.

COMMENTS: Sixty-six percent of the Humboldt Basal-notched bifaces were resharpened, but only one biface (20.3/9775, fig. 61q) was unused after resharpening. The hafted Humboldt biface (1-1B-7) may have been repeatedly resharpened, but none of the bifaces were reworked into other tool categories.

Wear patterns—bifacially crushed margins and striations running parallel or slightly oblique to the margins—indicate that 73 percent of the basal-notched bifaces were used for cutting; at the most, 13 percent may have been used as projectile points. But the light bifacial dulling observed on the "projectile points" could have resulted from either short-term soft cutting or from projectile point use, since both functions can leave similar wear patterns.

The distinct haft wear on 83 percent of the bifaces suggest that most were probably hafted and used as knives. In addition to some polish on the faces near the base, nine basal-notched bifaces (1-1B-286, fig. 61g; 1-1B-313, fig. 61i; 1-1B-615, fig. 61o; 2/32408, fig. 61l; 2/32734, fig. 61e; 20.4/813, fig. 61b; 20.4/908, fig. 61c; 20.4/985, fig. 61d; 20.4/1201, fig. 61k) have ground basal margins, probably to protect the sinew hafting.

MANUFACTURING DATA: Replicative manufacturing experiments suggest that these bifaces were made from medium-sized end-struck or side-struck flakes. The primary flake blank used in our experiments appears adequate, as the metric attributes of the experimental finished point compare favorably with the attributes of the archaeological specimens (table 51).

In this experiment, the knapper selected a medium-sized black obsidian cobble (approximately 20 cm. diameter) from near Goose Lake, California. Although all but one of the Hidden Cave specimens are made of Mono Basin obsidian (Hughes, chap. 23, this volume), this material approximated that of the Hidden Cave specimens in both color and clarity.

The cobble was trimmed to remove the cortex and set a platform. A primary flake blank was struck from the core and was subsequently trimmed with a medium-hard sandstone hammerstone by brushing the edges to remove the thinnest portions of the flake.

TABLE 51
Metric Attributes of Experimental Artifacts

Artifact Type	Length (mm.)	Width (mm.)	Thickness (mm.)
Rough percussion blank	81.0	56.3	10.0
Rough wide pressure flaked biface	72.5	43.7	8.3
Patterned wide pressure flaked biface	71.8	34.5	7.5
Fine thin pressure flaked biface	71.6	31.4	6.0
Even ribbon flaked biface	71.4	29.6	5.8
Experimental Humboldt Basal-notched biface	70.6	28.0	5.7
Hidden Cave Humboldt Basal-notched bifaces (mean values)	62.0 ±14	23.0 ±4	5.6 ±0.9

In the first reduction stage the bulb was removed with blows from an antler billet directed from the flake margin obliquely toward the bulb. This stage produced a rough percussion blank (table 51).

During the second stage, the knapper switched to a large antler pressure flaker. The objective was to remove thick areas of the biface and trim the edges in preparation for stylized thinning. Thinning was accomplished by heavy collateral pressure flaking. The finished point would have an oblique pattern, but collateral flaking was used initially because it was an expedient thinning pattern.

Stage II produced a triangular but rough and wide pressure flaked biface, widest at the base with fairly straight margins (table 51). Heavy pressure flaking served to thin the biface, although the amount of margin removed with each flake considerably reduced its width.

Margins were then crushed and abraded, and using the same flaker as in the previous stage, large oblique pressure flakes were removed from both faces. Once again, the width of the biface changed most, with relatively little modification to the length (table 51).

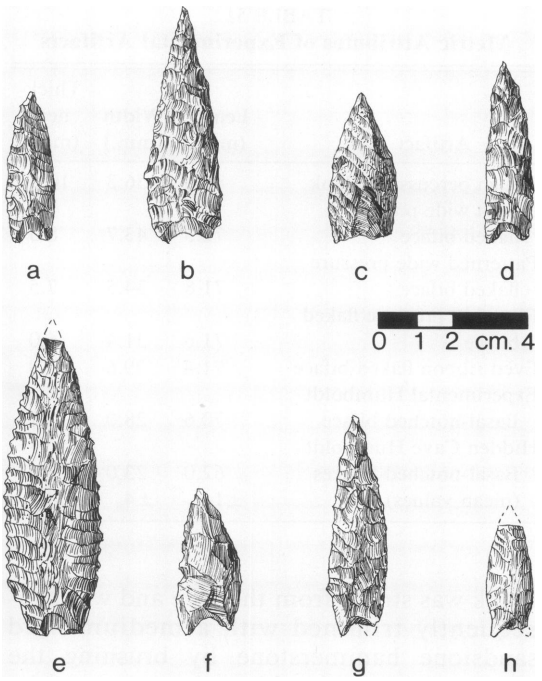

FIG. 63. Humboldt series points from Hidden Cave. a. 1-1B-871; b. 2/32570; c. 20.4/1679; d. 20.4/939; e. 2/32696; f. 2/32697; g. 20.3/9919; h. 20.4/584.

Provenience: Surface, a; Stratum II, b; Strata III/IV, c, d; Strata IX/X, e, f; not correlated (N.C.), g, h.

The next stage was directed toward producing thin ribbon flaking with a small antler tine. The slender tine thinned the biface without significantly reducing its width (table 51). A fine pressure flaked biface with narrow oblique ribbon flaking was produced.

Margins were still slightly uneven, so another row of oblique ribbon pressure flaking was applied. The biface was now the desired outline (excluding the basal indention), with smooth regular margins.

Then a longitudinal pressure flake was removed from each face of the thin basal section, resulting in a narrow "notched" basal concavity. The concavity was further deepened by smaller pressure flakes, covering the top and sides of the concavity. No actual lever notch flakes were used to manufacture the basal concavity.

A *t*-test shows at the 0.01 level (df = 18) that for all attributes, the finished experimental biface does not differ from the Hidden Cave sample of Humboldt Basal-notched bifaces (Thomas, 1976, pp. 240–241). In other words, we think that the flintknapping experiment may approximate the prehistoric situation rather well.

A somewhat truncated version of this production method was reported for five Humboldt Basal-notched bifaces associated with a burial in the Amargosa Desert (Muto, Mehringer, and Warren, 1976, pp. 270–272). Muto's analysis lends support to our experiments because our flint knapper had no previous knowledge of the Muto report. He essentially reinvented a technique that corresponds precisely with Muto's description.

HUMBOLDT SERIES

As defined in the Monitor Valley typology (Thomas, 1981a, pp. 25–26), the Humboldt series is differentiated from Humboldt Basal-notched bifaces by a higher maximum width position (Humboldt series MWP $\bar{X} = 35\%$; Humboldt Basal-notched MWP $\bar{X} = 0\%$), and lower basal width/maximum width ratio (Humboldt series $W_B/W_M \leq 0.90$; Humboldt Basal-notched $W_B/W_M = 1.0$). The Humboldt series is further differentiated from the Cottonwood series by its greater length, weight, and thickness.

Seventeen additional concave base points from Hidden Cave fall outside the ranges of both Humboldt series points and Humboldt Basal-notched bifaces. We discuss this "residual concave base" category below.

HUMBOLDT SERIES POINTS (fig. 63)

NUMBER OF SPECIMENS: Eight.

MATERIALS: Obsidian, six; chert, one; basalt, one.

PROVENIENCE: Table 53.

DIMENSIONS: Table 53.

CONDITION: Complete, six; lateral fractures, two.

PLAN VIEW: Humboldt series points are lanceolate, with excurvate margins and slightly contracting, shallow, concave bases. Basal margins on several points are slightly flared, forming small sharp ears. The bases are more shallow ($\bar{X}$ BIR = 0.94 ± 0.001)

than Humboldt Basal-notched bases ($\bar{X}$ BIR = 0.91 ± 0.02).[4]

LONGITUDINAL SECTION: Plano-convex longitudinal profiles predominate. Maximum thickness corresponds with the position of maximum width, at approximately 30 percent.

CROSS SECTION: Cross sections are equally divided between plano-convex and lenticular. One diamond-shaped cross section resulted from repeated resharpening.

FLAKE SCAR PATTERN: Seventy-five percent of the Humboldt points were flaked with a diagonal parallel style, meeting at the midline; the remainder were finished either with unpatterned or less regular parallel flaking. Several points were diagonally parallel flaked on the dorsal face, with unpatterned pressure on the ventral face. It is easier to flake a convex surface than a concave one, and the more stylized flaking on the dorsal face may reflect this.

Humboldt bases were generally (65%) flaked rather than notched. The bases were usually formed by one or more unifacial basal thinning flakes, over which small pressure flakes were removed to deepen the concavity.

FLAKE SCAR MORPHOLOGY: The pressure flake margins overlap, and therefore appear parallel. Non-overlapping scars are, however, widest near the margin, feathering to constricted terminations toward the midline.

COMMENTS: Several characteristics clearly set the Humboldt series points apart from Humboldt Basal-notched bifaces. While 66 percent of the Humboldt Basal-notched bifaces were resharpened, only 38 percent of the Humboldt series points were resharpened.

Over 75 percent of the Humboldt Basal-notched bifaces were used for cutting, but cutting wear was observed on only 25 percent of the Humboldt series points. Conversely, only 13 percent of the Humboldt Basal-notched bifaces show signs of having been used as projectile points. But 63 percent of the Humboldt series bifaces have observable projectile point wear.

Most Humboldt Basal-notched bifaces (83%) were hafted, but haft wear was rarely noted (25%) on the Humboldt series points.

No Humboldt series points were reworked into other tool categories, although 20.4/939 (fig. 63d) may have been used (as is) as a scraper. The margins of this point are unifacially crushed and striations running across the face perpendicular to the margin were observed.

Artifact 20.4/1679 (fig. 63c) may have been repeatedly resharpened, as suggested by the steepness of the bifacial resharpening. This point, which was weathered prior to resharpening, may have been curated from surface contexts.

Striae running parallel to the margins of 2/32570 (fig. 63b) cross-cut a greasy red pigment, perhaps the remnant of a poison compound applied to the tips of projectile points (Steward, 1941, p. 237).

RESIDUAL CONCAVE BASE POINTS

No firm typology has been devised for the ubiquitous concave base points found in the Great Basin, although a number of investigators have attempted such a temporal and/or spatial classification (Lanning, 1963; Clewlow, 1967, 1968b; Heizer and Clewlow, 1968; Thomas, 1971, 1981a; Green, 1975; Bettinger, 1978b; Pendleton, 1979, MS). To date, we lack a comprehensive treatment of either central tendencies or diversity within the concave base tradition of the Great Basin.

Seventeen concave base points from Hidden Cave do not fit within the Humboldt series or Humboldt Basal-notched categories, and these are grouped into a residual concave base point category (fig. 64). These points were excluded from the two previously defined types because of their W_B/W_M, BIR, and weight (see table 53 for metric and provenience data).

Residual concave base points are not homogeneous. Their similarity derives only from their concave bases and their exclusion from both previously defined types. These artifacts do, however, loosely cluster into several general categories.

BASAL WIDTH/MAXIMUM WIDTH RATIO: Artifacts 1-1B-399, 1-1B-510, 2/32405 and 20.4/979 (fig. 64e, n, i, q) exceeded Hum-

[4] See Green (1975, p. 166) for a thorough technological evaluation of Humboldt Concave Base points.

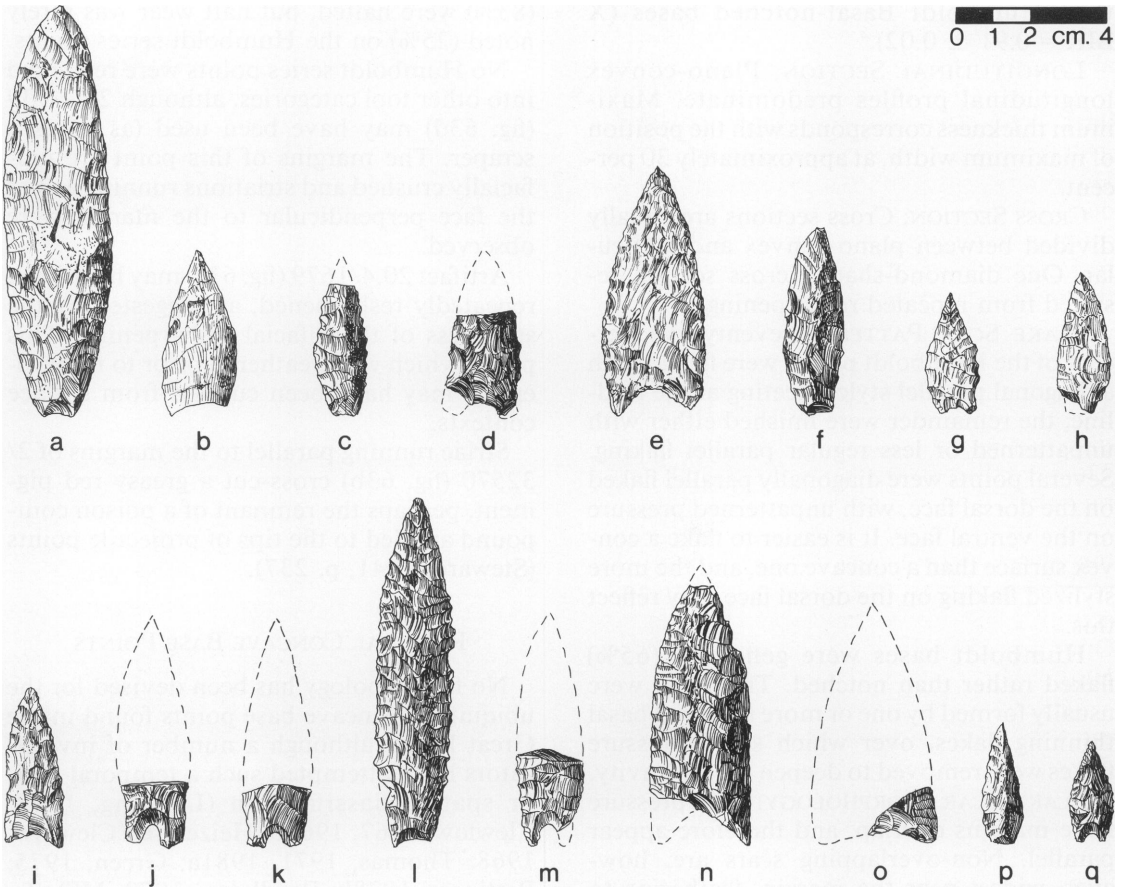

FIG. 64. Residual concave base points from Hidden Cave. a. 1-1B-130-19; b. 1-1B-246; c. 20.4/807; d. 20.4/965; e. 1-1B-399; f. 1-1B-646; g. 1-1B-410; h. 2/32404; i. 2/32405; j. 20.4/688; k. 20.4/861; l. 2/32695; m. 2/32698; n. 1-1B-510; o. 20.3/9785; p. 20.4/378; q. 20.4/979.

Provenience: Surface, a, b; Stratum I, c, d; Stratum II, e, f; Stratum III, g; Stratum IV, h–k; Strata IX/X; l, m; not correlated (N.C.), n–q.

boldt series ratios (the W_B/W_M was not ≤ 0.90), but they were not as triangular as the Humboldt Basal-notched bifaces (W_B/W_M was not 1.0). These artifacts also exceeded the size range for the Cottonwood series.

Artifact 20.4/979 is too small to fit within the Humboldt series, but fits the size range of the Cottonwood series. It was excluded from the Cottonwood series because its W_B/W_M ratio (0.63) was too low for a Cottonwood Triangular point and its concave base excluded it from the Cottonwood Leaf-shaped type (which has a rounded base). This artifact most closely resembles a small Humboldt series point.

Two points from the 1940 excavation (fig. 64e, n) resemble the Great Basin Concave Base series, typically considered relatively early in the Great Basin (Clewlow, 1968b; Davis and Shutler, 1969; Tuohy and Layton, 1977; Pendleton, 1979). While it is conceivable that they may have been curated from earlier contexts outside the cave, the lack of surface weathering suggests otherwise. They are also thicker than most of the early concave base series points.

These artifacts most closely resemble Humboldt Basal-notched bifaces in thickness, obsidian source, and provenience. But they differ from Humboldt Basal-notched bi-

faces in their sharp eared slightly contracting bases. These points are probably slightly aberrant Humboldt Basal-notched bifaces.

Artifact 2/32405 (fig. 64i) is generally similar to a Humboldt Basal-notched biface, but it differs in W_B/W_M ratio and material: all Humboldt Basal-notched bifaces from Hidden Cave are made of obsidian, but this specimen is chert. Furthermore, it was recovered from Stratum IV, stratigraphically well below the other basal-notched bifaces (which are all from Strata I and II).

BASAL INDENTION RATIO: The BIRs for artifacts 1-1B-130-19, 1-1B-646, 2/32695 and 20.4/807 (fig. 64a, f, l, c) are much larger than those acceptable for the Humboldt series. These artifacts are, however, probably aberrant Humboldt points.

WEIGHT: Artifacts 1-1B-410 and 20.4/378 (fig. 64g, p) weigh less than the Humboldt series, yet length and thickness exceed the accepted criteria for the Cottonwood series. Once again, these are probably very small Humboldt points.

The rest of the artifacts in this residual category—including 2/32698 (fig. 64m), one of the disputed "Anathermal" points—are too fragmentary for further classification.

COMMENTS: The ventral face of 1-1B-246 (fig. 64b) has a potlid fracture that gives it a fluted appearance, but the differences in patination between the channel flake scar and the remainder of the point suggest that the "flute" may be natural. The surface of the chert (wonderstone?) point is waxy, but the surface of the "flute" is granular. Had the point been subjected to intentional heat treatment—which would account for the waxy texture of the surface—the material would have been homogenous throughout. That is, the interior and exterior of the point would have had similar qualities of granularity or waxiness. The surface alteration on the point might also have been due to patination. The artifact could have lain on the surface of the Carson Sink, where it would have been subjected to intense temperature fluctuations resulting in a potlid fracture which resembles a flute. We think that the potlid fracture probably occurred subsequent to the abandonment of the point, and prior to its curation and storage in the cave.

Artifacts 1-1B-399 and 1-1B-510 (fig. 64e, n) are unifacially resharpened near the tips, and the resharpened areas are bifacially worn like knives. No haft wear was observed on these obsidian points and neither point has ground basal margins.

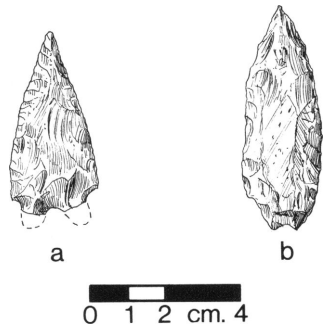

FIG. 65. Preforms from Hidden Cave. a. 1-1B-323; b. 2/32415.
Provenience: Stratum II, a; mixed Strata IX/X, b.

One of the "Anathermal" points (2/32695, fig. 64 l) was also used for cutting. High point rounding has modified its distal margins and parallel striations run adjacent to both margins. But they are unifacial on one margin and bifacial on the other. The point was apparently hafted, as the basal margins are ground and the flake ridges on the midsection are bifacially polished. Similar wear patterns were noted on another of the "Anathermal" points (2/32696, fig. 63e).

Haft wear, in the form of heavy bifacial dulling of the flake ridges, was noted near the base of one other concave base point (20.4/965, fig. 64d). This point had been resharpened and used prior to breakage.

The entire question of the "Anathermal" contexts of these Hidden Cave artifacts is considered in chapter 26.

PROJECTILE POINT PREFORMS

Two Gatecliff Split Stem preforms (fig. 65; see table 53 for metric and provenience data) were recovered from widely divergent contexts: 1-1B-323 from Stratum II and 2/32415 from the deeper Strata IX/X.

The latter preform (fig. 65b), made from low quality chert or shale, is partially flaked by poorly controlled diagonal to unpatterned pressure. It was probably made on an end-

struck flake that was heavily abraded into the basic Gatecliff shape. The blade was pointed by pressure flaking. The shoulders and base were formed by lever notches, but they may have been ground into their final form. Heavy abrasion of the base and shoulders served to smooth the margins.

Artifact 1-1B-323 (fig. 65a) is quite similar to, yet cruder than Gatecliff Split Stem point 20.4/472 (fig. 50n); both points are made from the same gold chert. The preform blade section is unfinished; the margin has been flaked with one row of pressure flaking. The shoulders, while unnotched, are pressure flaked with small chips, perhaps to prepare them for notching. Unlike most completed Gatecliff Split Stem points, the base is actually notched and has not been deepened by pressure flakes.

This point was produced from an end-struck flake with a ground platform. One margin has been ground, probably to strengthen the preform margin for additional pressure retouch.

Miscellaneous Projectile Points and Fragments

Eight projectile point fragments, although quite small, suggest their former shape; the remainder are merely blade, tip, and midsection fragments.

Number of Specimens: Sixty-four.

Provenience: Table 50.

Materials: Obsidian, 58; chert, five; basalt, one.

Dimensions: No estimates taken.

Condition: Nearly complete, eight; blade elements, 17; tips, 22; midsections, 17.

Two fragments had broken with twisted lateral fractures, probably the result of an oblique impact, or from having been stepped on. The perverse fracture on 20.4/1673 may have been a manufacturing error. Ninety-five percent of the fragments were broken by lateral end shocks, for which the precise cause is unknown. Since the bulk of these fragments were resharpened and/or utilized, they were probably finished points and did not break from manufacture.

Artifacts 2/32433, 2/32759, 20.4/1302, 20.4/1327, and 20.4/1672 are obsidian split-stem point fragments. The first two (fig. 66a, b) are probably Elko Eared points, the last two (fig. 66f, e) appear to be Gatecliff Split Stem points; 20.4/1302 (fig. 66c) is too fragmentary for assignment to a specific type.

Artifact 20.5/1600 (fig. 66h) is a Gatecliff Split Stem point made from a poor quality chert or granite. It was broken by a series of crenated fractures, which probably occurred after deposition.

Artifacts 20.4/397 and 20.4/1199 (fig. 66g, d) are finished Gatecliff Contracting Stem points, probably broken by impact fractures.

One margin of 2/32759 (fig. 66b) was resharpened over a fracture. Bilateral scalar wear on the margins is suggestive of drilling, but the parallel striations on isolated areas of the face are more indicative of cutting wear.

A unifacially resharpened fragment (20.4/1672, fig. 66e) was used as a scraper. One margin has been resharpened and crushed, and striations cross the face perpendicular to that margin.

ADDITIONAL BIFACIAL TOOLS

Recently, lithic biface analysis has begun to emphasize the blank-perform-product continuum (Muto, 1971; Bucy, 1974; Womack, 1977). This continuum implies several stages of bifacial reduction that lead to a finished bifacial implement such as a knife or projectile point (Thomas, 1983b).

The Hidden Cave sample contains both fine percussion bifaces and pressure flaked bifaces. There was, however, no biface reduction sequence *per se* within the assemblage. Bifacial reduction decidedly was not the focus of lithic activity within the cave.

The terms fine percussion biface and pressure flaked biface are used here *not* in the technological sense (denoting placement within a bifacial reduction sequence) but rather to describe a technological stage at which an artifact was "finished." That is, we think that the fine percussion blanks and pressure flaked bifaces from Hidden Cave are "finished" artifacts. The high percentage of utilized artifacts within each category suggests that the bifaces were finished for the functions in which they served.

Fine Percussion Bifaces

The bifaces are well shaped and symmetrical. They are not pressure flaked.

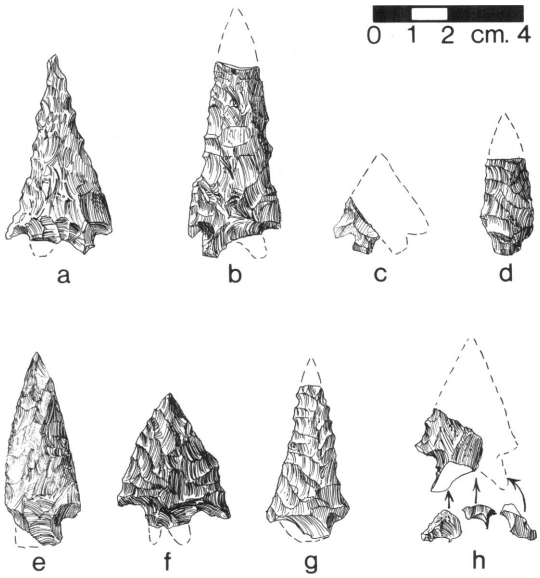

FIG. 66. Miscellaneous projectile points from Hidden Cave. a. 2/32433; b. 2/32759; c. 20.4/1302; d. 20.4/1199; e. 20.4/1672; f. 20.4/1327; g. 20.4/397; h. 20.5/1600

Provenience: Stratum II, a, b; Strata II/III, c; Stratum III, d; Stratum IV, e; not correlated (N.C.), f–h.

NUMBER OF SPECIMENS: Eight (fig. 67).

MATERIALS: Obsidian, five; chert, two; basalt, one.

PROVENIENCE: Stratum III, one; Stratum IV, two; Stratum VII, one; not correlated, four.

DIMENSIONS: For complete specimens, see table 53.

CONDITION: Complete, four; lateral fractures, three; diagonal fracture, one.

The diagonal and lateral fractures probably all resulted from end shocks, as the points of origin are undetectable.

PLAN VIEW: The bifaces are well shaped, with symmetrical outlines and biconvex margins; tips are pointed, if somewhat rounded. Margins are generally expanding, with ovate outlines and expanding bases.

One specimen (20.4/973, fig. 67e) has parallel margins. This artifact was recovered from below the Mazama ash, which makes it unique. Not coincidentally, the wide collateral percussion flaking on this artifact is also unique at Hidden Cave. This distinctive flake scar pattern is identical with many of the Great Basin Stemmed series of Paleo-Indian points recovered from pluvial environments ranging from the Columbia Plateau to San Diego (Tuohy, 1968, 1969b, 1974; Bedwell, 1973; Tuohy and Layton, 1977; Layton, 1979; Pendleton, 1979).

LONGITUDINAL SECTION: An even transverse section, expanding somewhat toward the base. The surfaces are slightly uneven and somewhat sinuous.

CROSS SECTION: Generally lenticular to ovate; symmetrical, unless the line has been interrupted with use wear.

FLAKE SCAR PATTERN: Unpatterned percussion covers both faces of the bifaces, with the exception of the collaterally flaked spec-

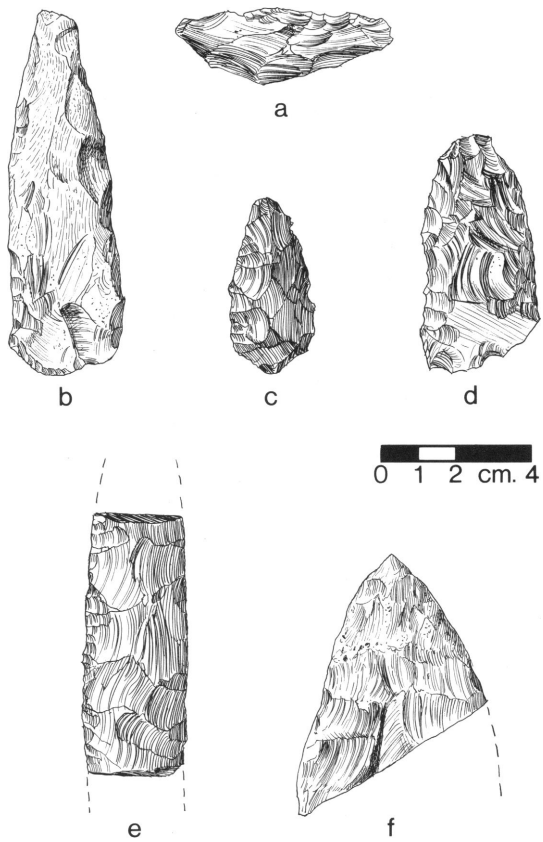

FIG. 67. Fine percussion bifaces and selected fragments from Hidden Cave. a. 20.4/660; b. 2/32515; c. 20.4/659; d. 20.4/832; e. 20.4/973; f. 1-1B-162.

Provenience: all not correlated (N.C.) except d (Stratum III) and e (Stratum VII).

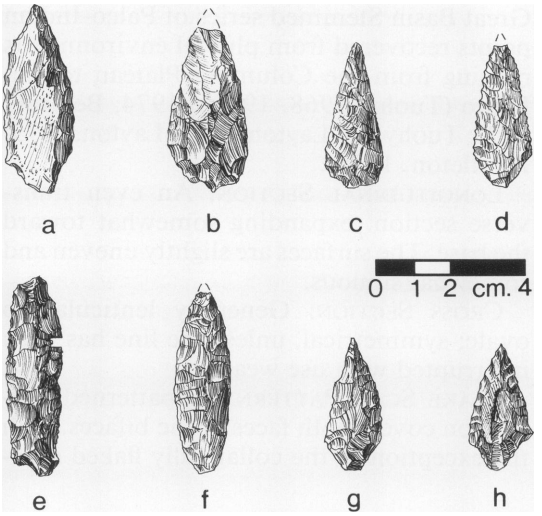

FIG. 68. Pressure flaked bifaces from Hidden Cave. a. 20.4/986; b. 1-1B-403; c. 1-1B-278; d. 2/32762; e. 20.3/9778; f. 20.4/327; g. 20.4/980; h. 1-1B-.

Provenience: Stratum I, a; Stratum II, b–d; not correlated (N.C.), e–h.

imen. The unpatterned flakes, which often overlap the midline, also overlap one another. A row of small expanding flakes, terminating near the margin, usually covers both faces.

FLAKE SCAR MORPHOLOGY: The flakes are generally shallow and expanding. We will not attempt to infer the resiliency of the hammerstones used to fashion these bifaces.

Margins are usually rounded unifacially or unilaterally on the high points; the entire margin area of several artifacts has been dulled and crushed, giving them rounded edges. Some obsidian artifacts are bifacially nibbled and crushed. Bilateral fine parallel striations were noted near, and parallel to, the margins on artifact 20.4/1273. It appears that many of these bifaces were used for cutting and scraping tasks.

The collaterally flaked biface from below the Mazama ash layer (20.4/973, fig. 67e) was subjected to scanning electron microscopy (40–400×). Initially, it appeared that the margins were dulled and rounded from use, but the SEM revealed that this artifact had been subjected to severe weathering. The entire surface was smoothed and sand blasted—actually water worn—and small pits dulled the entire surface. It may have been washed into the cave by wave action from one of the high stands of Lake Lahontan, or carried in after a lengthy time on the surface.

Specimen 20.4/659 (fig. 67c) is a concavo-convex biface, the base of which has been reworked into an end scraper. Microscopic examination of the base revealed steep unifacial crushing and step scars. Striations, running perpendicular to the right ventral margin were observed at 30× magnification.

Lateral margins of 20.4/832 (fig. 67d) are bifacially nibbled and crushed. No striae were observed, but the wear pattern suggests that the biface was used to cut a semi-hard surface.

PRESSURE FLAKED BIFACES

These bifaces are finished implements which have been, at least in part, shaped by pressure flaking. Some bifaces may have been used as points, whereas others were probably used as knives and scrapers.

COMPLETE PRESSURE FLAKED BIFACES

Unbroken artifacts cluster into two morphological categories: leaf shaped ovoids (fig. 68b–e) and bipoints (fig. 68a, f–h).

NUMBER OF SPECIMENS: Eight.

MATERIALS: Obsidian, six; chert, one; basalt, one.

PROVENIENCE: Stratum I, one; Stratum II, three; not correlated, four.

DIMENSIONS: Table 53.

PLAN VIEW: Three bifaces are leaf shaped, with slightly pointed tips. Margins are straight to diagonal and bases are rounded. The base of artifact 1-1B-403 (fig. 68b) was flaked into three "nubs," each of which is polished and could have been used to incise or score. Although less likely, the base may also have been used as a scraper.

The bipoints have symmetrical diamond-shaped margins and pointed bases. The widest point on the biface averages 45 percent of its length, considerably higher than the maximum width position of the ovate bifaces (16%). These bipoints resemble Cascade points (Butler, 1961).

LONGITUDINAL SECTION: Generally plano-convex; the greatest thickness coincides with the maximum width position.

CROSS SECTION: Plano-convex, four; ovate, three; lenticular, one.

FLAKE SCAR PATTERN: Less regular parallel, four; unpatterned, four.

FLAKE SCAR MORPHOLOGY: Overlapping parallel-sided pressure retouch meeting at, or extending past the midline.

COMMENTS: Artifact 20.3/9778 (fig. 68e) was reworked from a large biface. Steep margin retouch on the face cross-cuts older, shallow, thin pressure flaking in several places. One margin has been damaged by step and scalar scars which appear to have resulted from hard scraping (bone or wood).

Artifact 20.4/986 (fig. 68a) was resharpened with steep unifacial retouch. No particular wear patterns emerge; the tip is particularly sharp, which may indicate the piece was unused after it was resharpened.

No other use wear was noted on the bifaces.

PRESSURE FLAKED BIFACE FRAGMENTS

Our sample consists of six tips, eight midsections, and two bases. Several fragments are resharpened, and most have some form of edge damage from use.

NUMBER OF SPECIMENS: Sixteen.

MATERIALS: Obsidian, 14; chert, one; mudstone, one.

PROVENIENCE: Stratum I, three; Stratum II, two; Stratum III, one; Stratum IV, six; Stratum V, one; not correlated, three.

DIMENSIONS: No estimates taken.

CONDITION: End shocks, 10; perverse fractures, two; twisted fractures, two; burinations, two.

It appears that several bifaces were broken during manufacture, resulting in a high percentage of end shocks and perverse fractures. Yet, curiously, all but two of the bifaces were recovered and used after they were broken. Most of these bifaces have distinct use wear marks covering the old fractures, and several were retouched over a break.

The two burinated artifacts appear to be purposefully backed tools, intentionally dulled on one margin for ease of handling; one was subjected to considerable hard use along the retouched edge.

Three bifaces may have been used as projectile points but were included with the bifaces because of the degree and regularity of their pressure flaking.

The twisted breaks noted on two of the points probably resulted from use; one was used as a drill or borer. The tip is missing from the other specimen.

PLAN VIEW: Smooth, even, slightly excurvate margins.

LONGITUDINAL SECTION: Most were probably plano-convex, but the breaks obscure the overall shape of the artifacts.

CROSS SECTION: Lenticular, seven; ovate, five; trapezoidal, three; diamond shaped, one.

FLAKE SCAR PATTERN: Unpatterned, seven; diagonal parallel, four; obscured, five.

Three bifaces were unifacially resharpened, three were bilaterally resharpened, and one was bifacially resharpened. Several are pressure flaked over the entire surface, although pressure flaking is restricted to the margin areas on most of the bifaces.

FLAKE SCAR MORPHOLOGY: Five bifaces retain remnants of wide shallow percussion scars. The pressure flakes are generally short, elongated ovals that usually overlap.

COMMENTS: An organic residue clinging to the margin of a pressure-flaked biface midsection (20.4/509) has been identified as bat blood. Several bat hairs and downy hawk feathers are contained in the blood matrix (Thomas Loy, this volume; see also Loy, 1983). The margins of the biface were dulled and abraded, with parallel striations running through the blood film oblique to the margin. Apparently, this biface had been used to cut fresh bat meat.

BIFACIAL SCRAP

Artifacts 20.5/1587, 20.5/1593-1597, and 20.5/1600 are small biface fragments that do not comfortably fit any of the previous categories due to their small size and amorphous shapes. They are probably the shatter from one or several large bifaces.

NUMBER OF SPECIMENS: Seven.

MATERIALS: Obsidian, five; chert, two.

PROVENIENCE: Stratum II, one; Stratum III, three; Stratum IV, one; not correlated, two. All scrap was recovered in churned strata.

DRILLS

Several reworked drill fragments were recovered from Hidden Cave (fig. 69).

NUMBER OF SPECIMENS: Seven.[5]

[5] Several typable projectile points were reworked into drills, and their wear patterns are also discussed here.

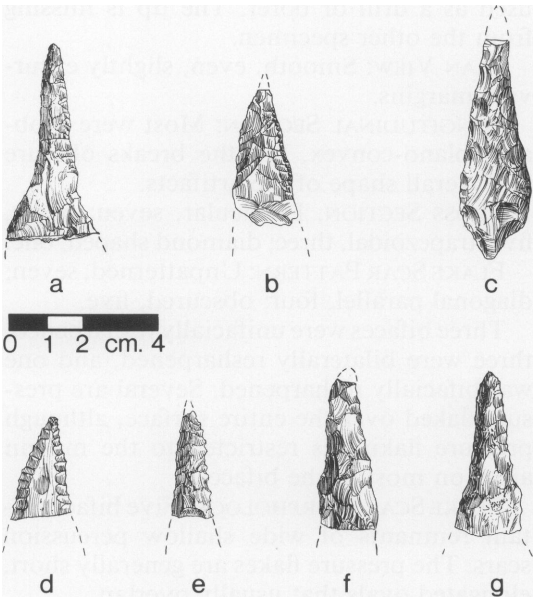

FIG. 69. Drills from Hidden Cave. a. 20.4/1231 & 20.4/732; b. 2/32409; c. 2/32641; d. 2/32648; e. 20.4/929; f. 20.3/9866; g. 20.3/9783.

Provenience: Stratum I, a; Stratum II, b–d; Stratum IV, e; not correlated (N.C.), f, g.

MATERIAL: Chert, three; obsidian, four.

DIMENSIONS: No estimates taken.

CONDITION: Broken, seven. Most of the breaks are twisted fractures; artifacts 20.4/732 and 20.4/1231 (fig. 69a) are the tip and midsection of the same drill.

PLAN VIEW: The blade margins are incurvate-excurvate, with shoulders that taper toward the base. The margins are generally parallel, tapering slightly toward the tip.

CROSS SECTION: Diamond-shaped to biconvex.

FLAKE SCAR PATTERN: Unpatterned flaking across the face near the tip. The drills were resharpened with bilateral flaking.

FLAKE SCAR MORPHOLOGY: Oval-shaped flakes, constricting toward the midline.

COMMENTS: The drills, examined by low power microscopic analysis (7–30×), exhibited use wear consisting of bilateral crushing and nibbling on the margins, as well as rounding and smoothing on the tips.

Most drills were reworked from projectile points; occasionally an unmodified flake was used.

One specimen (2/32641, fig. 69c) was reworked from a Gatecliff Contracting Stem point into a double drill, or possibly a knife. The tip is rounded and smoothed. Striations run diagonally across the dorsal face toward the tip; the ventral face is covered with striations that run perpendicular to the tip. The base has been used in a circular motion, resulting in a smooth, rounded surface. The margins just above the base, which were bilaterally resharpened, are nibbled and rounded, probably from long-term soft use.

In addition to the above fragments, eight typable projectile points were used as drills. Artifacts 1-1B-130 (fig. 50c), 20.3/9920 (fig. 54w), and 20.4/583 (fig. 54q) are reworked Gatecliff Split Stem points. The points were usually bifacially resharpened on one margin and unifacially resharpened on the other, which resulted in a diamond-shaped tip. Wear patterns consist of distinct bilateral crushing and dulling, particularly near the tip. A twisted fracture and diagonal bifacial striations on the tip of 1-1B-130 supports its use as a drill.

Artifact 1-1B-366 (fig. 55o) is a bilaterally crushed Gatecliff Contracting Stem point. The bilateral wear covers approximately 30 percent of the margin, terminating abruptly at a slight shoulder. This wear pattern, which probably resulted from its use as a hafted drill, consists of steep crushing, nibbling, and step scars along the left dorsal margin, and some high-point rounding and crushing on the right ventral margin. Artifact 1-1B-873 (fig. 55d), another Gatecliff Contracting Stem point, has a bilaterally crushed tip; it was used with a twisting motion.

A reworked Elko Corner-notched point (2/32440, fig. 58b) is perhaps the most distinctive drill in the collection. The point was resharpened several times; the last resharpening was partially obliterated by rounding and crushing over the entire face. The wear, although not excessively heavy, has reduced the cross section to a rounded diamond shape.

An Elko Eared drill (1-1B-129, fig. 59a) was unifacially resharpened by steep pressure flaking. Bilateral dulling and nibbling have worn smooth the formerly serrated margins of the tip.

Artifact 2/32433 (fig. 66a) was probably a Gatecliff Split Stem point, but the base is broken, and precise identification is impossible. The margins have been bilaterally resharpened and worn, suggesting use as a drill.

Two projectile point midsection fragments (20.3/9927, 20.4/737) were bilaterally resharpened and crushed, which could indicate that they were used as drills. However, the breaks are straight lateral impact fractures instead of the twisted fractures more commonly found on drill fragments. Artifact 20.4/737 is coated with red pigment (hematite?).

UTILIZED FLAKES AND GRAVER TIPS

Utilized flakes and graver tips are divided into categories which reflect the location of the edge damage; detailed discussion of these artifacts is postponed until chapter 15.

CHIPPAGE AND CORES

Chippage from Hidden Cave, 56 pieces in all, consists of primary, secondary, and tertiary flakes, and one core fragment. For the purposes of this analysis, *primary debitage* consists of cortex flakes; *secondary chippage* describes interior flakes without cortex or pressure flaking; *tertiary chippage* is restricted to flakes detached by pressure flaking.

Cores

The single core from Hidden Cave (20.5/1590; not correlated) is made of beige chert and has had at least five flake removals. One platform is crushed. What remains of the core (23.5 mm. × 16.4 mm. × 13.2 mm.) is too small for removal of any more flakes, but not too small for use as a tool (e.g., as a graver).

Primary Debitage

Number of Specimens: Eleven.

Material: Chert, eight; obsidian, two; basalt, one.

Provenience: Stratum II, five; Stratum IV, four; not correlated, two.

Primary debitage includes three end-struck flakes with diffuse bulbs of force and small platforms; their length exceeds their width. Two other flakes, detached by side-struck blows, have large deep bulbs and crushed platforms. The rest of the primary debitage consists of shatter (lacking bulb and platform).

Secondary Debitage

Number of Specimens: Thirty.

Material: Chert, 15; obsidian, 14; basalt, one.

Provenience: Stratum I, four; Stratum II, five; Stratum III, three; Stratum IV, three; Strata IX/X, one; not correlated, 14.

Secondary debitage includes seven biface manufacturing flakes with bulbs, and 20 biface manufacturing flakes without bulbs (shatter). Biface flakes were classified on the basis of prior flake removals from the dorsal face and gross size. The unfinished bifaces recovered from the cave suggest that only small and medium-sized debitage (*ca.* 20–25 mm.) would have resulted from their production.

In other words, since no large primary production stage bifaces were found in the cave, we do not expect that the large flakes found inside Hidden Cave resulted from biface production.

Of the seven secondary flakes with bulbs intact, three with extremely diffuse bulbs, may have been fashioned by a soft resilient hammerstone. One has a deep bulb, perhaps produced by a harder hammerstone; the other three offer no clues to their production mode.

Bulbs on the three large secondary percussion flakes are fairly diffuse. The two chert flakes have prepared platforms; one platform is ground, the other is faceted.

Tertiary Debitage

Number of Specimens: Fifteen.

Material: Obsidian, 10; chert five.

Provenience: Stratum I, one; Stratum II, three; Stratum IV, four; Stratum V, two; not correlated, five.

Tertiary debitage consists of flakes removed by pressure retouch. All but one of the flakes are small, with slightly expanding margins; the platforms are narrow, and the bulbs are acuminate. Numerous tiny compression rings run the length of the ventral face. The flakes are generally under 9.0 mm. long and less than 7.0 mm. wide; thickness rarely exceeds 3.0 mm.

One specimen is probably a waste flake from biface thinning. The bulb is missing, but the several old pressure scars appear near the margin. This flake is probably the result of biface sharpening. Several other flakes with crushed, yet sinuous dull edges, were removed from biface margins when they were resharpened.

TABLE 52
Obsidian Percentages by Artifact Category

Debitage	Percentage of Obsidian
Primary	17
Secondary	45
Tertiary	67
Artifacts	**Percentage of Obsidian**
Projectile points	74
Bifaces	76
Unifaces	18

Most flakes appear to be the debris from resharpening points or bifaces.

There is an interesting relationship between raw material and artifact staging (table 52). The following ratios hold for the debitage from Hidden Cave: primary flakes, 17 percent obsidian; secondary flakes, 45 percent obsidian; tertiary flakes, 67 percent. This trend is mirrored in the finished artifacts from Hidden Cave: projectile points, 74 percent obsidian; bifaces, 76 percent obsidian; unifaces 18 percent.

As would be expected, the tertiary debitage contains the same ratio of obsidian to non-obsidian as the points and bifaces: roughly three to one. Note the relative increase in obsidian in secondary and particularly in tertiary debitage, likewise resulting from reworking of bifaces and points.

Conversely, both utilized flakes and primary debitage are overwhelmingly non-obsidian. Primary debitage is large and easily reworkable. These ratios seem to suggest that non-obsidian materials were used for unifaces, whereas obsidian was used for bifaces and projectile points.

Material selection probably reflects the tasks for which the flakes were intended: chert is stronger than obsidian and a chert edge is more durable, requiring less resharpening when used for heavy tasks. Conversely, the chert edge is not as sharp as obsidian, nor can chert be sharpened to as fine a point as obsidian. For some tasks at least, chert may be a second choice when obsidian is readily available.

CRYSTALS AND PRISMS

Four prismatic objects were recovered from Hidden Cave. The prisms have not been retouched, but obviously they were transported into the cave deposits (see table 50 for provenience data for crystals and prisms).

Three specimens are obsidian prismatics or "tinklers"—natural four-sided elongate rectangles with long tapered ends. The Hidden Cave tinklers have broken truncated ends. Artifact 1-1B-79 is made of opaque brown obsidian. The margins are very smooth, which may have resulted from handling the object or abrasion from carrying it in a pouch. It is equally possible that the smooth surface is natural. Surfaces of the two black obsidian tinklers (20.4/743, 20.4/744) are unpolished.

A clear quartz crystal (20.4/769) was recovered with nicks and crushing on one end, but it does not appear to have been used.

Obsidian prismatics have been found associated with burials dated to the Early Horizon in central California (Lillard, Heizer, and Fenenga, 1939, pp. 40–41) and at other early sites in California (Beardsley, 1948; Heizer, 1949, fig. 14t–v; Nelson, 1910, p. 389, pl. 44, fig. 15). Obsidian bangles are ubiquitous in the Middle Horizon in the San Francisco Bay, Napa, and Marin districts (Elsasser, 1978, pp. 45–46), and in Late Horizon sites in central California (Heizer, 1949, p. 24) and Napa Valley (Heizer, 1953, pp. 264, 294).

Prisms are also recorded among the ethnographic Yurok, who used them as tinklers tied to their skirts (Kroeber, 1925, p. 76).

Quartz crystals are rather rare in this area, having been found previously at only 15 of the neary 3000 archaeological sites in western Nevada, most of which are in ethnographic Washoe territory (Pendleton, McLane, and Thomas, 1982, table 3). Crystalline quartz was commercially mined at Crystal Peak north of Verdi, but it is generally uncommon elsewhere in the Great Basin (Hattori, personal commun.).

One quartz crystal was recovered from Lovelock Cave (Loud and Harrington, 1929, p. 108), and another, excavated just above the third floor of Etna Cave, may have been used as a drill (Wheeler, 1942, p. 41).

Four quartz crystals were recovered from the Rose Spring site in Owens Valley (Lanning, 1963, p. 262), and three were excavated in Tommy Tucker Cave in northwestern California (Fenenga and Riddell, 1949, p. 209). Meighan reports one quartz crystal from ex-

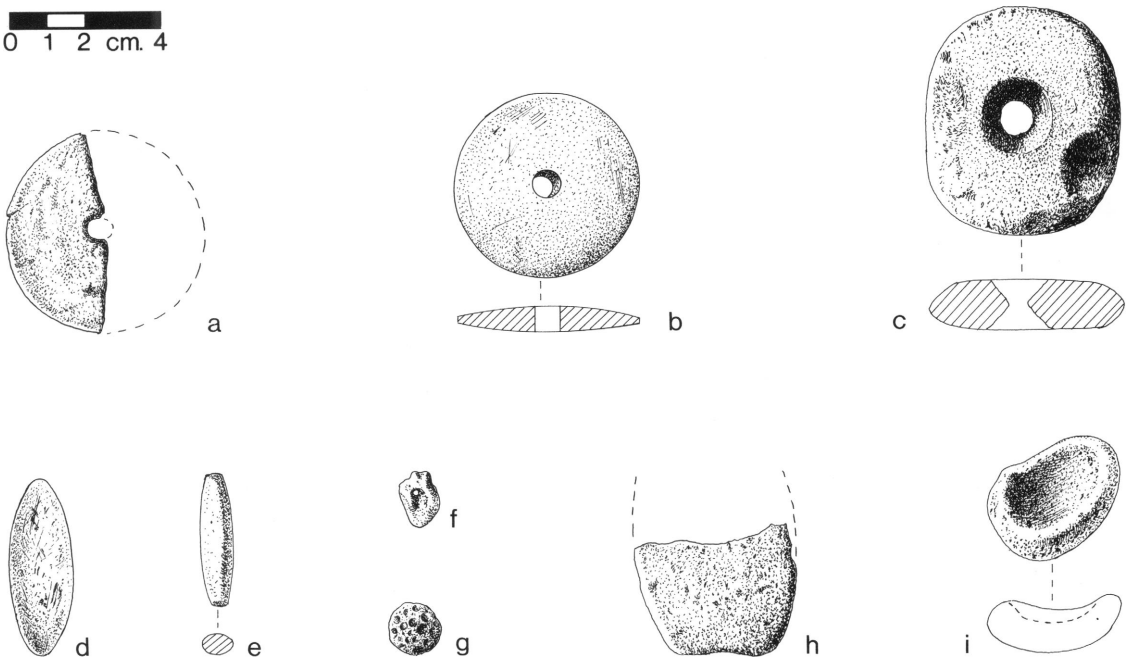

FIG. 70. Selected ground stone artifacts from Hidden Cave. discoidals, a–c; cylinders, d, e; bead, f; sphere, g; tablet, h; palette, i. a. 1-1B-369; b. 20.4/1729; c. 20.3/763; d. 1-1B-184; e. 20.4/870; f. 20.4/957; g. 1-1B-558; h. 1-1B-591; i. 20.3/379.

Provenience: Surface, d; Stratum II, a; Stratum IV, b, e; Stratum VII, f; not correlated (N.C.), c, g–i.

cavations at the Coville Rockshelter near Death Valley, and another from the Humboldt Lakebed site, Ch15 (Meighan, 1953a, p. 184).

Quartz crystals were also recovered from burials in Middle Horizon sites in central California (Elsasser, 1978, pp. 38–39; Fredrickson, 1974, table 3) and from several Early Horizon sites (Lillard, Heizer, and Fenenga, 1939; Ragir, 1972, pp. 23, 80, 95–96). Heizer (1949, p. 19), who believed quartz crystals are "a noteworthy and characteristic cultural item in the Early Horizon complex" mentions a prevalent belief among recent California tribes that quartz crystals are magically potent, and their use was restricted to people with special powers—especially for shamans. Quartz crystals, typically found with male burials from the Early Horizon in clusters around the necks or near the hands, probably served as ornaments and musical bangles (Ragir, 1972, p. 102).

GROUND STONE

Table 54 contains the metric and provenience data for ground stone artifacts recovered from Hidden Cave.

DISCOIDALS

Four perforated discoidals were recovered from Strata II and IV (fig. 70a–c). Three are made from an unidentified calcium carbonate material (probably marble); the fourth is made from basalt.

Two calcium carbonate discoidals are whole, and the third is broken in half. They may have been flaked into an initial roughout stage, but the final stage was completed by pecking. A biconical perforation was drilled through the center. The stone was then polished (probably with a series of progressively finer abrasives) into a smooth circle having a slightly lenticular cross section.

The ovoid basalt discoidal (20.4/763, fig. 70c) was made from a flat cobble by flaking, pecking, and smoothing. The central perforation consists of four articulated drill holes. This discoidal retains a red patina on both lateral margins and on the face, which suggests the artifact was once in contact with an ocher or hematite compound.

The Karlo site contained four discoidals, three of which are identical with the marble discoidals from Hidden Cave (Riddell, 1960, p. 57, fig. 21e). Another marble discoidal was excavated from the Falcon Hill caves, near Karlo (Hattori, 1982, p. 74). Heizer (1974) also recorded 50 centrally perforated stones from the Humboldt Valley, including 11 discoidals from the Humboldt Lakebed site and Lovelock Cave.

Tablet

Artifact 1-1B-591 (fig. 70h) is a rectangular flat fragment of limestone which was pecked and ground into a rectangle. Although the tablet contained no incising, it may have been perforated.

Cylinders

Two ground calcium carbonate cylinders (20.4/870, fig. 70e; 1-1B-184, fig. 70d) were recovered from the surface and Stratum IV. Both were ground into tapered cylinder shapes, one with flat ends and the other with tapered ends. It has been suggested that bone artifacts with shapes similar to these cylinders may have served as gaming counters (Dalley, 1970b, p. 101, fig. 69k–t).

Sphere

Artifact 1-1B-558 is a pecked and polished small calcium carbonate ball, about the size of a marble (fig. 70g).

Palette

A tiny mortar (20.4/379, fig. 70i) was pecked into a rounded calcium carbonate cobble. High spots within the concavity have been ground, and it is circumscribed by a highly polished shoulder. No traces of pigment or organics were noted within the concavity.

Two tiny mortars recovered from the Stahl site are similar to the Hidden Cave specimens (Harrington 1957, p. 47, fig. 37b).

Hammer/Pecking Stone-Mano

The gray basalt hammerstone recovered from Stratum III (2/32590) is a wedge-shaped cobble, both ends of which are battered. A central ridge, which runs the length of the stone, has a patina that probably developed from its secondary use as a mano.

Metate

A gray basalt unifacial metate fragment (20.4/855) was recovered from Stratum IV. High points of the crystals on the incurvate worked face of the metate are crushed and polished, but the rim is rough and unworked. The worked surface, which extends over the broken margins, may indicate that the artifact was used subsequent to its breakage.

Incised Tufa

One tabular tufa fragment (20.4/496) was recovered which does not appear to be part of the natural roof fall in the cave. The flat worked face is scored with three narrow, shallow, curved lines that cross the stone diagonally.

Stone Bead

One stone bead (20.4/957, fig. 70f) was recovered in Stratum VII in Hidden Cave. The oval calcium carbonate bead has uneven ground margins. A conical perforation was drilled from the ventral face; the hole is off-center near the top of the bead. The dorsal surface was lightly polished, but both faces retain an uneven, rough surface. The bead appears to have been made from a cortex flake, but not finished. It may be a bead blank.

Miscellaneous Ground Stone

Eleven pieces of miscellaneous ground stone were recovered. The bulk of these artifacts may be manos, but they were used only slightly if at all. Most are unifacially ground oval basalt cobbles with slight high point polish.

MISCELLANEOUS LITHIC MATERIAL

Ocher

Two red ocher fragments (2/32525 and 2/32608) were recovered from Stratum IV during the Berkeley excavations. Unfortunately, these specimens were unavailable for study.

TABLE 53
Metric Attributes for Bifacially Flaked Tools from Hidden Cave

Specimen Number	Stratum	Length Max. (mm.)	Length Axial (mm.)	Width Max. (mm.)	Width Basal (mm.)	Width Neck (mm.)	Thickness (mm.)	DSA	PSA	Weight Actual (grams)	Weight Total (grams)	Material
Gatecliff Split Stem Points:												
1-1B-30	II	51.3	49.5	20.5	10.5	12.6	6.9	170	70	6.0	6.0	(Basalt)
1-B-32	II	32.5	29.7	23.7	10.7	10.9	4.6	150	95	2.5	(2.7)	Chert
1-1B-59	Surface	48.6	(47.4)	18.3	(15.5)	15.8	4.5	185	100	3.5	(3.7)	Obsidian
1-1B-76	Surface	(40.0)	(37.4)	(24.0)	11.2	11.2	4.5	160	95	2.4	(3.6)	Chert
1-1B-128	Surface	36.9	34.1	(23.9)	9.2	7.8	5.2	160	100	2.6	(2.8)	Obsidian
1-1B-130	Surface	48.6	45.6	25.5	(14.7)	13.8	6.2	170	100	5.2	(5.6)	Obsidian
1-1B-131	Surface	40.4	37.3	16.6	(10.5)	10.3	5.0	200	100	2.8	(2.9)	Obsidian
1-1B-145	Surface	40.5	38.9	22.9	(10.7)	13.4	7.5	190	70	6.0	(6.2)	Obsidian
1-B-249	Surface	50.2	47.4	(18.5)	8.9	9.3	5.3	150	80	3.1	(3.5)	Obsidian
1-1B-259	Surface	36.4	34.4	20.2	9.4	10.8	6.3	200	85	3.1	3.1	Basalt
1-1B-307	IV	53.6	49.5	22.7	12.0	16.2	6.6	200	80	7.5	(7.7)	Obsidian
1-1B-326	IV	50.4	48.4	21.2	8.7	10.2	6.7	160	85	4.4	4.4	Obsidian
1-1B-365	II	57.1	53.5	18.6	(10.0)	11.6	5.8	185	85	4.8	(4.9)	Obsidian
1-1B-378	II	57.7	55.6	21.5	10.8	13.3	8.1	190	95	7.3	7.3	Obsidian
1-1B-399[a]	II	42.2	39.1	26.5	12.5	13.2	6.7	140	95	4.5	4.5	Obsidian
1-1B-430	II	53.3	50.6	18.9	9.5	12.4	4.7	190	100	4.9	4.9	Chert
1-1B-456	II	50.8	48.3	18.3	12.5	13.5	8.0	190	70	6.9	6.9	Obsidian
1-1B-586	II	58.2	56.0	20.5	10.1	13.3	4.6	185	85	4.9	4.9	Obsidian
1-1B-620	II	53.2	51.3	15.5	8.2	8.5	9.7	190	85	7.2	7.2	Obsidian
1-1B-683	V/IX	71.0	68.0	29.8	10.7	14.3	5.9	145	80	6.8	6.8	Chert
1-1B-706	II	40.6	37.3	(22.5)	(11.5)	11.1	4.8	200	95	3.3	(4.0)	Obsidian
1-1B-878	Surface	62.2	60.4	23.8	8.2	13.0	7.0	170	75	8.2	8.2	Obsidian
1-1B-883	Surface	(70.0)	(65.4)	28.5	14.5	15.7	8.1	160	95	9.3	(10.5)	Obsidian
1-1B-884	Surface	(32.0)	(29.6)	(20.5)	11.6	11.4	5.8	180	100	2.8	(3.3)	Obsidian
1-1B-958	Surface	34.4	32.0	15.7	(8.8)	8.6	5.5	140	85	2.6	(2.7)	Obsidian
2/21905	N.C.	66.2	61.0	19.7	10.3	9.7	6.3	160	90	5.7	5.7	Brown Chert
2/21906	N.C.	(59.0)	(55.8)	(26.0)	12.5	12.2	6.3	180	100	5.0	(5.4)	Chert
2/32403	IV/V	36.2	34.5	20.0	10.4	11.7	5.8	185	100	3.6	(3.8)	Obsidian
2/32442	IV	28.4	26.3	20.1	(10.4)	11.0	5.0	190	95	2.3	(2.5)	Obsidian
2/32463	II	(64.0)	(62.1)	(26.0)	12.2	14.7	6.4	180	85	1.5	(8.7)	Obsidian
2/32481	I	35.5	30.7	21.5	11.4	11.0	4.3	175	95	2.9	(3.0)	Obsidian
2/32506	N.C.	(39.0)	(35.4)	19.0	(9.5)	11.2	4.4	170	85	2.3	(2.5)	Chert
2/32509	N.C.	32.5	29.8	22.5	(8.1)	9.5	5.8	180	95	3.2	(3.5)	Obsidian
2/32584	I	44.2	42.5	19.1	8.7	8.9	5.2	150	85	3.4	3.4	Obsidian
2/32638	N.C.	47.5	44.4	(19.0)	12.5	12.2	5.1	190	95	3.4	(3.5)	Obsidian
2/32639	N.C.	57.2	52.0	28.0	15.6	17.8	5.2	200	90	6.3	6.3	Obsidian
2/32655	IV	52.6	50.8	20.4	(12.0)	9.4	5.9	170	105	4.6	(4.7)	Obsidian
2/32660	II	40.2	37.2	23.4	13.0	12.3	8.3	190	85	4.7	(5.0)	Obsidian
2/32749	II	24.4	20.4	23.7	(12.0)	12.0	3.2	110	90	1.3	(1.8)	Obsidian
2/32750	II	44.0	40.0	27.9	(11.5)	11.9	5.9	150	90	4.7	(5.0)	Obsidian
2/32761	IV	(66.0)	(62.4)	24.6	12.5	11.9	5.9	150	95	5.4	(6.2)	Chert
20.3/9784	N.C.	43.9	42.7	(24.0)	(10.0)	12.5	5.5	190	100	4.5	(5.0)	Obsidian
20.3/9920	N.C.	32.6	30.3	16.4	(10.0)	10.8	7.4	190	100	3.5	(3.7)	Obsidian
20.3/9921	N.C.	(46.0)	(42.7)	21.3	10.8	12.8	4.4	180	80	3.2	(4.0)	Chert
20.3/9923	N.C.	54.4	50.7	20.2	17.6	16.6	4.9	250	95	4.7	4.7	Obsidian
20.3/9929	N.C.	31.5	28.6	19.2	8.7	9.5	5.0	160	90	2.1	(2.3)	Obsidian
20.4/371	N.C.	(40.0)	(38.7)	18.8	12.4	13.3	4.5	180	100	1.5	(2.0)	Chert
20.4/386	N.C.	41.1	38.2	15.8	(8.5)	8.8	6.9	220	85	3.5	(3.8)	Obsidian
20.4/396	N.C.	(58.7)	(52.5)	27.3	(11.9)	13.4	6.8	160	80	5.9	(6.5)	Obsidian
20.4/472	I	44.8	41.1	21.6	16.4	14.4	4.9	185	100	4.5	4.5	Chert

TABLE 53—(*Continued*)

Specimen Number	Stratum	Length Max. (mm.)	Length Axial (mm.)	Width Max. (mm.)	Width Basal (mm.)	Width Neck (mm.)	Thickness (mm.)	DSA	PSA	Weight Actual (grams)	Weight Total (grams)	Material
20.4/479	N.C.	43.9	41.9	19.0	9.7	12.4	7.2	185	80	5.0	5.0	Basalt
20.4/555	III	49.3	46.8	27.0	13.7	18.3	7.3	140	70	7.4	7.4	Obsidian
20.4/572	II	(47.0)	(44.7)	22.4	10.8	11.5	6.2	140	95	4.4	(5.0)	Obsidian
20.4/583	N.C.	41.5	39.0	18.3	(8.9)	13.5	6.8	175	80	4.1	(4.5)	Obsidian
20.4/653	II	32.9	29.7	23.9	(11.5)	13.7	5.1	140	100	3.0	(3.1)	Obsidian
20.4/677	IV	45.0	44.0	26.5	11.5	12.5	6.0	160	70	3.9	(4.0)	Chert
20.4/678	IV	48.5	45.4	21.0	11.2	12.1	6.5	180	100	5.7	5.7	Chert
20.4/680	IV	53.4	48.6	20.7	14.4	14.6	6.5	190	100	5.8	5.8	Obsidian
20.4/681	IV	38.1	35.0	22.0	9.5	11.1	5.0	140	85	2.8	2.8	Obsidian
20.4/705	N.C.	39.1	36.1	(27.2)	(8.0)	(11.6)	5.7	150	65	3.1	(4.0)	Quartzite
20.4/756	N.C.	42.9	39.7	(24.5)	11.4	12.2	6.5	185	85	4.7	(5.0)	Obsidian
20.4/757	N.C.	(52.0)	(50.4)	19.6	9.5	10.2	6.1	170	80	5.0	(5.2)	Basalt
20.4/828	III	31.2	29.3	(18.5)	8.7	9.5	5.8	160	85	2.0	(2.3)	Obsidian
20.4/831	III	51.0	46.9	24.9	10.6	11.2	5.4	150	95	4.3	4.3	Chert
20.4/833	IV	78.0	75.7	21.5	9.7	11.4	5.4	170	85	7.7	(7.9)	Obsidian
20.4/852	IV	71.2	65.5	27.5	13.3	15.2	5.9	170	95	8.0	(8.2)	Obsidian
20.4/864	III/IV	29.0	26.9	19.2	(9.7)	10.3	5.3	160	85	1.9	(2.0)	Obsidian
20.4/909	I/II	(41.0)	(37.5)	23.3	11.6	13.3	6.5	160	95	4.6	(4.8)	Chert
20.4/936	IV	57.7	53.5	27.4	(11.9)	13.6	6.3	150	85	6.5	(6.6)	Obsidian
20.4/955	V	37.0	35.9	23.5	8.3	11.8	5.0	180	80	3.7	3.7	Obsidian
20.4/960	N.C.	32.3	29.0	16.9	10.2	9.6	4.3	135	100	2.2	(2.3)	Obsidian
20.4/1194	III	35.5	33.4	(21.7)	8.6	11.1	5.7	120	70	3.3	(3.5)	Obsidian
20.4/1211	II/III	34.4	30.5	(21.0)	9.5	12.0	5.4	180	95	3.1	(3.3)	Chert
20.4/1233	IV	33.5	31.0	18.1	10.5	11.3	6.5	180	95	3.4	(3.5)	Obsidian
20.4/1253	V	(59.0)	(55.6)	(20.0)	(10.0)	12.5	4.8	185	95	5.0	(6.0)	Chert
20.4/1312	III	68.1	63.2	28.8	(13.6)	16.7	7.2	170	100	9.3	(9.6)	Obsidian
20.4/1336	N.C.	(44.5)	(41.0)	(29.0)	(13.0)	15.1	5.0	185	95	4.6	(5.0)	Chert
20.4/1429	N.C.	36.5	34.7	19.1	(10.1)	10.1	4.5	190	80	2.6	2.6	Chert
20.4/1552	IV	48.5	46.8	17.9	9.3	10.9	5.0	200	85	3.9	3.9	Obisidan
20.4/1564	IV	52.3	50.5	19.1	6.7	7.5	6.4	160	85	5.1	5.1	Obsidian
20.4/1567	IV	38.0	36.6	23.5	9.5	10.1	6.4	175	80	4.1	4.1	Chert
20.4/1593	IV	48.8	44.3	21.0	(10.2)	11.4	7.7	170	100	4.7	(4.9)	Chert
20.4/1613	II/III	34.5	32.2	24.5	(10.1)	11.1	4.1	150	80	3.2	3.2	Chert
20.4/1618	N.C.	49.3	46.2	(27.4)	13.5	17.5	6.0	180	95	5.8	(5.9)	Obisidan
20.4/1619	N.C.	(42.0)	(37.0)	(26.0)	11.1	(13.0)	6.3	170	100	2.4	(6.0)	Obsidian
20.4/1641	III	42.5	40.6	15.8	8.4	11.2	4.5	190	90	3.5	(3.6)	Obsidian
20.4/1642	III	39.2	35.2	15.6	10.7	11.2	5.6	185	100	2.1	2.1	Chert
20.4/1651	III	37.6	35.0	21.6	10.6	11.6	5.2	185	95	3.5	3.5	Obsidian
20.4/1706	N.C.	33.3	31.4	15.2	8.1	7.8	5.1	175	85	2.5	2.5	Obsidian
20.4/1708	V	37.7	35.1	(23.6)	9.7	11.8	6.7	160	95	3.6	(3.7)	Obsidian
Gatecliff Contracting Stem Points:												
1-1B-214A	II	41.2	41.2	27.6	6.0	13.2	—	185	70	—	—	Obsidian
1-1B-214B	II	41.4	41.4	20.0	3.3	11.2	—	170	80	—	—	Basalt
1-1B-243	Surface	45.5	44.7	20.5	9.0	10.6	8.2	170	80	6.7	6.7	Quartzite
1-1B-244	Surface	43.4	43.4	19.6	5.3	12.1	5.2	180	85	3.5	3.5	Basalt
1-1B-273	II	(51.5)	(51.5)	22.2	(5.0)	15.1	8.0	185	60	6.3	(6.8)	Obsidian
1-1B-342	II	39.2	39.0	20.5	9.5	12.9	6.5	185	80	5.3	5.3	Basalt
1-1B-366	II	47.0	46.4	17.1	8.2	9.6	6.3	180	80	3.5	3.5	Obsidian
1-1B-429	II	(32.0)	(32.0)	17.5	7.9	12.2	5.3	195	70	2.5	(2.7)	Basalt
1-1B-436	II	57.4	57.4	17.2	9.6	10.9	6.3	200	95	5.2	5.2	Chert
1-1B-466	II	35.9	35.9	18.5	7.9	11.9	6.5	200	80	4.0	4.0	Obsidian
1-1B-534	II	35.0	35.0	17.5	(6.4)	(8.0)	4.8	150	85	2.1	(2.2)	Obsidian

TABLE 53—(*Continued*)

Specimen Number	Stratum	Length Max. (mm.)	Length Axial (mm.)	Width Max. (mm.)	Width Basal (mm.)	Width Neck (mm.)	Thickness (mm.)	DSA	PSA	Weight Actual (grams)	Weight Total (grams)	Material
1-1B-664	II	35.0	35.0	22.4	8.5	12.4	6.0	180	80	3.2	3.2	Chert
1-1B-865	III	59.8	59.8	(28.0)	4.2	11.4	6.8	180	70	7.4	(7.6)	Obsidian
1-1B-873	Surface	(50.0)	(50.0)	14.9	(6.9)	7.9	5.8	170	85	3.3	(3.5)	Obsidian
1-1B-874	Surface	50.7	50.7	24.7	4.7	10.9	8.0	175	95	7.5	7.5	Obsidian
1-1B-880	Surface	27.4	27.4	28.5	6.2	10.1	5.6	170	80	3.2	3.2	Obsidian
2/32357	I	67.0	66.3	19.2	8.3	10.5	6.6	190	80	7.2	(7.4)	Obsidian
2/32359	II	36.8	36.8	20.0	11.6	10.6	5.7	160	90	3.3	3.3	Obsidian
2/32387	I, II	57.9	57.9	22.1	7.4	8.5	5.3	110	80	5.9	5.9	Obsidian
2/32485	(II)	40.0	40.0	21.2	4.6	6.3	3.5	110	60	2.4	2.4	Obsidian
2/32725	(II)	36.5	36.5	14.7	6.8	7.0	5.0	200	80	2.6	2.6	Chert
2/32747	(II)	39.8	39.8	20.0	10.6	10.4	5.4	190	60	3.7	3.7	Obsidian
2/32752	II	(73.0)	(73.0)	19.9	6.2	10.0	6.1	200	60	7.8	(8.3)	Basalt
2/32758	IV	48.8	48.8	24.1	7.0	9.0	8.5	170	85	7.8	(8.1)	Obsidian
20.3/9922	N.C.	51.7	51.7	23.0	6.0	8.7	6.2	140	80	4.3	4.3	Obsidian
20.3/9925	N.C.	39.2	39.2	18.1	4.8	9.7	5.8	140	60	3.3	(3.5)	Obsidian
20.3/9926	N.C.	47.2	46.9	18.4	6.5	11.1	7.6	180	60	5.4	5.4	Obsidian
20.4/328	N.C.	24.8	24.8	19.5	6.7	8.9	4.0	150	70	1.5	1.5	Obsidian
20.4/382	N.C.	39.3	39.0	17.0	5.7	6.1	3.8	130	80	1.8	1.8	Obsidian
20.4/398	I	38.6	38.6	16.7	1.8	9.4	6.5	170	60	2.5	2.5	Obsidian
20.4/434	II	(35.0)	(35.0)	21.5	7.0	11.7	5.4	160	85	3.0	(3.2)	Obsidian
20.4/441	III/IV	39.6	39.6	26.9	7.7	11.2	6.5	130	80	4.0	4.0	Chert
20.4/480	N.C.	50.0	50.0	20.0	3.0	12.4	6.8	175	60	5.2	(6.0)	Chert
20.4/507	N.C.	35.6	35.6	19.6	6.5	9.2	5.5	185	70	2.9	2.9	Chert
20.4/549	II	54.6	54.6	18.6	3.0	9.4	6.6	140	60	4.8	4.8	Obsidian
20.4/557	III	34.5	34.5	17.9	3.9	6.8	4.4	110	80	2.0	2.0	Obsidian
20.4/658	N.C.	26.7	26.7	21.4	8.4	10.5	5.2	160	70	2.2	2.2	Chert
20.4/685	N.C.	56.5	56.5	17.0	7.8	10.4	7.6	190	85	6.9	6.9	Obsidian
20.4/686	N.C.	49.5	49.5	18.9	7.3	8.8	4.9	140	85	4.1	4.1	Obsidian
20.4/687	N.C.	50.0	50.0	20.3	5.3	5.6	4.7	110	85	3.4	(3.5)	Obsidian
20.4/696 20.4/704	N.C.	(50.0)	(49.6)	18.1	8.6	8.8	2.9	140	85	2.4	(2.6)	Obsidian
20.4/765	N.C.	50.4	50.4	17.3	(7.5)	10.0	7.3	150	85	4.7	(4.8)	Chert
20.4/766	N.C.	49.2	48.4	18.7	9.4	10.0	6.5	200	85	4.3	4.3	Chert
20.4/767	N.C.	39.0	39.0	27.9	6.4	10.1	6.4	180	80	3.3	3.3	Chert
20.4/768	N.C.	(55.0)	(54.0)	26.0	12.4	10.9	6.5	160	100	4.3	5.0	Obsidian
20.4/836	II	40.5	40.5	16.3	10.6	11.9	4.8	200	95	2.7	2.7	Basalt
20.4/856	IV	57.0	57.0	22.7	8.3	13.3	6.4	185	85	5.6	(6.5)	Basalt
20.4/863	III/IV	65.7	65.7	35.5	16.3	17.3	7.0	120	85	9.3	9.3	Obsidian
20.4/865 20.4/905	III/IV III	51.5	51.5	21.0	8.0	10.1	4.9	160	70	4.6	4.6	Chert
20.4/928	IV	68.0	68.0	20.0	(9.0)	10.9	4.3	150	85	4.3	(5.5)	Obsidian
20.4/958	N.C.	46.2	45.3	26.5	9.2	14.6	8.1	165	80	6.9	6.9	Obsidian
20.4/959	N.C.	41.2	40.3	18.5	10.5	11.7	3.6	200	80	3.6	3.6	Chert
20.4/1005	II	48.9	48.9	25.2	6.4	10.7	5.1	130	70	4.4	4.4	Obsidian
20.4/1245	I/II	44.4	44.4	16.5	4.9	6.7	6.4	175	70	3.2	3.2	Obsidian
20.4/1291	I/II	38.6	37.9	19.7	8.7	9.6	6.6	170	80	4.0	4.0	Obsidian
20.4/1430	N.C.	41.6	41.4	19.7	5.8	9.7	6.4	180	70	3.9	3.9	Chert
20.4/1431	N.C.	38.2	38.2	18.8	5.4	9.2	5.8	190	80	3.2	(3.3)	Obsidian
20.4/1501	IV/V	(65.5)	(65.5)	26.6	9.1	15.3	8.1	170	60	9.8	(10.5)	Obsidian
20.4/1523	N.C.	29.4	29.4	24.6	(8.0)	10.7	6.2	180	80	3.1	(3.3)	Obsidian
20.4/1623	II/III	60.4	60.4	27.5	8.2	13.9	7.8	160	50	11.4	11.4	Chert
20.4/1648	III	40.9	40.9	18.1	4.2	9.2	6.2	180	70	3.4	(3.5)	Obsidian

TABLE 53—(*Continued*)

Specimen Number	Stratum	Length Max. (mm.)	Length Axial (mm.)	Width Max. (mm.)	Width Basal (mm.)	Width Neck (mm.)	Thickness (mm.)	DSA	PSA	Weight Actual (grams)	Weight Total (grams)	Material
20.4/1678	III/IV	49.2	(49.2)	18.8	(10.1)	8.7	9.6	170	100	6.3	(7.0)	Obsidian
20.4/1689	IV	58.2	58.2	23.4	7.7	12.5	5.7	135	70	5.9	5.9	Obsidian
Elko Corner-notched Points:												
1-1B-28	Surface	65.0	61.4	25.3	(21.2)	20.3	6.2	185	130	8.4	(8.6)	Chert
2/32440	II	63.7	61.7	19.0	16.9	15.4	6.7	210	110	6.6	6.6	Chert
2/32526	II	34.3	32.4	24.2	11.4	11.5	5.2	140	110	3.2	3.2	(Quartzite)
2/32607	V	(74.0)	(71.0)	22.0	(14.5)	11.8	7.0	160	110	8.6	(10.0)	Obsidian
20.3/9924	N.C.	30.0	29.2	25.2	12.5	11.5	5.2	170	120	2.9	2.9	Obsidian
20.4/435	III	43.5	42.1	24.2	17.5	12.1	5.0	160	120	4.0	4.0	Chert
20.4/1546	N.C.	36.1	36.1	19.0	11.4	10.6	2.8	180	110	1.8	1.8	Chert
Elko Eared Points:												
1-1B-129	Surface	38.5	35.5	28.2	10.6	12.4	7.1	140	120	3.8	(4.0)	Obsidian
2/32629	I/II	33.8	30.5	20.0	13.5	11.1	4.7	170	110	2.4	(2.5)	Obsidian
20.3/9777	N.C.	40.9	37.5	25.7	(14.7)	13.1	6.0	145	110	4.5	(5.0)	Obsidian
20.4/329	N.C.	32.5	29.5	22.6	(10.1)	10.3	7.5	175	110	3.1	(3.5)	Obsidian
20.4/597	N.C.	41.9	36.7	22.1	13.7	13.0	5.3	200	110	4.0	(4.2)	(Chert)
20.4/1238	IV	51.1	47.2	24.4	(12.2)	12.0	6.3	150	110	6.2	(6.5)	Obsidian
Rosegate Series Points:												
1-1B-114	I	25.4	25.4	(15.8)	7.2	7.4	3.1	140	100	0.9	(1.0)	Obsidian
1-1B-872	I	35.7	35.7	22.1	6.9	6.6	4.3	120	95	2.0	2.0	Obsidian
1-B-890	I	25.9	(25.9)	16.6	(9.1)	9.0	4.7	150	110	1.9	(2.0)	Obsidian
2/32557	II	35.8	35.8	15.1	6.9	6.9	5.0	170	90	1.8	1.8	Obsidian
2/32640	II	35.7	35.7	18.2	(9.4)	8.7	3.4	110	100	2.1	(2.2)	Chert
20.3/9782	N.C.	53.8	53.0	(19.4)	7.8	8.2	3.5	110	100	2.8	2.8	Chert
20.3/9930	N.C.	(20.0)	(19.7)	15.5	7.0	6.9	3.2	120	100	0.7	(1.0)	Obsidian
20.4/1182	I	37.6	36.2	17.3	8.8	7.5	3.4	130	110	1.6	(1.9)	Chert
Humboldt Basal-notched Bifaces:												
1-1B-7	N.C.	29.0	—	21.2	21.2	—	3.9	—	—	—	—	Obsidian
1-1B-216	II	(70.0)	(63.1)	26.1	26.1	—	7.0	—	—	10.9	(12.0)	Obsidian
1-1B-286	II	65.5	60.2	24.8	24.8	—	5.8	—	—	6.8	(6.9)	Obsidian
1-1B-296	II	41.5	35.2	27.8	27.8	—	—	—	—	—	—	Obsidian
1-1B-290	II	(55.0)	(50.0)	23.0	23.0	—	4.8	—	—	3.6	(6.0)	Obsidian
1-1B-313	II	(70.0)	(64.3)	24.1	24.1	—	5.3	—	—	8.3	(9.3)	Obsidian
1-1B-341	II	(70.0)	(64.3)	(26.0)	(26.0)	—	6.2	—	—	4.5	(9.5)	Obsidian
1-1B-615	II	40.4	36.9	11.8	11.8	—	4.7	—	—	2.2	(2.3)	Obsidian
1-1B-885	Surface	26.8	23.4	16.1	16.1	—	4.0	—	—	1.5	(1.8)	Obsidian
2/32408	II	(65.0)	(62.8)	22.5	22.5	—	4.6	—	—	4.4	(8.0)	Obsidian
2/32611	II	65.0	59.7	25.4	25.4	—	5.5	—	—	7.6	(7.5)	Obsidian
2/32734	II	86.6	(78.7)	(25.5)	(25.5)	—	6.5	—	—	10.4	(10.8)	Obsidian
2/32751	II	51.8	46.3	24.0	24.0	—	6.1	—	—	6.0	(6.2)	Obsidian
20.3/9775	N.C.	(69.0)	(62.7)	26.2	26.2	—	6.6	—	—	8.1	(8.5)	Obsidian
20.4/813	I	(75.0)	(68.4)	24.0	24.0	—	7.0	—	—	9.6	(9.8)	Obsidian
20.4/827	II	40.6	34.7	32.5	32.5	—	3.8	—	—	3.3	(3.5)	Obsidian
20.4/908	I/II	(60.0)	(54.5)	22.0	22.0	—	5.2	—	—	3.9	(5.0)	Obsidian
20.4/985	I	(60.0)	(54.1)	(21.0)	(21.0)	—	5.7	—	—	5.2	(7.0)	Obsidian
20.4/1201	II	(68.0)	62.9	(26.5)	(26.5)	—	4.7	—	—	7.1	(8.0)	Obsidian
Humboldt Series Points:												
1-1B-871	Surface	39.7	37.1	12.4	10.5	—	4.3	—	—	2.2	2.2	Obsidian
2/32570	(II)	62.0	58.9	19.4	17.2	—	6.7	—	—	7.2	7.2	Obsidian

TABLE 53—(*Continued*)

Specimen Number	Stratum	Length Max. (mm.)	Length Axial (mm.)	Width Max. (mm.)	Width Basal (mm.)	Width Neck (mm.)	Thickness (mm.)	DSA	PSA	Weight Actual (grams)	Weight Total (grams)	Material
2/32696	IX/X	(87.0)	(83.0)	25.6	(12.0)	—	6.5	—	—	12.9	(13.2)	Obsidian
2/32697	IX/X	38.6	35.0	17.9	12.2	—	6.9	—	—	4.8	4.8	Basalt
20.3/9919	N.C.	58.1	55.0	15.3	11.0	—	6.0	—	—	5.0	(5.3)	Obsidian
20.4/584	N.C.	(34.0)	(32.2)	13.0	(10.1)	—	4.4	—	—	1.9	(2.3)	Obsidian
20.4/939	IV	46.8	43.8	12.5	11.2	—	5.7	—	—	3.1	3.1	Obsidian
20.4/1679	III/IV	38.4	37.0	18.1	(15.4)	—	5.6	—	—	4.3	4.5	Chert
Residual Concave Base Points:												
1-1B-130-19	Surface	109.0	107.1	27.5	9.9	—	10.6	—	—	34.1	34.1	Chert
1-1B-246	Surface	43.0	—	19.4	(13.8)	—	6.8	—	—	4.9	(5.5)	Chert
1-1B-399[a]	II	64.1	57.3	26.9	(25.5)	—	7.3	—	—	10.4	(10.5)	Obsidian
1-1B-410	III	30.5	28.6	13.8	10.7	—	4.1	—	—	1.4	1.4	Chert
1-1B-510	Surface	(70.0)	(62.9)	26.7	(26.5)	—	7.8	—	—	12.5	(13.5)	Obsidian
1-1B-646	II	49.2	48.2	15.7	9.5	—	5.7	—	—	4.4	4.4	Obsidian
2/32404	IV	36.0	(34.4)	14.5	(7.5)	—	4.7	—	—	2.5	(2.8)	Chert
2/32405	IV	41.0	37.8	15.5	15.0	—	6.4	—	—	3.6	3.6	Chert
2/32695	IX/X	91.1	88.9	21.0	10.0	—	7.3	—	—	12.3	(12.4)	Obsidian
2/32698	IX/X	(56.0)	(51.1)	(17.7)	(12.4)	—	(6.3)	—	—	2.3	(6.0)	Obsidian
20.3/9785	N.C.	—	—	—	—	—	—	—	—	0.8	—	Obsidian
20.4/378	N.C.	32.1	32.6	10.4	5.7	—	1.4	—	—	1.4	1.4	Obsidian
20.4/688	IV	—	—	—	—	—	—	—	—	1.7	—	Obsidian
20.4/807	I	(40.0)	(39.3)	13.5	6.4	—	4.9	—	—	2.1	(2.5)	Obsidian
20.4/861	IV	—	—	—	—	—	—	—	—	1.7	—	Obsidian
20.4/965	I	—	—	—	—	—	—	—	—	3.9	—	Obsidian
20.4/979	N.C.	26.1	24.0	11.6	7.3	—	3.6	—	—	1.0	—	Obsidian
Projectile Point Preforms:												
1-1B-323	II	46.6	44.9	22.9	17.3	16.1	6.1	—	—	—	5.1	Chert
2/32415	IX/X	57.7	56.4	20.5	9.1	9.6	5.8	—	—	—	7.8	Chert
Complete Fine Percussion Bifaces:												
2/32515	N.C.	94.4	94.4	29.7	29.7	—	8.9	—	—	—	27.5	Chert
20.4/659	N.C.	46.1	46.1	22.5	7.8	—	12.2	—	—	—	10.4	Obsidian
20.4/660	N.C.	20.2	—	56.6	—	—	9.6	—	—	—	8.3	Obsidian
20.4/832	III	62.6	62.6	31.0	31.0	—	9.4	—	—	—	17.3	Obsidian

Specimen Number	Stratum	Length Max. (mm.)	Length Axial (mm.)	Width Max. (mm.)	Width Basal (mm.)	Thickness (mm.)	Weight (grams)	Material
Complete Pressure Flaked Bifaces:								
1-1B-	N.C.	32.4	32.4	15.3	4.6	8.0	3.5	Obsidian
1-1B-278	II	37.4	37.4	15.1	9.4	4.0	1.9	Obsidian
1-1B-403	II	42.2	42.2	20.6	15.0	9.1	7.2	Obsidian
2/32762	II	(42.0)	(42.0)	15.7	5.0	5.1	(3.0)	Chert
20.3/9778	N.C.	51.1	51.1	14.3	12.0	7.8	6.0	Obsidian
20.4/327	N.C.	47.4	47.4	15.4	3.8	5.9	4.0	Obsidian
20.4/980	N.C.	34.0	34.0	15.4	5.1	7.3	3.5	Obsidian
20.4/986	I	49.7	49.7	18.4	9.2	6.4	5.1	Basalt

[a] These projectile points were assigned the same catalog number.

TABLE 54
Attributes for Ground Stone from Hidden Cave

Specimen Number	Stratum	Length (mm.)	Width (mm.)	Thickness (mm.)	Weight (grams)	Perforation Diameter (mm.)	Material
Discoidals							
1-1B-369[a]	II	52.5	52.5	8.5	(25.0)	7.6	Calcium carbonate
2/32358	II	49.2	49.2	7.7	28.5	7.7	(Marble)
20.4/763	N.C.	59.1	49.0	14.4	61.3	8.4 × 5.7	Basalt
20.4/1729	IV	49.2	49.2	7.5	25.5	7.7	(Marble)
Tablet							
1-1B-591[a]	N.C.	—	41.5	6.5	—	—	Limestone
Cylinder							
20.4/870	IV	34.0	8.5	7.0	3.2	—	Marble/limestone
1-1B-184	Surface	46.3	17.2	14.0	16.0	—	Marble/limestone
Sphere							
1-1B-558	N.C.	—	14.0	—	2.9	—	Marble/limestone
Palette							
20.4/379	N.C.	35.1	27.5	12.9	16.5	—	Marble/limestone
Hammerstone/Mano							
2/32590	III	130.0	78.0	46.0	752.5	—	Basalt
Metate Fragment							
20.4/855	IV	185.0	90.0	58.9	1100.1	—	Basalt
Incised Tufa							
20.4/496	N.C.	98.6	74.7	10.9	98.5	—	Tufa
Stone Bead							
20.4/957	VII	13.6	9.5	2.3	0.5	1.5	Calcium carbonate
Miscellaneous							
1-1B-957	I	65.0	24.0	26.0	50.5	—	(Basalt)
1-1B-964	I	70.0	68.0	27.0	197.0	—	(Basalt)
2/32385	III	133.0	75.0	30.0	418.6	—	Basalt
2/32386	III	127.0	64.0	40.0	477.0	—	Basalt
2/32393	IV	140.0	90.0	54.0	606.0	—	Basalt
2/32437	(IV)	98.0	81.0	62.0	473.0	—	Basalt
2/32591	(IV)	122.0	76.0	54.0	—	—	(Basalt)
2/57829	IV	130.0	49.0	33.0	221.5	—	—
2/57865a	IV	64.0	55.0	32.0	162.4	—	Basalt
2/57865b	IV	116.0	97.0	42.0	641.0	—	Basalt
20.4/494	N.C.	66.2	52.4	34.2	155.5	—	Basalt

[a] Fragmentary specimen.

CHAPTER 15. MATERIAL CULTURE: FUNCTIONAL ANALYSIS OF HIDDEN CAVE LITHICS

LORANN S. A. PENDLETON

We explore the question of lithic curation at Hidden Cave in this chapter. Several research questions guide this inquiry: Were the lithics utilized; if so, was this use heavy or repeated? What is the nature of haft wear on the points; can we demonstrate that utilized points were stored in the cave? Were the projectile points resharpened; if so, was resharpening a recurring event? Were projectile points and/or bifaces reworked into other tool categories? What is the nature of the breakage patterns on lithics; what do these patterns suggest about artifact function and curation? And, finally, were Hidden Cave lithics curated or stockpiled?

The correlation of wear patterns with specific tool function—that is, was the artifact used to cut fish, to scrape hides, to whittle wood or what?—is a current goal of lithic analysis in general (Hayden and Kamminga, 1979, p. 5). That goal may be achieved in the near future; however, the future is not now. This genre of use-wear studies relies on a complex of strategies including replicative experimentation, study of diversity in raw materials, measurement of edge angles, length and shape of margins, plus the use of powerful magnification. Higher magnification ranges (>200×) are thought to detect subtle striations and polish undetectable at lower power settings.

Hidden Cave lithics were examined with a Bausch and Lomb binocular stereoscopic microscope (7–30×) to detect edge damage, haft wear, pronounced striations, resharpening, and breakage patterns. In addition, selected artifacts were examined at magnifications ranging from 40–400× using a Stereoscan 250 scanning electron microscope to detect polish, striation direction, and to identify certain equivocal characteristics. Unfortunately, the results of the scanning electron microscopy are inconclusive and are excluded from this analysis for the most part.

A CAUTION REGARDING USE-WEAR STUDIES

The Hidden Cave collection seems to afford ideal conditions for use-wear analysis. This is a dry cave with relatively minor disturbance. Artifacts may have been stockpiled, so that their surfaces are relatively unaltered. All were carefully excavated and curated. Most artifacts are obsidian, a material which is highly susceptible to edge damage, and on which use wear is highly visible. Adhering organic residues from several artifacts have yielded data on the substances with which they were in contact (see chap. 14, this volume).

We could identify a variety of distinct wear patterns, e.g., bifacial nibbling, unifacial scalar scars, bilateral rounding. But it became apparent that though the patterns were indeed distinct, they did not necessarily lead to meaningful interpretation (for a thorough examination of the various factors affecting use wear, see Keeley, 1980).

The lack of substantial data generated from the several hundred hours of use-wear analysis on the Hidden Cave collection is, we feel, a function of weak interpretive models. At present, the data that relate use-wear patterns to tool function are minimal.

While recognizing the value of detailed macro and microscopic examination of edge damage, we view these studies with a degree of skepticism.

If use-wear analysis is to achieve the level of meaningful interpretation, it will be through a series of controlled experiments employing valid replication. Such validity is obtained only when one precisely controls the variables that directly affect the results: similar raw materials; similar heat treatment of the raw material; similar worked materials; similar handling and storage conditions; and, perhaps the most important variable, the skill level of the replicator.

The value of the analysis rests on the care with which the replication was conducted: "Casual experiments in tool use by untrained persons have no more value than casual experiments by an untrained flintknapper" (Frison, 1979, p. 266).

Although we conducted no specific replicative experiments on the wear patterns in the Hidden Cave collection, we have participated in a variety of experiments dealing with edge damage. To supplement this firsthand experience, we relied on previously reported experiments (Tringham et al., 1974; Ahler, 1979; Frison, 1979; Greiser and Sheets, 1979; Odell, 1979; Sampson, 1982).

Relatively few such studies (e.g., Greiser and Sheets, 1979; Sampson, 1982) deal with obsidian edge damage. Obsidian, which comprises 64 percent of the Hidden Cave lithic sample, is subject to more rapid edge attrition than chert (Greiser and Sheets, 1979, p. 295). Although use wear is more easily visible on obsidian than on chert, actual edge damage patterns are similar. Furthermore, obsidian flakes more easily than chert, leading to measurable differences in edge and spine plane angles. These angles, according to Sampson (1982, p. 73), have relatively little effect on tool function. Duration of use wear, rather than material, seems to be the most critical factor in use-wear patterning.

Inherently greater visibility of such patterning on obsidian should provide a wealth of information on use wear; however, this advantage is minimized by the lack of controlled experiments with obsidian functional patterning. The dearth of controlled experimentation, combined with several noise factors inherent in lithic use-wear analysis (e.g., fats, sources of abrasion, manufacturing damage, patination, and the like) result in our extremely cautious approach to use wear on the Hidden Cave collection (Sheets, 1973; Brose, 1975; Brink, 1978; Patterson, 1981). We cannot, at this time, relate wear patterns we have observed to *specific* tool use; we restrict interpretation to fairly general statements on the nature of use wear.

Functional Categories

Projectile Point Wear: Light to moderate bifacial damage on both margins. The face adjacent to the margin is relatively fresh. Projectile point wear on the margins is typically accompanied by haft wear, which consists of dulling on the face of the point at the level of the shoulder.

Cutting: Moderate to heavy uneven bifacial or bilateral wear on one or both margins. Edge damage is typically accompanied by striations that run parallel or oblique to the margin. Margins are either rounded or beveled.

Drilling: Even bilateral crushing and dulling on the margins.

Scraping: Unifacial or bilateral wear on discrete margin elements.

Graving: Limited to tips or edge protrusions and wear on one face of the tip.

We will follow this conservative approach to use wear until more powerful interpretive models become available.

USE WEAR ON PROJECTILE POINTS

Eighty-eight percent of our AMNH sample of 178 bifacial lithic artifacts were utilized. Of the sample of 136 projectile points and projectile point fragments (excluding the 17 concave base points), 88 percent were utilized; 69 percent were used strictly as projectile points. An additional 9 percent were used for cutting, 6 percent as scrapers, and 4 percent as drills. Most points had been used as projectile points in addition to other functions.

Seventy-one percent of the concave base point sample of 17 points were utilized: 35 percent were used to cut, 24 percent were used solely as projectile points, and 12 percent as scrapers. Use wear could not be determined for 29 percent of the concave base points, most of which were residual concave base points.

The entire sample of the nonprojectile point bifaces had been utilized. Over half (53%) were used as cutting implements. Eighteen percent may have been used as projectile points, although projectile point wear was restricted to the complete pressure flaked bifaces. Scraping wear was observed on 24 percent of the bifaces, and 6 percent were used as gravers. Suspecting that the Hidden Cave lithics held the potential for successful or-

ganic residue analysis, we sent one of the more obvious examples to Thomas Loy for identification. This pressure flaked biface (20.4/509) was found to contain dried bat blood with bat hairs and *Falconiformes* feathers imbedded into its matrix. Both the blood and use wear suggest this biface had been used as a knife on a fresh bat carcass, and perhaps on a bird of prey as well (Loy, this volume).

Of the total AMNH sample of 178 bifacially flaked artifacts, only 22 (12%) had no detectable use wear, but six were resharpened points from which the edge damage had been removed.

Haft Wear

We considered *haft wear* to be present on a point if the surface at the neck and/or shoulder was dulled or polished.

We approach the study of haft wear with several cautions in mind. First, we lack replicative data on haft wear. There are, to our knowledge, no studies dealing with the time in which haft wear accrues. Such wear probably builds slowly, which may result in a number of hafted specimens without any visible sign of haft wear.

Furthermore, haft wear is almost undetectable on chert. Typically, haft wear on chert was keyed to ancillary data such as pitch residue, heavily abraded margins, or fragments of sinew. Moreover, it would be fairly difficult to distinguish haft wear from other forms of polish on the bifaces. Artifact 20.3/9933 (fig. 62a), the hafted projectile point midsection, clearly demonstrates the variability in hafting technique. In this case, a broken artifact without a base had been hafted for use.

Due to the amorphous nature of haft wear, we restrict this analysis to AMNH specimens, which were available for repeated observations. The other collections were subjected to less scrutiny, primarily because they were less easily available. Although this procedure effectively reduced the size of our sample, what was lost in sample size was gained in precision.

Of the sample of 115 typable projectile points (in the AMNH-excavated collection), 34 percent had clear indications of haft wear. The presence of haft wear was variable between projectile point types: No haft wear was detected on the Rosegate points, but that may have been due, in large measure, to a combination of the small Rosegate sample ($n = 3$) and the choice of material (chert). Three of seven (43%) Elko series points had haft wear; the sample was equally divided between obsidian and chert. Within the Gatecliff series, 26 percent of the contracting stem points had distinct haft wear, whereas 42 percent of the split stem points were definitely hafted.

Surprisingly few Humboldt series points or residual concave base points (36%) had detectable haft wear, whereas 83 percent of the Humboldt Basal-notched bifaces had clear evidence of hafting. (Keep in mind that the three sinew-wrapped artifacts from the cave, two of which were still hafted, were all Humboldt Basal-notched bifaces, or portions thereof.)

Resharpening

Thirty-three percent of the entire collection of typable projectile points were resharpened. Only 16 percent of the projectile point fragments were resharpened, undoubtedly prior to breakage. Twenty-two percent of the bifaces and biface fragments (including the residual concave base points) were resharpened.

Repeated resharpening is difficult to detect because resharpening tends to obliterate the previous flake scars. But, based on conservative estimates, 11 of the 201 typable projectile points were resharpened more than once. In addition, one pressure flaked biface and one drill fragment may have been repeatedly resharpened.

Of the 67 resharpened projectile points, only six remained unused after they were resharpened. Apparently, several of the points had been curated from surface contexts, as their surfaces were quite weathered before resharpening.

Breakage

Most projectile points recovered from Hidden Cave were unbroken. In fact, excluding the concave base points, only 12 percent of the typable projectile points were broken.

Only 1 percent of those fractures was perverse and attributable to manufacturing errors. The remainder were end shock fractures, which could be attributed to a variety of factors. End shocks can result from manufacturing errors but they are relatively rare in the final stages of pressure flaking. Since all end shocks occurred on finished points, they most likely resulted from some other cause. The fracture patterns, in conjunction with the scarcity of chippage, suggest that lithic reduction was not a major activity inside Hidden Cave.

A much higher percentage of concave base points (42%) was broken than would be expected from the overall point breakage pattern in the cave (12%). This is particularly striking when compared with the percentage of broken Humboldt Basal-notched bifaces (47%) and lends further support to the concept of functional differentiation between concave base and other point types.

Roughly 40 percent of all bifacial lithic artifacts from Hidden Cave were broken. Most fragments are large, and would have provided a readily reworkable raw material source. With few exceptions, the Hidden Cave lithics are fully usable. This assemblage could certainly have functioned as an *ad hoc* quarry where materials were reclaimed, reworked, and recycled—or merely reused.

Reworking

Projectile points or bifaces reworked into other tool categories were relatively rare in the Hidden Cave assemblage. Eight projectile points were reworked—seven into drills; one was resharpened specifically for cutting. Of eight drill fragments, seven were reworked from Gatecliff and Elko series points.

USE WEAR ON UTILIZED FLAKES[1]

Utilized flakes are divided into categories which reflect the location of their edge damage (e.g., unifacial, bilateral, bifacial, graver tips). They are discussed in terms of the general use wear categories defined above.

For the purposes of this discussion, utilized flakes include both utilized and retouched-utilized flakes; retouch, when present, is unifacial.

Unifacial Use Wear

Number of Specimens: Ten (1-1B-65, 1-1B-965, 1-1B-411; 2/32844; 20.4/443, 20.4/1427, 20.5/1588, 20.5/1589, 20.5/1592, 20.5/1598).

Provenience: Stratum I, two; Stratum II, two; Stratum III, two; Stratum IV, two; not correlated, two.

Materials: Chert six; basalt, two; slate, one; obsidian, one.

Edge Angle: $\bar{X} = 47°$; range from 20° to 70°.

The flakes are utilized on the dorsal face. Use wear is usually restricted to small discrete sections of the edge, i.e., isolated on naturally protruding elements. Wear patterns consist of unifacial nibbling and small scalar scars; no striations were observed.

The specific tasks for which these flakes were used remain problematical, but the light use wear suggests they were probably used to scrape soft materials, such as meat or plants. One particularly large flake (1-1B-411) has distinct unifacial, irregular large scalar wear, and the 1940 catalogue suggests it was used as a fish knife. The flake is made of slate, a material with naturally irregular fracturing qualities which tend to conceal wear patterns. The shape is, however, reminiscent of the ubiquitous *ulu* or *teshoa* flake knife/chopper (Mason, 1891; Renaud, 1959; see particularly Eyman, 1968, fig. 4a).

Teshoa is a Shoshone term for a simple large flake knife which, because of its expedience of manufacture, was used throughout the West (Eyman, 1968, pp. 11–15). It is a simple butchering tool, usually made from a large cobble of some granular raw material from which the large percussion *teshoa* flake is struck.

In the historic period, the tool, whose simple shape lends itself to a variety of tasks including butchering and hide-scraping, was allegedly used primarily by women; speci-

[1] Several utilized and/or retouched utilized flakes were unavailable for study from the Nevada State Museum, and are not included in this summary: 1-1B-26; 1-1B-343; 1-1B-837; 1-1B-866; 1-1B-962; 1-1B-966; 1-1B-967.

mens which were repeatedly resharpened were used as choppers (Eyman, 1968, p. 16).

The slate flake from Hidden Cave has unifacially retouched scalar margins. Most *teshoa* knives have bifacially crushed margins; retouch varies between unifacial and bifacial.

Bilateral Use Wear

Number of Specimens: Six (1-1B-513; 2/32845; 20.4/944, 20.4/1218, 20.4/1228, 20.4/1232).

Provenience: Stratum I, one; Stratum II, one; Stratum III, two; Strata III/IV, one; not correlated, one.

Materials: Chert, four; obsidian, two.

Edge Angle: $\bar{X} = 49° \pm 21°$ ($n = 11$ edges), range from 20° to 80°.

Bilateral wear on unifaces could have occurred either as a series of discrete events, consisting of the unifacial use of opposite margins, or as a continuous event in which the contact between the flake and the worked material was erratic, resulting in use wear on alternating faces of the same margin.

Four of the flakes have concave margins. Unifacial wear within the concavities probably resulted from scraping rounded objects (e.g., sticks or bone). Wear patterns consist of small nibbling with edge angles in excess of 40°. Additional bilateral wear appears contiguous to the concavities on three of the scrapers.

Two flakes have straight beveled margins covered with bilateral scalar scars and small nibbles which probably resulted from light scraping on semisoft materials such as hides or fleshy plants.

Bifacial Use Wear

Number of Specimens: Four (1-1B-956; 2/32654, 2/32848; 20.4/738).

Provenience: Surface, one; Stratum II, two; Stratum III, one.

Materials: Chert, four.

Edge Angle: $\bar{X} = 56° \pm 15°$ ($n = 7$ edges); range from 40° to 75°.

Three bifacially utilized flakes are elongated ovals, both margins of which have been used; the other is square with one rounded margin and was probably used as a backed knife.

Bifacial use wear consists of somewhat rounded margins with scalar and trapezoidal scars; several margins are crushed. The wear patterns suggest light cutting of semisoft material, or prolonged cutting of soft material.

Graver Tips

Number of Specimens: Six (2/32407; 20.4/568, 20.4/759; 20.4/1449; 20.5/1591; 20.5/1599).

Provenience: Stratum II, one; Stratum III, one; Strata III/IV, one; not correlated, three.

Materials: Chert, three; obsidian, three.

Edge Angle: Tip angles range between 60° and 80°.

Gravers were usually retouched into one or more points. The sole exception, 20.4/568, is the remnant of an obsidian nodule with a series of four natural graver edges formed on its square cross section.

Two gravers were also used as scrapers. They have been bilaterally retouched, and the margins are worn with step flakes and crushing.

The tip on 2/32407 is polished in one direction, toward the dorsal face; this is typical of the wear pattern on incising implements that are held with the ventral face oblique to the working surface.

The tip on 20.4/759 is relatively fresh. The flake, which is serrated along the dorsal face on both lateral margins, is broken by crenated fractures. Although this retouched flake has no distinct wear patterns, it is shaped like a graver. More than likely, it is an unfinished point which was curated for other purposes.

Artifact 20.5/1599 appears to have been a scraper/graver. The left dorsal margin is rounded and smoothed, probably from scraping soft material. The opposite right dorsal margin was retouched into a single graver point midway along the margin. Use wear is most prominent on the distal portion of the tip, indicating the flake was held perpendicular to the working surface.

Artifacts 20.4/1449 and 20.5/1591 are small flakes with multiple graver tips. The former is not actually a flake, but rather a piece of dome-shaped shatter with a series of unmodified sharp projections. Two of the "tips" have been unilaterally used. The con-

cavity between the two graver tips was also used. Artifact 20.5/1591 is a small circular flake with a series of six retouched graver tips; it resembles a small circular saw. Use wear consists of rectilinear nibbles with steep edge angles (80° to 90°) on the left dorsal margin. Ventral use wear covers the opposite margin and, again, consists of overlapping rectilinear small flakes. All tips are dulled, but no particular directionality is apparent.

There may be some relationship between the quantity of gravers and the abundance of incised artifacts from the cave. In fact, artifact 20.5/1591 would have served well as the incising tool for the punctated designs on several of the bone artifacts (1-1B-570, 20.4/453, and 20.4/569), or for one of several incised bone whistles (2/32565) which were found in the same stratum as the graver.

PRELIMINARY RESIDUE ANALYSIS: AMNH SPECIMEN 20.4/509

THOMAS LOY[2]

Artifact 20.4/509 was submitted for analysis of residues because it appeared to have been used. The bifacially worked obsidian artifact was received, packed in a plastic bag; no obvious matrix or surficial deposits were observed loose in the bag at the time of unpacking. A label of white and black ink and clear nail polish showing the artifact designation number was affixed to one side; the artifact had been handled enough to apply the label and conduct preliminary microscopic analysis (see Pendleton, this chap.), but it is my understanding that that was the extent of handling. Using a stereobinocular microscope (Wild M-4) at magnifications up to 32 diameters, we saw no obvious modern contamination.

At low magnification (Wild M-4, 5 to 60 diameters) two distinct types of residue were observed: (1) a widespread thin clear film that showed scratch marks and polygonal cracking patterns, and (2) plaques and thick deposits of a mix of fine-fraction soil particles (clay and silt) bound by a red, vitreous appearing material. Within the plaques and thick deposits sometimes underlying these deposits, small fibers were observed locally in great numbers (20 to 30) and also isolated singly at various locations on the surface.

The tool was mounted on a resin-coated wooden stub (the resin was in contact with the label only) to support it for high power microscopic examination. Only the face obverse to the label was examined at high magnification using a Reichert Me-F2 inverted stage instrument. Illumination was provided with a 100 watt quartz-iodine lamp through incident light Epilium objectives. A complete sweep of the surface was made at 120 diameters, and selected areas were examined at magnifications up to 800 diameters.

During the high magnification examination, the fibers observed at low magnification were resolved and identified as from the bat genus *Myotis*; species level is not supported by this hair identification. Both shield and basal scale patterns as illustrated in Moore, Spence, and Dugnolle (1974, fig. 18, p. 61, pls. B and F) were observed on individual hairs. Diameters, as measured by an eyepiece micrometer-scale, varied from 11 to 12 micrometers, well within the range for this genus. The scale pattern of basal hairs for bats is very distinctive and is not easily confused with that of other North American mammalian hairs. The hairs are widely distributed over the face examined; clusters are common in thick deposits and plaques. The outline of the basal hair region was observed lying within the clear thin coating in three places. In each case, these hairs were observed to lie within or underneath the deposits; that is, these hairs are not simply adhering to the surface by electrostatic attraction, they are firmly part of the surficial deposit.

Along the retouched edges, both plaques and thick deposits as well as thin clear films were observed; and as on the face, bat hairs of the same genus were evident. In addition to the hair, individual feather downy-barbules were observed. In one location three barbules were found extending out of a thick plaque near the edge of the tool. These bar-

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bules can be characterized to the order Falconiformes on the basis of the morphology of nodal spurs. Feather barbules are segmented (the feathers observed have an average segment length of 20 micrometers and a diameter of 10 micrometers), and at the point of joining (the node) there are spurs or other projections that are diagnostic of this order.

Again, the presence of the feather barbules lying under or within the thick deposits or plaques indicates that they were deposited at the time of formation of the plaque/deposit.

Optical measurements were made to determine the relative refractive index of the clear thin surficial film. Using transmitted light at 300 diameters and applying an approximate correction to counter the black pigmentation of the obsidian, it was determined that the refractive index was greater than 1.55, suggesting that the film was not a hydration layer, but was in fact a film of protein. Observed polygonal cracking and crazing patterns are consistent with drying shrinkage in proteinaceous films.

Chemical tests to verify the presence of protein were made with the Chemstrip testing procedure: 10 microliters of deionized, distilled water were applied to a selected spot on the face of the tool obverse to the label and allowed to remain for 10 minutes; about 8 microliters were removed with a sterile pipette and placed upon the hemoglobin-myoglobin sensitive pad on the Chemstrip testing strip. The reaction was immediate and very positive. After two minutes of reaction time, the semiquantitative determination indicated in excess of 250 erythrocytes (red blood cells) per microliter. This reaction is typical when whole blood is applied directly to the testing pad. The pad, which is sensitive to serum albumen, gave very positive results as well. These reactions are strong presumptive evidence for the presence of blood.

Unfortunately, at the present moment I am unable to pursue the chemical/crystallographic identification to species of origin owing to equipment failure and the lack of control samples for species of bat. Nevertheless, during high magnification of the area tested with the Chemstrip, 10 red cells were observed within a red-colored plaque of blood with bat hair directly associated. These cells measured between 7.0 and 7.5 micrometers in diameter, were non-nucleated, circular, and hence typical of mammalian blood.

In summary, chemical testing and microscopic examination have established the presence of blood on the surface of this tool. The distribution, and especially the thin clear layer that underlies the thick plaques, suggests that the tool was used at least two separate times, and both involved the cutting of, or contact with, a bat of the genus *Myotis* as supported by the positive identification of that animal's hair. In at least one subsequent use, contact with both blood and Falconiformes feathers is indicated. The locations along the cutting edge of the tool suggest further that the contact with that bird was one of cutting rather than simple accidental contact with a bird feather.

A detailed life-history of the tool, or expansion of the discussion to include the use of bats within the subsistence patterning of the prehistoric user of the tool is beyond the scope of this examination. Much more can be learned from a detailed examination of surface scratches on the protein film coating which would indicate direction of tool movement; examination of residues in the flake scar terminations along the working edges may bear out an initial impression that both cutting and scraping functions were performed by this tool.

Clearly, the presence of bat hair, blood, and feathers does not reflect a noncultural deposition process; details remain to be established.

CHAPTER 16. MATERIAL CULTURE: ARTIFACTS OF BONE AND HORN

LORANN S. A. PENDLETON

Artifacts of horn and bone are discussed here in specific descriptive and functional categories: bone awls, pressure flakers, bone beads, incised bone artifacts, polished bones, etc. Subsistence and settlement implications of this artifact set will be discussed in subsequent chapters. See table 55 for bone and horn artifact proveniences.[1]

POINTED BONE

Forty-nine bone artifacts were sharpened to points (see table 56 for metric and provenience data), including an incised bone (discussed in the following section), two perforated bones, 27 awls or points, seven flakers, and 12 unclassified pointed bones which are probably awl fragments; the unclassified bone fragments are not individually tabled.

Twenty-seven artifacts have been classified as awls or projectile points on the basis of tip width and tip angle: width of tip ($\bar{X} = 1.47 \pm 0.496$ mm.; range, 0.4 mm.–2.5 mm.), and angle of the tip ($\bar{X} = 23.6° \pm 0.7°$; range, 10°–40°). Seven bone artifacts were classified as pressure flakers, based on similar criteria: width of tip ($\bar{X} = 5.1 \pm 0.83$ mm.; range, 4.0 mm.–6.5 mm.), and tip angle ($\bar{X} = 67.1° \pm 16°$; range, 40°–80°).

Bone Awls and Points

Of the 27 bone awls or awl fragments, four are made of bird or jack rabbit bone, and the remainder are made from mammal bone. Proximal artiodactyl cannon bone is most prevalent, followed by artiodactyl radii. Artifact 20.4/437 (fig. 71m) may have been made from an artiodactyl thoracic vertebra. Bird bone awl 2/32416 was made from the tibiotarsus from a Western Grebe, *Aechmophorus occidentalis* (Roust and Grosscup, n.d., p. 71).

The Hidden Cave awls were classified by Dalley's typology (1970b, pp. 106–113), and include four type A awls, with the head of the bone intact (fig. 71a, b); seven type C awls, with a partially modified head (fig. 71c–f); and 16 type G awls, which are reworked fragments (fig. 71g–o).

Several of the type G awls were probably points (1-1B-223; 1-1B-260; 1-1B-295; 2/32360; 2/32384; 20.4/570; 20.4/1181 and 20.4/1320), all of which were shoulderless with round sharp tips (e.g., see fig. 71g, k, l, n, o). Apparently, there is considerable variation in the manufacture of bone awls and points: the bulk of bone artifacts are made from split bone; points are made from unsplit bone, which has more inherent integrity than split bone, producing a stronger tip. Several points appear to have been fire hardened, which would also have strengthened the tip; none of the awls were burnished.

The awls and points were subjected to low power microscopic analysis (7–30×). The tips are highly polished and sharp, tapering gently to a slight shoulder. Six tips (1-1B-180; 1-1B-1009; 2/32402; 2/32774; 20.4/437; 20.4/1583) are recurved, forming a nipple, above which is a distinct shoulder (e.g., fig. 71c–e, h, m). The shouldering, which was usually restricted to the lateral margins, may have resulted from repeated resharpening (see Meighan [1953b] and Newcomer [1974] for various experiments with awl manufacture and use wear).

Most of the wear on the awls consists of a highly polished sheen. Striations generally circumscribe the margins just above the tip, but parallel and diagonal striations were also noted. The deeper striations probably occurred during manufacture; however, the sheen and polish seem to be use wear.

[1] Several other bone artifacts were unavailable for analysis: 1-1B-203; 1-1B-215; 1-1B-271; 1-1B-330; 1-1B-336; 1-1B-364; 1-1B-376; 1-1B-428; 1-1B-467; 1-1B-548; 1-1B-559; 1-1B-566; 1-1B-655; 1-1B-693; 1-1B-743; 1-1B-744; 1-1B-904; 1-1B-906; 1-1B-907; 2/32483; 2/32605; 2/57821. The three Lowie Museum artifacts are awls; one was identified by Seth Benson (University of California, Museum of Vertebrate Zoology) as part of the lower penis bone of a black or grizzly bear, probably the latter (Roust and Grosscup, n.d., p. 71, fig. 30).

TABLE 55
Provenience of Bone and Horn Artifacts from Hidden Cave

Type	*n*	Surface	I	I/II	II	II/III	III	III/IV	IV	IV/V	V	VII	IX/X	N.C.
Bone awls														
Type A	4	1	—	—	2	—	1	—	—	—	—	—	—	—
Type C	7	2	1	—	2	—	1	—	—	—	—	—	—	1
Type G	16	2	1	—	5	1	2	1	2	—	—	—	1	1
Flakers	7	1	—	—	4	—	—	—	1	—	—	—	—	1
Perforated pointed bone	2	—	—	—	1	—	—	—	—	—	—	—	—	1
Unclassified pointed bone	1	—	—	—	—	—	—	—	1	—	—	—	—	—
Unclassified pointed bone fragments	12	—	—	—	—	—	2	1	8	—	—	—	—	1
Beads and tubes	5	—	—	—	3	—	—	—	—	—	—	—	1	1
Antler pendant	1	1	—	—	—	—	—	—	—	—	—	—	—	—
Pond turtle pendant	1	—	—	—	1	—	—	—	—	—	—	—	—	—
Horn pendants	19	1	2	3	2	—	—	—	—	—	—	—	—	11
Incised bone	9	1	—	1	2	—	1	1	1	—	—	—	—	2
Tabular bone	3	—	—	1	1	—	—	—	—	—	—	—	—	1
Composite bone	1	1	—	—	—	—	—	—	—	—	—	—	—	—
Totals	88	10	4	5	23	1	7	3	13	0	0	0	2	20

Pressure Flakers

Seven pressure flakers were recovered (fig. 72). Two were probably made from split artiodactyl cannon bones. The flakers are generally ground along the margins, and the tips are blunted and crushed. The flakers were repeatedly resharpened; several were resharpened down to the porous inner core of the bone.

Four flakers were small enough for hafting, but the other three fit comfortably into the palm of the hand and were probably used without handles. Artifact 1-1B-538 (fig. 72c) has a beveled tip reminiscent of contemporary pressure flakers (cf., Crabtree, 1967, fig. 3). The tip is dulled, with deep parallel striations.

The size of pressure flaker used varies according to the stage of artifact fabrication (Crabtree, 1967, p. 65). Several stages of pressure flaking, and the use of several sizes of pressure flakers are particularly evident on Gatecliff series and Humboldt Basal-notched points. The pressure flaker discussed above would have been an ideal tool for the initial pressure work required to manufacture these points.

Ethnographic research among the Shoshone and Northern Paiute suggests that antler was preferred for pressure flaking tools (Steward, 1941, p. 288; Stewart, 1941, p. 383). Therefore, it seemed curious that the pressure flakers in Hidden Cave were made from bone rather than antler. But a quick review of the literature indicates that bone, particularly rib bone, was a common pressure flaking material in prehistoric times (Dalley, 1970b, fig. 79c–e; Fowler, 1968, fig. 9f; Hattori, 1982, pp. 144–145; Heizer and Krieger, 1956, p. 19, pl. 10m; Muto, Mehringer, and Warren, 1976, p. 273; Steward, 1937, pp. 115–116). Crabtree (1967, p. 66) provides a detailed description of the use of various bones as pressure flakers, and most of the Hidden Cave flakers are consistent with his suggestions. Murdoch (1892, p. 288) claims that hard bone was the conventional material for Eskimo composite flakers, and Gifford (1940, pp. 170–171) lists various examples of bone flakers used by the ethnographic tribes in California.

TABLE 56
Metric Attributes for Pointed Bone Artifacts from Hidden Cave[a]

Specimen Number	Stratum	Length (mm.)	Width (mm.)	Thickness (mm.)	Tip Width (mm.)	Tip Angle (degrees)	Weight (grams)	Material
Awls and Points								
Type A								
1-1B-247	Surface	159.3	17.7	8.3	0.6	25	—	Metapodial artiodactyl
1-1B-526	III	179.6	13.2	2.5	0.7	20	—	Metapodial artiodactyl
2/32416	II	140.1	10.0	2.7	1.3	20	1.9	Tibiotarsus *Aechmorphus occidentalis*
2/32553	II	85.1	14.8	9.9	1.2	25	5.2	Bird or jack rabbit
Type C								
1-1B-368	II	62.4	22.5	11.5	1.1	15	—	Metapodial artiodactyl
1-1B-180	Surface	77.8	13.4	11.5	1.6	20	7.7	Cannon bone artiodactyl
1-1B-875	Surface	99.1	16.7	4.8	0.9	15	—	Longbone shaft
2/32402	II	171.5	16.4	9.5	2.0	15	17.0	Cannon bone artiodactyl
2/32774	I	91.8	22.7	12.2	1.1	30	11.7	
20.4/233	N.C.	95.3	15.9	12.5	2.5	20	12.6	Cannon bone artiodactyl
20.4/1735	III	145.3	17.5	14.0	1.5	30	24.5	Radius or cannon bone artiodactyl
Type G								
1-1B-223	II	—	—	—	1.0	10	—	
1-1B-260	Surface	—	—	—	1.0	25	—	
1-1B-295	II	—	—	—	0.7	25	—	
1-1B-1009	Surface	—	17.1	7.0	1.5	15	—	
2/32360	X	—	7.4	5.3	1.3	30	—	
2/32365	II	—	—	—	0.7	30	—	
2/32384	III	—	—	—	1.9	30	—	
2/32632	II	—	10.0	6.5	1.4	20	—	
20.4/437	II/III	—	10.9	3.2	2.3	30	—	Artiodactyl thoracic vertebra
20.4/570	III	—	—	—	2.2	40	—	
20.4/938	IV	—	—	—	1.0	20	—	
20.4/1181	I	—	—	—	1.0	20	—	Probably artiodactyl
20.4/1320	II	—	4.1	4.1	1.7	20	—	Bird bone
20.4/1583	N.C.	—	17.4	10.0	1.5	10	—	Probably artiodactyl, long bone fragment
20.4/1600	IV	—	—	—	1.4	20	—	
20.4/1676	III/IV	—	5.7	4.9	1.5	40	—	Bird bone or possibly *Lepus* tibia
Flakers								
1-1B-20	II	—	8.9	4.3	4.5	80	—	
1-1B-144	Surface	55.7	15.5	11.7	4.6	50	4.9	
1-1B-538	II	(107.3)	12.4	6.7	6.5	70	6.3	
1-1B-765	IV	48.9	8.2	6.3	5.5	70	1.8	
2/32663	II	94.7	22.0	17.1	4.0	40	16.4	
2/32741	II	52.0	15.0	(4.0)	5.0	80	2.8	
20.4/707	N.C.	63.5	8.2	4.9	5.5	80	2.7	Possibly artiodactyl
Perforated								
2/32733	II	108.2	18.6	4.2	1.6	25	8.2	
1561[b]	N.C.	77.9	9.7	2.9	1.5	15	2.4	

[a] Unclassified pointed bone was not tabled.

[b] Artifact and catalog number are from the Margaret M. Wheat Collection.

FIG. 71. Selected bone awls from Hidden Cave. a. 2/32416; b. 2/32553; c. 2/32774; d. 1-1B-180; e. 2/32402; f. 20.4/233; g. 1-1B-260; h. 1-1B-1009; i. 2/32632; j. 2/32365; k. 1-1B-295; l. 1-1B-223; m. 20.4/437; n. 2/32384; o. 2/32360. Type A awls, a, b; Type C awls, c–f; Type G awls, g–o.

Provenience: Surface, c, d, g, h; Stratum II, a, b, e, i–l; Strata II/III, m; Stratum III, n; Strata IX/X, o; not correlated (N.C.), f.

PERFORATED POINTED BONE

Artifact 2/32733 (table 56) is a biconically perforated long bone splinter or horn fragment (Roust and Grosscup, n.d., p. 79, fig. 37) which has been polished and burnished to a high sheen. The split bone has a concavo-

convex cross section, and the wide tip is sharply pointed. Similar specimens were found at Kramer Cave, but these are incised (Hattori, 1982, pp. 67, 69). It has been suggested that tools of this type may have been used for scratching or hair arranging. They were thought to have been suspended on cordage and worn around the neck. A similar specimen, illustrated from Humboldt Cave (Heizer and Krieger 1956, pp. 19, 141, pl. 10g), was thought to have been a thatch needle. The width of the tip and tip angle of the Hidden Cave specimen suggest it may have been used as an awl, although no distinct wear patterns were noted.

Unclassified Pointed Bone

A split proximal cannon bone fragment (20.4/446, fig. 73a) has been sharpened into a point at the tip, and the head has been ground into a rounded knob. The tip covers half the length of the artifact, and one surface has been polished flat. The tip and part of the tip margin are highly polished, but the lack of characteristic use wear and rounding on any portion of the flattened surface makes its use as an awl questionable. It is similar to elements described in the ethnographic ring and pin game, or it may have been an atlatl engaging spur (Riddell and McGeein, 1969).

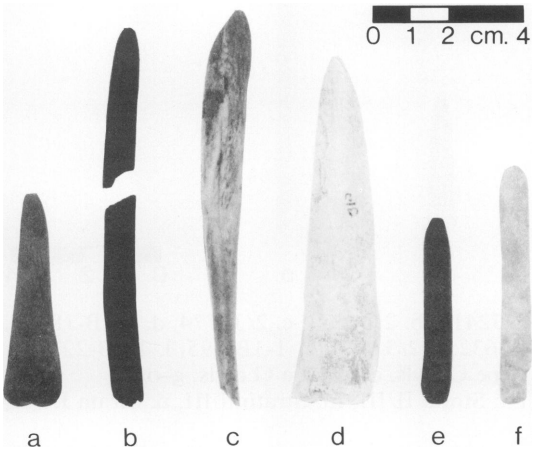

Fig. 72. Selected bone pressure flakers from Hidden Cave. a. 1-1B-144; b. 1-1B-20; c. 1-1B-538; d. 2/32663; e. 1-1B-765; f. 20.4/707.

Provenience: Stratum I, a; Stratum II, b–d; Stratum IV, e; not correlated (N.C.), f.

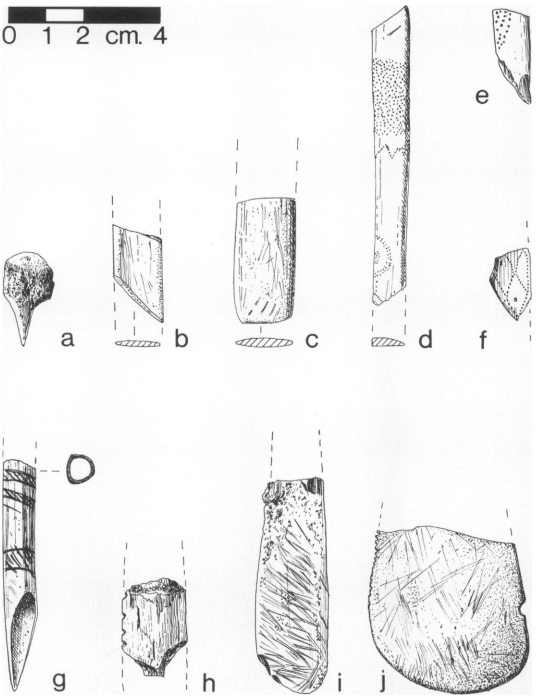

Fig. 73. Miscellaneous bone artifacts from Hidden Cave. a. 20.4/446; b. 20.4/1187; c. 20.4/1569; d. 20.4/453; e. 1-1B-570; f. 20.4/569; g. 20.4/1432; h. 1-1B-241; i. 1-1B-256; j. 20.3/9999. Unclassified pointed bone, a; tabular bone, b, c; punctated incising, d–f; banded incising, g; incised margins, h–j.

Provenience: Surface, h; Strata I/II, b; Stratum II, e, i; Stratum III, f; Strata III/IV, d; Stratum IV, a; not correlated (N.C.), c, g, j.

Unclassified Pointed Bone Fragments

Twelve unclassifiable polished, pointed bone fragments were recovered from the cave (20.4/571; 20.4/665; 20.4/670; 20.4/672; 20.4/676; 20.4/683; 20.4/937; 20.4/941; 20.4/1221–1223; 20.4/1645). Generally, these pieces consist of bone splinters which were once parts of awls or various other polished bone artifacts.

Specimens 20.4/1221–1223 consist of five burned fragments which are probably all part

of the same awl tip. Three other fragments (20.4/571, 20.4/683, 20.4/937) are burned.

Artifact 20.4/1645 is a small sharpened bone fragment with a lightly polished tip, one end of which has been sharpened to a point with a beveled cut. This may have been an expedient tool; the user took advantage of a point formed by a natural fracture.

BEADS AND PENDANTS

Bone Beads and Tubes

Undecorated tubular bone artifacts are relatively rare in the collection. Four large cylinders (diameters, 5.9 mm.–9.0 mm.) which probably functioned as tubes were recovered (fig. 74a–c). The small cylinders (20.4/956, 20.3/9972) are probably beads (fig. 75d, e). Only one bone tube (2/32606, fig. 74a) is unbroken. The tubes were lightly polished, retaining many of the defleshing and cut marks.

Gifford (1940, p. 179) suggests that bone tubes were used as beads, nose and ear sticks, drinking tubes, whistles, and mouthpieces for pipes. Steward (1941, pp. 259–262) suggests the Western Shoshone used these objects as sucking tubes in curing ceremonies. The Northern Paiute used bone tubes as nose ornaments and dress decorations (Stewart, 1941, pp. 391, 393, 435). Hollow bones were part of the Paiute hand game (*naiakwi*) (Stewart, 1941, pp. 397, 402). Similar uses were recorded for the Shoshone (Steward, 1941, pp. 297, 299, 303).

Bone tubes are widely distributed in California and the Great Basin. Ninety beads and eight tubes were excavated, for example, from Gatecliff Shelter (Thomas, 1983b). Six undecorated bird and mammal bone tubes were recovered below the 24-inch level at South Fork Shelter (Heizer, Baumhoff, and Clewlow, 1968, pp. 17–18). Eighty-eight bone tubes were excavated from Kramer Cave, the bulk of which were strung in a necklace as spacers between juniper seed beads (Hattori, 1982, pp. 55–58, 66–67, figs. 18, 21d, e). Fifty-six bird and mammal bone tubes were recovered from Lovelock Cave (Loud and Harrington, 1929, p. 38). A cache of four coyote bone tubes and three isolated bird tubes were found in Humboldt Cave (Heizer and Krieger, 1956, p. 70). Wheeler (1942, p. 19, fig. 26a) excavated bone tubes from Etna Cave, where they were attached to strings and used as loop snares (Wheeler, 1942, p. 31). Twenty-six bone tubes of various sizes were recovered from Karlo, primarily in the top 24 in. (Riddell, 1960, pp. 43–44), and 14 were excavated from Tommy Tucker Cave (Riddell, 1956). Tubes were also found at Hogup Cave (Aikens, 1970, pp. 88–90), Danger Cave (Jennings, 1957, p. 200), Promontory Caves, No. 1 and 2, and Black Rock Cave (Steward, 1937, pp. 27–28, 101, 116, fig. 8). Heizer and Krieger (1956, pp. 84–85) suggest these tubes were common in the Basin, and were frequently associated with southwestern Basketmaker and Pueblo sites.

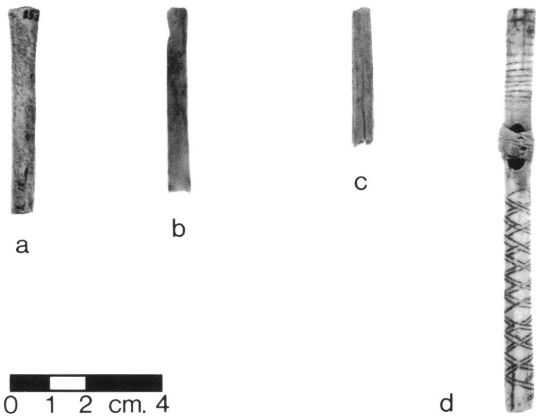

FIG. 74. Miscellaneous tubular bone artifacts from Hidden Cave. a. 2/32606; b. 1-1B-502; c. 2/57826; d. 2/32565. Bone tubes, a–c; bone whistle, d.

Provenience: Strata I/II, d; Stratum II, a, b; not correlated (N.C.), c.

Antler Pendant

One perforated hollow antler tine was found on the surface in Hidden Cave (20.4/359, fig. 75c). The pendant (length, 54.3 mm.; width, 17.2 mm.; thickness, 13.9 mm.; perforation diameter, 3.8 mm.) is a highly polished tine which may have been burnished; its surface is covered with a thin black substance of unknown origin. Gifford (1940, p. 232, illustration II) shows a similar antler tine ornament with a perforation on the opposite end.

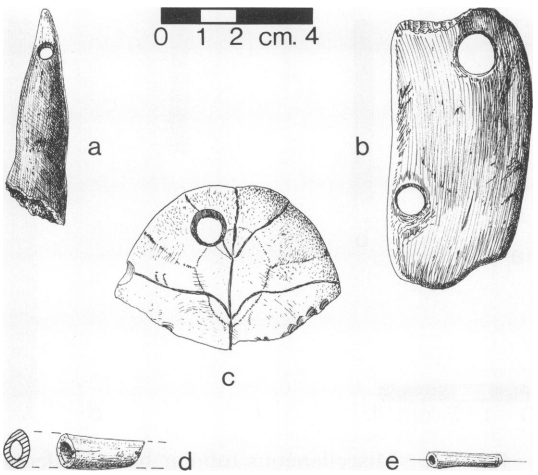

FIG. 75. Selected miscellaneous bone ornaments from Hidden Cave. a. 20.4/359; b. 20.4/1229; c. 1-1B-189; d. 20.4/956; e. 20.3/9972. Antler pendant, a; bighorn pendant, b; pond turtle pendant, c; beads, d, e.

Provenience: Surface, a, b; Stratum II, c, e; Strata IX–XII, d.

POND TURTLE PENDANT

A western pond turtle plastron (*Clemmys mammorata*)[2] from Stratum II was manufactured into a semicircular pendant (1-1B-189, fig. 75c). The light umber-colored plastron has a highly polished dorsal face (length, 43.0 mm.; width, 57.5 mm.; thickness, 4.6 mm.; weight, 8.8 grams). The ventral face is unmodified, with a fleshy residue adhering in the crevices. A beveled, conical perforation near the top margin, about 3.0 mm. to the left of center, has been drilled from the dorsal face. The lower margin was cut or broken along a natural suture, after which it was polished; the other margins are unmodified, but smooth.

This specimen resembles Kramer Cave artifact 2212, which dates to about 1750 B.C. (Hattori, 1982, p. 94, fig. 26a). Although Hattori's detailed examination of western pond turtle biogeography leaves some doubt about the availability of pond turtle in prehistoric western Nevada, various prehistoric pond turtle remains have been recovered from Marble Bluff at Pyramid Lake, at the Chinese settlement at Lovelock, and from Windmiller sites in central California (Hattori, 1982, pp. 92–97).

HORN PENDANTS

Bighorn sheep horn artifacts are relatively rare in the Great Basin, reported from fewer than 10 sites. Hidden Cave contained 19 such horn artifacts[3] (see figs. 75b, 76; metric and provenience data for 17 of the pendants are listed on table 57).

Fourteen of the artifacts are conically or biconically drilled with one perforation; two (2/32609; 20.4/1229) are biconically drilled with perforations at either end (2/32609 may once have had a third perforation along the broken lateral margin); pendant 2/21907 is biconically drilled with eight perforations.

The pendants are generally rectilinear with smoothed margins, varying between ovoid and triangular outlines. The surfaces are highly polished, either intentionally or from considerable handling.

They appear to have been manufactured by cutting sections of bighorn sheep horn to the desired shape (see Loud and Harrington, 1929, fig. 9), drilling the perforations, and then polishing both faces and the margins with a series of finely graduated polishing tools; they were probably finished with an exceptionally soft material, such as hide.

Artifact 2/32604 (fig. 76b) may be a pendant preform. The perforation is biconical but incomplete: the interior perforation is 3.6 mm., considerably smaller than the lip surrounding it (10.6 mm.). The lip appears to be the beginning of a larger perforation. Another indication that perforations were manufactured in stages is that the 3.6 mm. perforation is considerably smaller than the mean perforation diameter of the group as a whole (6.9 ± 1.6 mm.) Furthermore, the unpolished rough margins on this artifact lend support to the conclusion that it was unfinished.

Pendant 1-1B-13-G-20 (fig. 76c) has been incised with dots. Both faces are highly pol-

[2] We thank Dr. Eugene Hattori for the identification of this specimen.

[3] Two horn pendants (1-1B-8 and 1-1B-1047) were unavailable for study.

ished, as are the margins, and a smooth biconical perforation has been drilled near the upper margin. The incising, which was applied subsequent to the polishing, is somewhat rough and detached tiny chips from the surface around the dots. A reddish pigment was applied to the tiny circles, some of it bleeding onto the face of the pendant. The dots vary in depth, becoming more shallow toward the perforation. The pigment, probably hematite, apparently was mixed with some greasy substance, leaving a coagulated deposit inside the circles. The circles are deep, conical in shape, and were produced by a very narrow sharp-tipped implement which was twisted on the face of the pendant. Microscopic examination revealed no change of instrument in the dot manufacture, suggesting the incising was probably accomplished in a single episode. A similar specimen was part of a horn rattle at Lovelock Cave (Loud and Harrington, 1929, p. 45, fig. 11j).

Several other horn pendants were also incised, including artifact 2/32609, which has deeply cut V-shaped bifacial notches on the exterior lateral margins of the horn and shallow U-shaped notches on the interior along the proximal margin. The cuts along the right dorsal lateral margin do not overlap onto the ventral face. The notches were made with a thin flake. The lateral cuts seem to form two sets of three incisions, with an additional cut along the distal margin. The left dorsal margin may have been broken, and what appears to be half of a perforation occurs near the proximal end of this margin. The margin surface is rough and convoluted, but there was an apparent attempt to smooth the margin after the break occurred.

Artifact 2/32753 appears to be a bird effigy. The margins are incised with V-shaped and U-shaped cuts. The base is notched by pressure flaking, similar to pressure flaking on stone. The pressure notches are oriented downward, forming deep uneven serrations. Four of the notches give the pendant a shouldered appearance, dividing it into thirds. The pendant is most heavily smoothed within the interior of the shoulder notches. The perforation is conical, drilled from the exterior surface of the horn.

Perforated horn artifacts recovered elsewhere in the Basin are generally considered

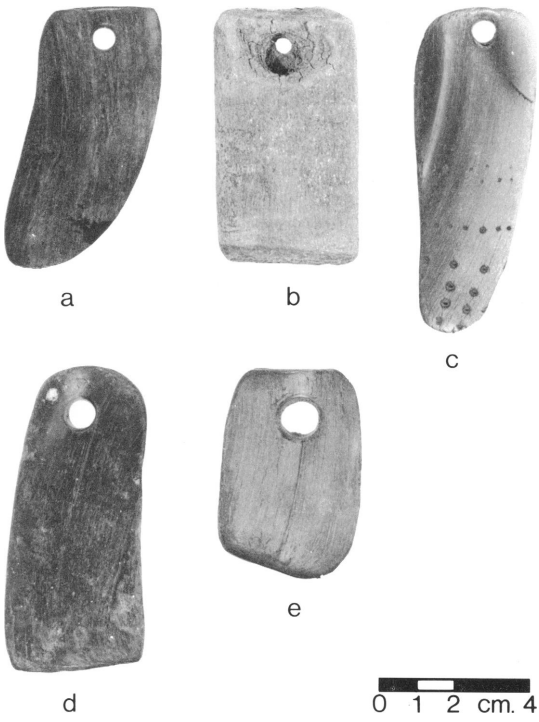

FIG. 76. Selected perforated horn pendants from Hidden Cave. a. 1-1B-876; b. 2/32604; c. 1-1B-13-G-20; d. 1-1B-792; e. 2/32644.

Provenience: Surface, a. Strata I/II, b; not correlated (N.C.), c–e.

to be either shaft wrenches or pendants. Shaft wrenches usually consist of thick pieces of horn or bone with one or more perforations; the perforations are manufactured at diagonal angles to the face of the horn. Pendants, on the other hand, are distinguished by their relative delicacy and the strategic positioning of the perforation. For example, a pendant usually has one or two perforations at either end, or near one lateral margin. Conversely, a wrench may have several perforations across the face. Perhaps thickness can also be used to distinguish between pendants and wrenches.

Loud and Harrington (1929, pp. 43–45, pl. 11, fig. 15) excavated 18 pendants from Lovelock Cave that are similar to the Hidden Cave objects. None were over 5.0 mm. thick. Fourteen of the artifacts were part of a rattle which was found in association with a burial of a 5½-year-old child. Grosscup (1960, pp.

TABLE 57
Metric Attributes for Bighorn Sheep Horn Pendants from Hidden Cave[a]

Specimen Number	Stratum	Length (mm.)	Width (mm.)	Perforation Diameter (mm.)	Thickness (mm.)	Th/W Ratio	Th/L Ratio	Weight (grams)
1-1B-13-G-20	N.C.	87.4	32.0	4.9	4.9	0.153	0.056	9.5
1-1B-792	N.C.	80.4	36.5	6.5	5.1	0.140	0.063	14.6
1-1B-876	I	74.9	32.6	5.0	5.5	0.169	0.073	10.5
2/21907	N.C.	107.1	26.7	6.6	4.4	0.165	0.041	7.9
				6.2				
				6.6				
				6.4				
				6.6				
				6.3				
				6.1				
				7.3				
2/32401	(I/II)	68.1	22.4	4.3	3.5	0.156	0.051	4.4
2/32603	N.C.	61.2	37.4	7.4	5.4	0.143	0.088	10.0
2/32604	(I/II)	67.2	36.6	3.6	10.6	0.290	0.158	25.6
				10.9				
2/32609	II	67.3	49.9	7.4	6.8	0.136	0.101	17.3
2/32643	N.C.	60.2	35.4	7.1	3.8	0.107	0.063	4.4
2/32644	N.C.	56.4	37.1	9.4	6.5	0.175	0.115	11.3
2/32645	N.C.	85.0	25.6	6.6	2.3	0.009	0.027	4.7
2/32693	N.C.	59.9	27.5	8.6	4.7	0.171	0.080	6.3
2/32694	N.C.	61.4	31.8	7.4	5.5	0.173	0.090	8.6
2/32741	N.C.	80.2	34.5	6.5	5.8	0.168	0.072	10.3
2/32753	II	83.4	35.2	6.0	4.5	0.128	0.054	8.4
2/32789	I/II	56.4	27.2	8.7	6.5	0.239	0.115	6.4
20.4/1229	I	74.8	36.5	9.6	6.5	0.178	0.009	12.5

[a] Horn pendants 1-1B-8 and 1-1B-1047 were unavailable for study.

22–23) has described other Lovelock horn artifacts in the Heye Foundation collections.

Heizer and Krieger (1956, pp. 14–16, pl. 9f) illustrate a horn artifact with 90 perforations from Humboldt Cave. The fragility of the specimen suggests it functioned as a pendant. A late prehistoric horn fragment from Tommy Tucker Cave is similar to, but considerably shorter than, the Hidden Cave artifacts (Fenenga and Riddell, 1949, pp. 211–212, fig. 58j).

Such horn pendants were reported by only one of Stewart's informants (1941, p. 391), whereas horn shaft wrenches (generally with two or three graduated holes) were fairly common among the Northern Paiute of central Nevada and northeastern California. Steward also reports horn wrenches among the northern band Shoshone informants, noting further that they are common in northern California and among the Ute, but the use of horn pendants is unreported (Steward, 1941, pp. 237, 290).

Gifford (1940, p. 183) suggests that shaft wrenches were used as arrowshaft straighteners, concluding that perforation size served to shape the wood into suitable arrowshafts. Lending support to this conclusion is the shaft wrench recovered from Lovelock Cave in association with four wooden sticks which fit its smallest perforation (Loud and Harrington, 1929, p. 42, pl. 15j, k). An ethnographic sketch of a Shoshone using such a wrench to straighten arrowshafts appears in Hodge (1907, p. 92).

Multiperforated shaft wrenches are reported from both Kramer Cave and Empire Cave (Hattori, 1982, p. 146), Humboldt Cave (Heizer and Krieger, 1956, p. 16, pl. 9f, see p. 78 for distributional data throughout the

Southwest and Great Basin), Lovelock Cave (Loud and Harrington, 1929, p. 42, pl. 15j, k), Hogup Cave (Aikens, 1970, pp. 91, 94, fig. 57), Danger Cave (Jennings, 1957, p. 194), and Coville Rockshelter (Meighan, 1953a, p. 184). These specimens are thicker than the Hidden Cave examples, and usually have several graduated perforations oblique to the surface of the horn. None of the Hidden Cave specimens has oblique perforations.

If the Hidden Cave horn artifacts were shaft wrenches, the perforation diameters should correlate with either arrowshaft or atlatl shaft sizes, but the degree of variation in our sample of perforation diameters seems to preclude meaningful comparison. In fact, the perforation diameters on one artifact would have fit both atlatl and arrow foreshafts.

Although the Hidden Cave perforated horn artifacts could have been shaft wrenches, we suggest that they were pendants, based on their thickness, surface finish, lack of use wear around the perforations, and the decorative incising.

INCISED BONE

Hidden Cave contained a wide variety of incised bone artifacts. This relatively diverse category will, therefore, be described in groupings which stress their individuality.

Banded Incising

One complete bird bone whistle (2/32565, fig. 74d) was recovered from the upper strata (length, 104.5 mm.; width, 8.2 mm.; thickness, 8.1 mm.; weight, 2.7 grams; perforation width, 6.3 mm.). The bone has been cut and polished on both ends, and was subsequently incised with 45 large double cross-hatched cuts that circumscribe the bone with a thick X-shaped design. The cross-hatching is restricted to the distal section below the elongated oval stop. Above the stop, a continuous line was incised with slightly upward strokes, circumscribing the upper part of the bone approximately 10 times. The incising has been enhanced by dark pigment. Tule fibers were woven across the 14.0 mm. stop for a distance of 7.0 mm.

A small hole was cut into the bone about 30.0 mm. from the mouth, and a daub of ocher(?) was inserted into the base of the hole for air deflection. The whistle plays a high D pitch (Roust and Grosscup, n.d., p. 75). Bone whistles have been found at Humboldt Cave (Heizer and Krieger, 1956, pl. 30k, l), and an incised flute was recovered from Lovelock Cave (Loud and Harrington, 1929, p. 39, fig. 7a). An undecorated bird bone whistle fragment was excavated with a burial at Karlo (Riddell, 1960, p. 76). The Hidden Cave whistle is identical with Gifford's type FF3 (1940, pp. 182, 230), and a similar piece was excavated in the Napa region (Heizer, 1953, p. 271).

The other incised bird bone (20.4/1432, fig. 73g) is probably an awl fragment (length, 59.4 mm.; width, 7.5 mm.; thickness, 7.0 mm.; weight, 1.0 grams); the proximal end is broken at one of the incising marks, and the distal end is cut at an angle similar to Type A4 bird bone awls illustrated in Gifford (1940, pp. 169, 203).

The incised bands on the proximal portion form a spiral, winding around the shaft. The fracture interrupts one of the spirals that were carefully carved to form a double band. Within the perimeters of this double band, diagonal lines are incised perpendicular to the bands. The precision of the incising suggests that considerable effort was expended to keep the diagonal lines within the band margins. Apparently, the double bands were applied first and were generally carved with a single stroke; double incising marks are rare. The incising was enhanced with black pigment which was daubed into the lines; under the microscope the pigment appears as a series of overlapping spots. An ethnographic account of the enhancement of incising with paint is given by Dixon (1905, p. 166).

The double lines closest to the tip are relatively poorly made. The diagonal lines cross-cut the bands in this section, and the paint in this area appears fresher and darker, suggestive of two incising episodes.

Long linear striations were noted near the highly polished tip, a wear pattern observed on many of the awls. But the bone is quite thin and fragile, suggesting it may not have been used as an awl. Similar specimens have been found at Tommy Tucker Cave (Riddell, 1956, p. 16, pls. 1, 13) and Lovelock Cave (Loud and Harrington, 1929, pl. 12d).

Punctated Incising

Three narrow bone fragments are incised and decorated with punctations (1-1B-570, 20.4/453, 20.4/569, fig. 73d–f), and all three could easily have been part of the same artifact. The fragments are polished to such a high gloss that they resemble ivory; the convex face, onto which the dots were incised, is particularly smooth. Microscopic observation (20–30×) indicates that the dots were incised by an extremely fine, sharp implement which was twisted in place. Some dots were formed by twisting, producing a circle; others were formed by minute lines (cutting), and the third type combines the elements into a circle with a slight tail. Several of the deeper circles run together.

The punctations were enhanced with a greasy black substance (e.g., black fern root mixed with fat?). The black pigment has worn off 20.4/453 (fig. 73d), and is cracked and peeling in several others. It appears that several incising tools were used on this specimen, perhaps suggesting several incising episodes. T. Thomas (1983) notes that similar sequentiality in decorative motifs elsewhere in the Basin may suggest concepts of periodicity within the prehistoric mind-set, a natural outgrowth of cultures intimately involved with environmental predictability.

Hidden Cave punctated design elements are similar to several from Lovelock Cave and Karlo (Loud and Harrington, 1929, pl. 12h; Riddell, 1960, fig. 17f). A similar technique may have been used to incise a punctated chevron design on a large bone artifact from 26-Wa-197 (Hester, 1974, p. 10).

Incised Margins

Four artifacts have incising of varying depths on their margins (1-1B-241, 1-1B-256, 20.3/9999, 20.4/682)[4]; two specimens (1-1B-241, 1-1B-256) were burnished as well. Artifact 1-1B-241 (fig. 73h) was incised with two techniques: V-shaped cuts were made by sawing the bone margin with an obliquely held flake; U-shaped cuts were made by sawing the margin into a V and scraping the concavity. The serrations along one margin of this fragment are similar to notches made on bones used as scrapers, bullroarers, pendants, and tablets for notation, but they are found primarily on fleshers (Gifford, 1940, p. 172), a function substantiated by Schenck (1926, p. 219). It has also been suggested that bones modified in this manner were used as bark shredders (Harrington, 1933, p. 137).

Two incised artifacts have red pigment adhering to their surfaces, particularly within the incising. Specimen 1-1B-256 (fig. 73i) is an unidentified burned bone with smoothed incised margins; the incising extends diagonally across the dorsal face, which is covered with red pigment. Artifact 20.3/9999 (fig. 73j) is particularly unusual because it appears to be an incised human cranial fragment with remnants of red pigment staining the dorsal surface. This surface is covered with striations which probably resulted from scraping or defleshing the bone. Three of the margins have been polished and serrated; one is broken. The bone could either be part of a frontal or parietal section, based on placement of the foramina and arterial grooves.

It appears that this artifact was used as a hematite spatula, in a manner similar to skull receptacles recovered from burials at 4-SJo-68 and 4-Sac-107c in central California: "Although rare, these worked human bones are characteristic of the Windmiller Culture . . ." (Ragir, 1972, p. 117), which is estimated to date sometime after 2000 B.C.

POLISHED BONE

Tabular

Three flat polished tabular bone fragments were recovered (2/32808, 20.4/1187, 20.4/1569; e.g., fig. 73b, c), two of which are burned, and have one broken margin. The third fragment has two broken ends and may have once connected the other two fragments into a single artifact (width, 19.9 mm., 12.7 mm., 15.9 mm.; thickness, 3.5 mm., 1.8 mm., 3.1 mm.; weight, 4.4 grams, 0.7 grams, 2.3 grams).

[4] Artifact 20.3/9786 is a bone with incised margins which was recovered outside the cave in backdirt from previous excavations and is not included in this analysis.

It has been suggested that such flat tabular bone objects were gaming pieces (Dalley, 1970b, pp. 101–102), but similarly shaped specimens are usually incised for use as dice. Dalley (1970b, pp. 103–105, fig. 70p) illustrates a bone pendant "blank" (undrilled) which resembles the Hidden Cave specimens.

Composite Polished Bone Artifact

One of the most curious artifacts in the cave is 20.4/360 (fig. 77), two broken polished bird bones which are lashed to the sides of a small rectangular folded fiber bundle by three cordage loops and one *Apocynum* fiber loop. The lashing was used to position the bones into a V-shape.

The artifact resembles the "anthropomorphs" from Hogup Cave (Aikens, 1970, p. 121, fig. 83). Although its exact function is unknown, the bone bundle could have been used as a harpoon or leister, fitting into a socketed haft (see Bennyhoff, 1950, fig. 1c).

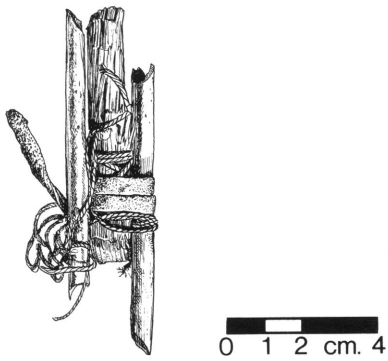

Fig. 77. Composite bone artifact from Hidden Cave 20.4/360.
Provenience: Surface.

CHAPTER 17. MATERIAL CULTURE: ARTIFACTS OF SHELL

LORANN S. A. PENDLETON

California shell beads and ornaments, which are abundant and relatively well-dated in the western Great Basin, are often useful as time markers. Shell artifacts appear particularly sensitive to finite stylistic and temporal definition.

The following section describes the shell beads and ornaments from Hidden Cave and their relationships with similar objects from California and the Great Basin. Bennyhoff and Hughes (ms.) was the primary source for the description and cross-dating of Hidden Cave beads.[1]

Recovered from Hidden Cave were 143 shell artifacts (132 beads and 11 ornaments),[2] comprising 24 bead and 11 ornament types and eight shell species. Three beads were made from unidentifiable species of *Olivella* (probably *biplicata*), one was made from *Olivella baetica,* but the vast majority (97) were manufactured from *Olivella biplicata.* Two beads were made from limpet shells. Twenty-seven beads were made from clam shell: seven from *Macoma* sp., two from *Tivela* sp., and two from *Saxidomus* sp. The other 16 clam shell beads were made from either *Macoma* sp. or *Tivela* sp., but *Tivela* is the most likely source (Richard Hughes, personal commun.).

Five ornaments were manufactured from *Margaritifera* sp., a local Great Basin freshwater mussel. Five ornaments were made of *Haliotis* sp., and one was made from *Busycon perversum* sp., a left-handed whelk shell, probably from the Gulf of California (W. Old, American Museum of Natural History, personal commun.; also so identified by Dr. William Clench, University of California, in Roust and Grosscup, n.d., p. 82).

Brief descriptions of bead and ornament types are provided in the following pages. Table 58 contains shell provenience summary data; metric and provenience data are found in tables 60 to 62. Seed, bone, and stone beads are discussed elsewhere.

BEADS

Olivella Spire-lopped Beads

Forty-one whole *Olivella* shell beads with spires ground perpendicular to the long axis of the shell comprise this category. No further modifications, such as aperture grinding or incising were noted. Two Spire-lopped beads (type A1b, 1-1B-132), which were strung together with cordage, are discussed with the shell ornaments; their metric data are included in table 60 with type A1b.

Fourteen of these are subclassified as Small (type A1a, maximum diameter 4.0 mm.–6.5 mm.), 23 are Medium (type A1b, maximum diameter 6.51 mm.–9.5 mm.), and four are Large (type A1c, maximum diameter 9.51 mm.–14.0 mm.) (see table 60). Extensive well-dated collections of these beads are rare; therefore size variation has little temporal significance within the Spire-lopped category.

There was an emphasis on type A1a beads (fig. 78a) in the Early Horizon, lasting through the Early/Middle Transition Period in central California, as well as during terminal Oak Grove in southern California. Medium Spire-lopped beads (A1b) are often found in Early Horizon sites. Type A1a beads are most abundant during the Early Period and Phase 1 of the Late Period in central California, but are found throughout the sequence (Bennyhoff and Hughes, ms.).

Type A1a has been recovered from early Lovelock Culture deposits in central Nevada, but diminishes in emphasis toward the north. This type is stratigraphically old at Gatecliff Shelter, dating from about 1450 B.C. (Bennyhoff and Hughes, 1983).

Type A1b (fig. 78b) has been found at about 12 sites in the Great Basin, dating from 1300 B.C. to A.D. 1816, but is most common after A.D. 100 (Bennyhoff and Hughes, ms.). Seventy beads within the size range of A1b were

[1] We gratefully acknowledge the assistance of Dr. James Bennyhoff and Dr. Richard Hughes with this analysis.

[2] Fifteen shell beads and ornaments from the Nevada State Museum collection were unavailable for study and are not included in the tallies or analysis.

TABLE 58
Provenience of Shell Beads and Ornaments from Hidden Cave

Type	*n*	Surface	I	I/II	II	II/III	III	III/IV	IV	IV/V	V	VII	IX/X	N.C.
BEADS														
A1a Small Spire-lopped	14	1	1	—	4	1	2	—	2	1	2	—	—	—
A1b Medium Spire-lopped	23	6	1	—	1	—	5	1	2	—	5	—	—	2
A1c Large Spire-lopped	4	1	—	—	1	—	—	—	—	—	1	—	—	1
A2a Small Oblique Spire-lopped	2	—	—	—	2	—	—	—	—	—	—	—	—	—
A2b Medium Oblique Spire-lopped	3	—	1	—	—	—	—	1	—	—	—	—	—	1
B2a Small End-ground	4	—	—	—	1	1	1	—	—	—	1	—	—	—
B2b Medium End-ground	4	—	—	—	2	—	—	—	1	—	—	—	—	1
B2c Large End-ground	2	—	1	—	—	—	1	—	—	—	—	—	—	—
B3b Medium Barrel	1	1	—	—	—	—	—	—	—	—	—	—	—	—
C3 Split Oval	6	—	—	—	4	—	—	—	—	—	—	—	—	2
F2a Full Saddle	2	—	1	—	—	—	—	—	—	—	—	—	—	1
G1 Tiny Saucer	1	—	—	—	—	—	1	—	—	—	—	—	—	—
G2a Small Saucer	3	—	1	—	1	—	—	—	1	—	—	—	—	—
G2b Large Saucer	4	—	—	—	3	—	—	—	—	—	—	—	—	1
G3b Large Ring	1	—	—	—	1	—	—	—	—	—	—	—	—	—
L2b Thick Rectangle	10	—	1	—	1	—	—	—	2	—	3	—	—	3
N1 Large Grooved Rectangle	16	—	—	1	—	—	2	—	3	—	3	—	—	7
N2 Small Grooved Rectangle	1	—	—	—	—	—	—	—	—	—	—	—	—	1
(E2)	1	—	1	—	—	—	—	—	—	—	—	—	—	—
(F1 or G3)	1	—	—	—	—	—	—	—	1	—	—	—	—	—
Saxidomus sp.	2	—	—	—	2	—	—	—	—	—	—	—	—	—
Macoma sp.	7	—	5	—	—	—	—	—	—	—	—	—	—	2
(*Tivela* sp.)	18	—	—	—	—	—	—	1	16	—	—	—	—	1
Limpet	2	—	—	—	—	—	—	—	—	—	—	—	—	2
ORNAMENTS														
Margaritifera	5	—	—	—	2	—	1	—	—	—	—	—	—	2
Haliotis	5	—	2	—	1	—	—	—	—	1	—	—	—	1
Whelk	1	—	—	—	1	—	—	—	—	—	—	—	—	—
Totals	143	9	15	1	27	2	13	3	28	2	15	0	0	28

excavated from Kramer Cave, one of these was incised. One specimen was attached to the end of a wooden wand. Spire-lopped beads were recovered from several other Falcon Hill sites, but the subtypes are unknown. The Kramer Cave specimens date to 3745 ± 30 B.P. (Hattori, 1982, pp. 12, 75, 78–81).

Large Spire-lopped beads (A1c, fig. 78c) predominate in the Middle and Protohistoric periods in central California, and have been recovered from several dozen Great Basin sites. They date from 1300 B.C. to A.D. 1880, but are most abundant during the period between 300 B.C. and A.D. 700 (Bennyhoff and Hughes, ms.). Large Spire-lopped beads have been found with transitional Karlo burials, in the Humboldt Phase at 26Pe14, in late Lovelock components at 26Ch39, and in Horizon 6 at Gatecliff Shelter (Bennyhoff and Hughes, 1983), which dates to approximately 500 B.C. (Thomas, 1983b).

Olivella Oblique Spire-lopped Beads

Hidden Cave contained five complete *Olivella* shell beads with diagonally ground spires (table 60). Subtypes of these type A2 beads

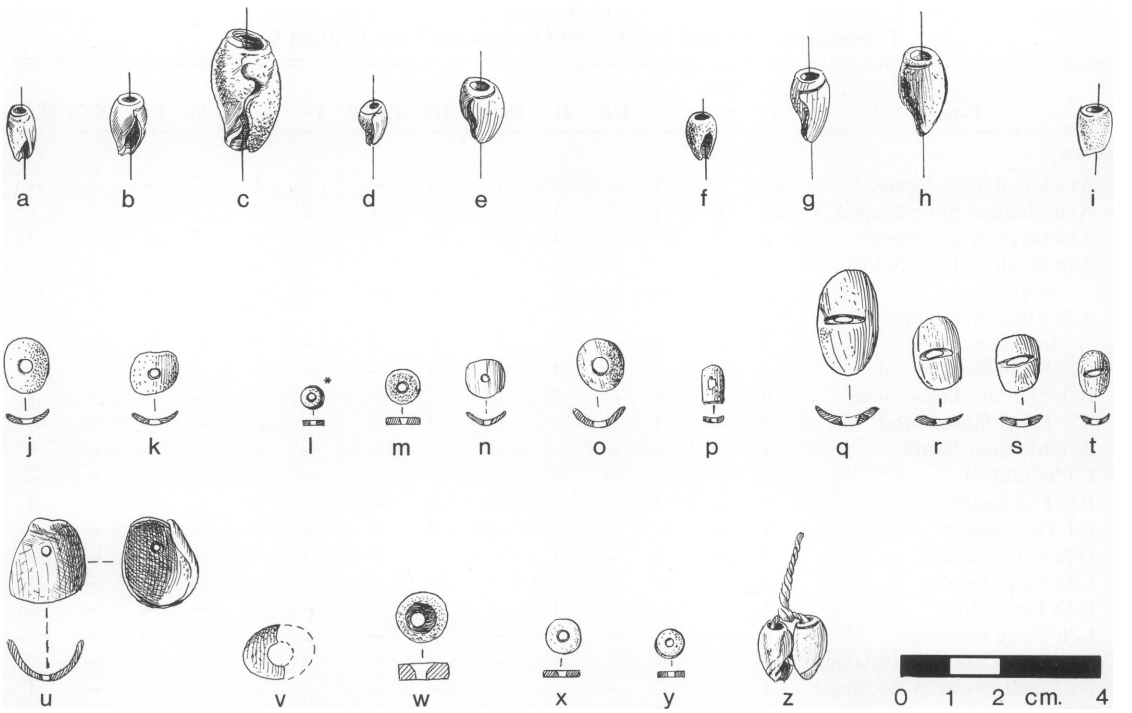

FIG. 78. Selected shell beads from Hidden Cave. a. 1-1B-198; b. 1-1B-1044; c. 1-1B-985; d. 20.4/1337; e. 20.3/9971; f. 1-1B-207; g. 20.4/1638; h. 20.4/829; i. 1-1B-250; j. 20.4/376; k. 20.4/577; l. 20.4/438; m. 1-1B-1024; n. 1-1B-291; o. 1-1B-23; p. 20.3/9773; q. 20.4/706; r. 20.4/1682; s. 20.3/9996; t. 20.4/1686; u. 1-1B-1042; v. 20.4/1465; w. 1-1B-810; x. 1-1B-976; y. 20.4/897; z. 1-1B-132. a. (A1a) Small Spire-lopped; b. (A1b) Medium Spire-lopped; c. (A1c) Large Spire-lopped; d. (A2a) Small Oblique Spire-lopped; e. (A2b) Medium Oblique Spire-lopped; f. (B2a) Small End-ground; g. (B2b) Medium End-ground; h. (B2c) Large End-ground; i. (B3b) Medium Barrel; j. (C3) Split Oval; k. (F2a) Full Saddle; l. (G1) Tiny Saucer; m. (G2a) Small Saucer; n. (G2b) Large Saucer; o. (G3b) Large Ring; p. (L2b) Small Plain Thick Rectangle; q–s. (N1) Large Grooved Rectangles; t. (N2) Small Grooved Rectangle; u. (E2?) Thick Lipped; v. (F1 or G3) Oval Saddle or Ring; w. *Saxidomus* Disc; x. *Macoma* Disc; y. *Tivela*? Disc; z. Composite Shell Bead Ornament.

Material: *Olivella,* a–v, z; Clam, w–y.

Provenience: Surface, b, c, i, z; Stratum I, m, u, x; Stratum II, a, d, f, n, o, w; Stratum III, l, h; Stratum IV, v, y; not correlated (N.C.), e, g, j, k, p, q–t.

* Illustration has been enlarged. Actual diameter size = 3.3 mm.

are based on the same metric attributes as type Al. Two beads are classified as Small (A2a, fig. 78d), and three are Medium (type A2b, fig. 78e). Three beads are made of *Olivella biplicata,* and one from *O. baetica*; the remaining bead is from an unidentified *Olivella* species.

Oblique Spire-lopped beads are relatively nondiagnostic time markers in California and the Great Basin. There is an emphasis on Oblique Spire-lopped beads during the Early Period in central California, but they are generally found in the Early/Middle Transition and Protohistoric periods in southern California (Bennyhoff and Hughes, ms.). According to Gibson (1976, p. 87) this type is typically found in deposits dating between 1500 B.C. and 500 B.C., but persists until 0 A.D. in southern California. Eight Oblique Spire-lopped beads have been recovered from archaeological sites in the Great Basin, including Grimes Point and Lovelock Cave, where they date from approximately 2500 B.C. to 2200 B.C. (Bennyhoff and Hughes, ms.).

Olivella End-ground Beads

Ten complete *Olivella* shell beads with both spire and aperture removed (type B2, End-ground) were recovered from the cave in the top five strata, predominantly in Strata II and III.

Type Al metric subdivisions apply to type B2. Four beads were classified as Small (B2a, fig. 78f); four are Medium (B2b; fig. 78g); and two are Large (B2c, fig. 78h). All of the End-ground beads are made from *Olivella biplicata* (see table 60).

Several End-ground beads have been recovered from 26Wa197, where they were undated but thought to be early. Type B2b beads were recovered from early components at 26Ch2, Karlo, and 26Wa1502; all were associated with burials which may date between 2500 B.C. and 1500 B.C. Type B2a beads are found in contexts equally divided between the Early and Late periods. They have been recovered from early contexts (approximately 2200 B.C. to 1100 B.C.) at 27Wa1502, Karlo, and Lovelock Cave; one was found at 26Ch2. Type B2c beads have a more restricted distribution: two were found in Late Period deposits. One was from the Early/Middle Transition deposit at 4-Las-2F, associated with a burial. Late prehistoric deposits at Lovelock Cave contained the most extensive collection. End-ground beads are most pervasive in the Early Period and Phase 1 of the Late Period in central California (Bennyhoff and Hughes, ms.).

Olivella Barrel Bead

One *Olivella biplicata* Medium Barrel bead (type B3b, fig. 78i) was recovered from the surface of Hidden Cave (see table 60). Barrel beads are manufactured by extensive grinding on the aperture end of complete *Olivella* shells, leaving the maximum diameter in the center of the bead.

Barrel beads comprise 82 percent of the unbroken beads recovered from Kramer Cave ($n = 635$); 571 of the beads were strung. Their average size places them in the B3a category, and they date to 3745 ± 30 B.P. (Hattori, 1982, pp. 12, 78–80).

Prior to the publication of the Falcon Hill sites, three other Medium Barrel beads have been found in the Great Basin, including one from Horizon 8 at Gatecliff Shelter which dates from 1350 B.C. to 1300 B.C. (Bennyhoff and Hughes, 1983). They were also found in Early Karlo and Early Lovelock contexts, probably dating to around 1500 B.C. (Bennyhoff and Hughes, ms.)

Barrel beads have been recovered from the Early/Middle Transition Period in central California (Bennyhoff and Hughes, ms.). They are characteristic of the Hotchkiss Culture, and have been found in Windmiller sites (Elsasser, 1978, p. 38; Hattori, 1982, p. 89).

Olivella Split Oval Beads

Of six *Olivella* Split Ovals (type C3, fig. 78j) four were recovered from Stratum II (see table 60). The Split Oval bead is medium-sized, centrally perforated, and made from one-quarter of the complete shell. None of the Hidden Cave Split Ovals are shelved. These beads typically date to the Early Middle Period in the Great Basin, and to the Middle/Late Transition in California (Bennyhoff and Hughes, ms.).

Split Oval beads were found with Lovelock Cave burials dating between 1500 B.C. and 1200 B.C.; they date somewhat later at 26Wa1016. The bulk of Split Oval beads recovered in the Basin date between 200 B.C. and A.D. 100. They have been excavated from the Humboldt Lakebed site, Lovelock Cave, Pelican Island, Tommy Tucker Cave, and 26Pe27 (Bennyhoff and Hughes, ms.).

Olivella Saddle Beads

Two Full Saddle beads (type F2a, fig. 78k) were recovered in the top strata (see table 60). Full Saddles are elongated oval beads, with small central perforations; their width exceeds their length. The beads are deeply curved, with uniform cross sections.

Full Saddle beads are Middle Period time markers in California. Several Full Saddle beads were recovered from sites in Churchill County, including Lovelock Cave. They were also found at Tommy Tucker Cave in Lassen County. They date between 300 B.C. and 800 B.C. (Bennyhoff and Hughes, ms.).

Olivella Saucer Beads

Class G, Saucer beads, are centrally perforated beads made from the *Olivella* shell

wall with ground margins. They are divided on the basis of diameter and perforation size (see table 60).

One Tiny Saucer bead (type G1, fig. 78 l) was recovered from disturbed Stratum III deposits in Hidden Cave. Type G1 beads are not particularly diagnostic in California, occurring throughout the sequence. They are primarily recovered from Middle/Late Transition deposits in the Great Basin, especially from Thea Heye Cave and Tommy Tucker Cave. Tiny Saucer beads are thought to date between A.D. 100 and A.D. 700 (Bennyhoff and Hughes, ms.).

Three beads assigned to type G2a (Small Saucer beads, fig. 78m) were excavated from Strata I, II, and IV. They are circular shallow beads with small central perforations. Three of the four Large Saucer beads (G2b, fig. 78n) were recovered in Stratum II; one was from uncorrelated fill.

Small Saucer beads are time markers for the Early Phase of the Middle Period in central California. They were recovered from three sites in the Basin, including Gatecliff Shelter where they date from 1000 B.C. to 300 B.C. (Bennyhoff and Hughes, 1983; Thomas, 1983b). They were also found at 26Wa1016, where they date to approximately A.D. 130 ± 180 (Bennyhoff and Hughes, ms.; Tuohy and Stein, 1969, p. 101).

Large Saucer beads are indicative of the early phases of the Middle Period in central California. They were recovered from two sites in the Great Basin associated with burials and radiocarbon dates of 30 B.C. ± 95 (I 3148). They were recovered from the Humboldt Lakebed site and 26Pe67, where they date between 1300 B.C. and 1250 B.C., and they date to early Reveille times (about 1300 B.C.) at Gatecliff Shelter (Bennyhoff and Hughes, 1983; Thomas, 1983b).

One Large Ring bead (G3b, fig. 78o) is from Stratum II. It is a circular shallow bead with a large central perforation and ground margins. The Large Ring bead is a time marker for the Early Phase of the Middle Period in central California, and has been recovered from similar contexts as type G2. Two were recovered from Lovelock Cave in strata presumed to date between 1300 B.C. and 1250 B.C. (Bennyhoff and Hughes, ms.).

Olivella Thick Rectangular Beads

Ten Small Plain (non-shelved) Thick Rectangular beads (type L2b) were excavated from Strata I–V (see table 60). Type L2b beads (fig. 78p) are rectangular, with central perforations drilled from the interior of the bead. They are distinguished from type L1b because they are less than 10.9 mm. long. They differ from Class M (Thin Rectangular) beads in their greater thickness (usually over 1.5 mm.) and larger perforations (generally over 2.0 mm.) (Bennyhoff and Hughes, ms.).

These beads appear in all but the earliest phases of the Early Period in central California. Twenty L2b beads were found in Grave 18L at Lovelock Cave and are believed to date between 1500 B.C. and 1300 B.C. Several others were found with early burials in Washoe County (Bennyhoff and Hughes, ms.).

Grooved Rectangle Beads

Seventeen Hidden Cave beads are Class N, Grooved Rectangles (see table 60). Sixteen are subtype N1 (Large) and one is subtype N2 (Small) (Bennyhoff and Hughes, ms.). The Large subtype (fig. 78q–s) is a semirectangular quarter shell bead with ventral face grinding. The Small subtype (fig. 78t) is similar to the Large, but is more rectangular. The bead is perforated by incised lines perpendicular to the growth lines on the dorsal face. It appears that a flake was used to incise the perforation, leaving an elongated oval beveled groove which extends beyond the hole. Six of the large specimens retain their shelf, nine have a remnant of the shelf edge, and one specimen has been extensively ground, effectively obliterating the shelf.

The beads are extremely smooth and well finished. One specimen (20.4/1682, fig. 78r) has color enhanced dorsal incising which runs perpendicular to the groove. Remnants of black pitch adhering to 20.3/9996 (fig. 78s) suggest it may have been attached to a basket or ornament. This bead type and the various techniques used for its attachment are illustrated from strung specimens recovered from Lovelock Cave (Orchard, 1929, p. 24, fig. 10).

The Large beads, probably of local Great Basin origin, were previously unreported (Bennyhoff and Hughes, ms.). Robert Elston

(personal commun.) notes six to eight additional Large Class N beads have been recovered from an open dune site in the Stillwater Marsh. Termed "Stillwater Kerfed" by Elston, they are identical with specimens 20.4/706 and 20.4/932 from Hidden Cave. The Stillwater artifacts were apparently associated with a Desert Side-notched and small concave base (Cottonwood?) point.

The bulk of the Large Grooved Rectangle beads in Hidden Cave were concentrated in and below the 32 Inch Midden. Bennyhoff and Hughes (ms.) suggest that this bead type marks the late Early Period but may have persisted into the early phase of the Middle Period in southern California and the Great Basin.

Twenty-three Small Grooved Rectangle beads have been found in western Nevada, at Lovelock Cave ($n = 16$), and Pe67 ($n = 1$) (Bennyhoff and Hughes, ms.), at Kramer Cave ($n = 5$), and Shinners Site F ($n = 1$) (Hattori, 1982, pp. 82, 87). Though rare, this type has also been reported from four southern California sites ranging in age from the late part of the Early Period through the early phase of the Middle Period (Bennyhoff and Hughes, ms.).

Lovelock Cave and Pe67 beads are believed to date from 1300 B.C., though they have not been radiocarbon dated (Bennyhoff and Hughes, ms.). The Kramer Cave beads are radiocarbon dated between 3900 ± 100 B.P. (UCLA-976) and 3620 ± 80 B.P. (UCLA-976) (Hattori, 1982, p. 17). The Shinners Site F beads date beween 580 ± 100 B.P. (UCLA-677) and 3325 ± 90 B.P. (UCLA-931) (Hattori, 1982, p. 18).

Hattori (1982, p. 90) notes that these beads were previously undated at Lovelock, but their co-occurrence at Kramer Cave supports Grosscup's (1960, p. 38) estimates of an early Lovelock age for the Lovelock Cave grooved rectangles.

Miscellaneous *Olivella* Beads

Two *Olivella* beads did not fit comfortably within the existing typology. Artifact 1-1B-1042 (fig. 78u) is a fairly large oval bead with a central perforation. It is most likely a type E2 Thick Lipped bead; however, it may be one of the other subtypes within type E: It exceeds all size ranges for type E beads. The other bead (20.4/1465, fig. 78v) may be an Oval Saddle (type F1) or it may be a G3 Ring. It has a great deal of curvature, suggesting that it is a saddle rather than a ring. But the central perforation exceeds the size limits for Saddle beads, falling within the perforation sizes suggested for Rings (metric attributes for these beads are provided in table 62).

Type E beads are generally recovered from deposits dating from the Late Period into the Historic Period in central California. Previously reported type E beads are restricted to type E1 from 26Ch15 and the Cottonwood Creek site in Inyo County, California. Only one other type F1 bead has been recovered in the Great Basin at the Cottonwood Creek site. It is a time marker for the early Middle Transition Period in central California (Bennyhoff and Hughes, ms.).

Clam Disc Beads

The 27 clam beads excavated from the cave (see table 61) were manufactured from three species of clam, each associated with a distinct stratum. Two *Saxidomus* beads (Bennyhoff and Heizer, 1958) were recovered from Stratum II. The seven *Macoma* sp. discs were recovered from Stratum I and uncorrelated deposits. Sixteen clam beads were made from either *Tivela* sp. or *Macoma* sp., but *Tivela* is the more likely choice (Bennyhoff and Hughes, personal commun.); most *Tivela* beads were recovered from Stratum IV.

Most ($n = 14$) of the *Tivela* sp. beads were found in a cache with traces of red ocher. The Hidden Cave *Tivela* beads are unusually small (fig. 78y); their size and early stratigraphic position in the cave casts some doubt on their genus identification. *Tivela* beads, particularly early *Tivela* beads from southern California, are considerably larger than the Hidden Cave specimens. They could have been reworked locally from one of the thick *Tivela* cylinders more commonly found in the Early Period. At any rate, we are somewhat uneasy about the genus assignment of these beads.

The *Saxidomus* Discs (fig. 78w), which are identical in size, are thick circles drilled with conical perforations and ground edges. Only

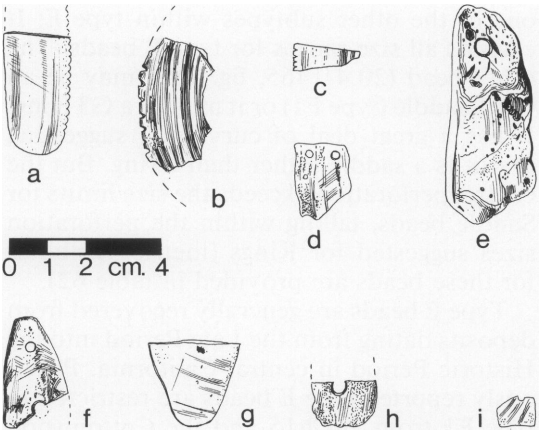

FIG. 79. *Margaritifera* and *Haliotis* ornaments from Hidden Cave (*Margaritifera* ornament 20.4/578 was too fragile for illustration.) a. 1-1B-325; b. 1-1B-642; c. 20.4/647; d. 20.4/830; e. 20.4/931; f. 20.4/401; g. 20.4/1184; h. 20.4/1671; i. 20.4/657.

Provenience: Stratum I, e, g; Stratum II, a, c, i; Stratum III, d; Stratum IV, h; Stratum V–IX, b; not correlated (N.C.), f.

Material: *Margaritifera*, a–d; *Haliotis*, e–i.

10 *Saxidomus* beads have been found previously in the Great Basin, where they date to the protohistoric period (Bennyhoff and Hughes, ms.). By the time of contact, the Achomawi were supplying the Northern Paiute with clam disc beads (Davis, 1961, p. 15). *Saxidomus* beads were used as currency north of Monterey during this period (King, 1978, p. 61).

Tivela beads were also used as currency in protohistoric California by tribes south of Monterey (King, 1978, p. 61). Two-thirds of the *Tivela* beads found in the Great Basin are from protohistoric or historic contexts. *Tivela* beads were at the Cottonwood Creek and Rose Spring sites where they are believed to date between A.D. 700 and A.D. 1100 (Bennyhoff and Hughes, ms.). The Hidden Cave beads—considering their location in a Stratum IV cache and their small size—are highly unusual, and may be a new type.

The *Macoma* beads from Stratum I (fig. 78x), on the other hand, usually date quite early. They are typical of the Early/Middle Transition Period. *Macoma* beads are smaller than *Saxidomus* beads, being round, fully ground, with central perforations. *Macoma* Discs have been found at 26Ch2, 26Wa1502, Karlo, and Lovelock, where they date between 1500 B.C. and 1300 B.C. (Bennyhoff and Hughes, ms.).

LIMPET SHELL BEADS

Two limpet shells, which were recovered from uncorrelated contexts (see table 62), are extremely small, round, and wholly unmodified limpet Rings (the limpets were too small for effective illustration).

Limpet shell beads, which are rare in the Great Basin, have been found at two Death Valley sites in contexts dating between A.D. 1500 and A.D. 1700 (Bennyhoff and Hughes, ms.)

ORNAMENTS

The 11 simple shell ornaments which comprise the Hidden Cave sample (see table 62) are classified by the criteria suggested by Bennyhoff and Hughes (ms.). The composite shell ornament metric data are presented in table 60.

COMPOSITE SHELL ORNAMENT

Artifact 1-1B-132 (fig. 78z) consists of two type A1b medium-sized *Olivella* Spire-lopped beads which are strung side by side through

FIG. 80. Whelk shell ornament (2/32630) from Stratum II in Hidden Cave.

a looped section of S twist, two strand *Apocynum* cordage. The cordage was run through the top of the left bead, brought out the aperture, and then inserted into the aperture of the right bead. The cordage was drawn through the top of the right bead and knotted above both beads, orienting the shells with facing apertures. The cordage strand, including the loop, is 23.3 mm. long and 1.5 mm. wide. This stringing technique has not been previously recorded in the Great Basin (Orchard, 1929; Carroll, 1970).

Margaritifera Ornaments

1-1B-325 (FIG. 79a); TYPE uM.BA1f: This rectangular ornament has ground margins, one of which is serrated. The ornament was manufactured with obvious care: the dorsal surface has been ground and polished, removing the epidermis; the serrations have been polished, probably with a soft abrasive or hide. Half of the original ornament is intact. The longitudinal section is concavo-convex. The nacreous portion is intact, and quite vibrant.

1-1B-642 (FIG. 79b); TYPE uM.AA1f: The fragment is crescent shaped, with uneven polished serrations along one margin. The artifact reflects less care in its manufacture than did the previous ornament, and, in fact, appears unfinished. The longitudinal section is concavo-convex.

20.4/578; TYPE uM.BA3j: This paper-thin fragment may be part of another ornament. It is rectangular, with a small perforation.

20.4/647 (FIG. 79c); TYPE: SERRATED SPOON: Both lateral margins are broken, but portions of the proximal and distal ends are intact. The distal margin was serrated with three cuts, which were subsequently smoothed and polished.

20.4/830 (FIG. 79d); TYPE uM.PA2o: This fragment was ground into a trapezoid. Two conical perforations have been drilled on either side of the midline, and two others are drilled near the lower right ventral margin. The perforations and smoothed margins may be natural; several incomplete "perforations" were noted on the ventral face. Microscopic analysis did not clarify their origin, and the classification of this artifact remains in doubt.

COMMENTS: *Margaritifera* ornaments were probably made locally. Several have been recovered at Tommy Tucker Cave, dating between A.D. 1100 and A.D. 1500 (Bennyhoff and Hughes, ms.), and several others were recorded at Lovelock Cave and other Humboldt Valley sites (Loud and Harrington, 1929, pp. 106, 150, pls. 53e, 66k).

TABLE 59
Summary of Hidden Cave Bead Chronology

Type	Date
A1a	1450 B.C.–500 B.C. and late period
A1b	1300 B.C. and late period
A1c	1300 B.C. and late period
A2	2500 B.C.–2200 B.C.
B2	2500 B.C.–1100 B.C. and late period
B3	1350 B.C.–1300 B.C.
C3	1500 B.C.–A.D. 100
F2	700 B.C.–300 B.C.
G3	A.D. 100–A.D. 700
G2a	1000 B.C.–A.D. 130
G2b	1300 B.C.–30 B.C.
G3b	1300 B.C.–1250 B.C.
L2	1500 B.C.–1300 B.C.
N	1300 B.C.–1250 B.C.
Haliotis disc	1000 B.C.–500 B.C.
Haliotis oblong	(A.D. 1)
Haliotis square	1350 B.C.–1300 B.C.
Macoma	(1300 B.C.)
Saxidomus and *Tivela*	Protohistoric
Limpet	post A.D. 1500
Margaritifera	post A.D. 1100

Haliotis Ornaments

20.4/401 (FIG. 79f); TYPE uH.PA8j: This triangular pendant fragment may once have been more rectilinear. The pendant was perforated twice; the fracture intersects the lower perforation. The margins have been ground, and the interior surface is iridescent. The exterior has been polished to remove the epidermis, revealing the nacreous layer.

20.4/657 (FIG. 79i); TYPE uH.1a: This fragment was originally square or rectangular. All of the margins have been ground, and the fracture intersects one of the perforations.

20.4/931 (FIG. 79e); TYPE uH.BB3j: A narrow rectangular *Haliotis* pendant with a biconically drilled perforation on one end. The

TABLE 60
Attributes for *Olivella* Shell Beads from Hidden Cave

Specimen Number	Stratum	Length (mm.)	Width (mm.)	Thickness (mm.)	Perforation Diameter (mm.)	Perforation Diameter (mm.)	Weight (grams)	Species
Type A1a, Small *Olivella* Spire-lopped Beads:								
1-1B-175	Surface	8.2	—	—	5.0	1.5	0.1	*Olivella biplicata*
1-1B-198	II	9.0	—	—	5.2	1.8	0.2	*Olivella biplicata*
1-1B-614	II	6.7	—	—	5.5	2.4	0.2	*Olivella biplicata*
1-1B-618	IV	9.8	—	—	6.3	1.8	0.3	*Olivella biplicata*
1-1B-738	II	8.5	—	—	6.0	1.8	0.2	*Olivella biplicata*
2/32541	IV	10.0	—	—	6.2	—	0.3	*Olivella biplicata*
20.4/850	II	9.4	—	—	5.6	2.0	0.2	*Olivella biplicata*
20.4/991	I	7.5	—	—	4.0	1.5	0.1	*Olivella biplicata*
20.4/1306	V	8.9	—	—	6.4	2.8	0.2	*Olivella biplicata*
20.4/1307	V	8.7	—	—	5.0	2.0	0.15	*Olivella biplicata*
20.4/1452	III	9.0	—	—	5.7	2.3	0.1	*Olivella biplicata*
20.4/1470	III	8.9	—	—	5.4	2.3	0.2	*Olivella biplicata*
20.4/1502	IV/V	9.9	—	—	6.2	2.2	0.2	*Olivella biplicata*
20.4/1614	II/III	4.7	—	—	3.2	1.6	0.05	*Olivella biplicata*
Type A1b, Medium *Olivella* Spire-lopped Beads:								
1-1B-132	Surface	11.3	—	—	6.7	2.9	0.3	*Olivella biplicata*
1-1B-132	Surface	10.5	—	—	6.9	1.8	0.3	*Olivella biplicata*
1-1B-138	Surface	11.5	—	—	7.0	3.6	0.2	*Olivella biplicata*
1-1B-619	IV	9.7	—	—	7.1	1.7	0.4	*Olivella biplicata*
1-1B-644	IV	12.7	—	—	8.4	2.1	0.5	*Olivella biplicata*
1-1B-823	II	12.3	—	—	8.0	1.8	0.8	*Olivella biplicata*
1-1B-977	Surface	11.0	—	—	7.3	1.0	(0.4)	*Olivella biplicata*
1-1B-979	Surface	11.0	—	—	7.0	1.7	0.4	*Olivella biplicata*
1-1B-1037	N.C.	9.8	—	—	7.2	2.9	0.3	*Olivella biplicata*
1-1B-1044	Surface	11.5	—	—	7.2	2.1	0.5	*Olivella biplicata*
2/32410(b)	V	11.4	—	—	7.8	—	0.5	*Olivella biplicata*
2/32800	I	13.4	—	—	7.8	—	0.5	*Olivella biplicata*
20.4/385	N.C.	12.5	—	—	7.0	—	0.3	*Olivella biplicata*
20.4/1195	III	12.2	—	—	7.4	—	0.3	*Olivella biplicata*
20.4/1256	III/IV	12.0	—	—	7.0	1.5	0.3	*Olivella biplicata*
20.4/1305	V	9.7	—	—	6.9	3.3	0.3	*Olivella biplicata*
20.4/1309	V	12.4	—	—	7.6	1.9	0.4	*Olivella biplicata*
20.4/1310	V	11.8	—	—	7.1	2.0	0.3	*Olivella biplicata*
20.4/1466	III	11.8	—	—	6.7	1.4	0.2	*Olivella biplicata*
20.4/1467	III	12.2	—	—	7.2	1.6	0.3	*Olivella biplicata*
20.4/1468	III	12.0	—	—	7.2	1.6	0.3	*Olivella biplicata*
20.4/1469	III	12.3	—	—	6.7	1.3	0.3	*Olivella biplicata*
20.4/1674	V	10.2	—	—	6.7	1.9	0.3	*Olivella biplicata*
Type A1c, Large *Olivella* Spire-lopped Beads:								
1-1B-985	Surface	23.8	—	—	13.6	6.2	2.2	*Olivella biplicata*
1-1B-1037	N.C.	17.1	—	—	10.1	3.1	1.0	*Olivella biplicata*
2/32410(a)	V	14.1	—	—	9.8	2.9	0.8	*Olivella biplicata*
2/32430	II	19.1	—	—	10.7	3.0	1.2	*Olivella biplicata*
Type A2a, Small *Olivella* Oblique Spire-lopped Beads:								
20.4/851	II	8.5	—	—	4.9	1.9	0.1	*Olivella* sp.
20.4/1337	II	9.4	—	—	5.9	1.7	0.2	*Olivella biplicata*

TABLE 60—(*Continued*)

Specimen Number	Stratum	Length (mm.)	Width (mm.)	Thickness (mm.)	Perforation Diameter (mm.)	Perforation Diameter (mm.)	Weight (grams)	Species
Type A2b, Medium *Olivella* Oblique Spire-lopped Beads:								
20.3/9971	N.C.	11.7	—	—	7.9	4.2	0.5	*Olivella biplicata*
20.4/399	I	12.0	—	—	6.9	2.5	0.3	*Olivella biplicata*
20.4/501	III/IV	17.8	—	—	7.6	2.2	0.6	*Olivella (baetica)*
Type B2a, Small End-ground *Olivella* Beads:								
1-1B-207	II	8.1	—	—	5.8	2.1	0.2	*Olivella biplicata*
20.4/806	III	9.7	—	—	5.5	2.9	0.1	*Olivella biplicata*
20.4/948	V	5.4	—	—	4.3	1.8	0.2	*Olivella biplicata*
20.4/1216	II/III	9.4	—	—	6.6	2.1	0.2	*Olivella biplicata*
Type B2b, Medium *Olivella* End-ground Beads:								
20.4/656	II	14.0	—	—	9.0	3.5	0.9	*Olivella biplicata*
20.4/834	IV	11.8	—	—	6.7	1.4	0.2	*Olivella biplicata*
20.4/1638	N.C.	13.7	—	—	8.2	3.3	0.6	*Olivella biplicata*
20.4/1650	II	9.1	—	—	7.3	2.2	0.4	*Olivella biplicata*
Type B2c, Large *Olivella* End-ground Beads:								
20.4/829	III	15.7	—	—	9.7	3.1	0.8	*Olivella biplicata*
20.4/987	I	15.7	—	—	10.8	4.3	0.9	*Olivella biplicata*
Type B3b, Medium *Olivella* Barrel Beads:								
1-1B-250	Surface	9.1	—	—	7.2	2.8	0.3	*Olivella biplicata*
Class C3 Split Oval *Olivella* Beads:								
20.4/376	N.C.	10.3	8.5	1.2	—	2.5	0.3	*Olivella biplicata*
20.4/419	II	12.2	8.8	1.2	—	2.7	0.3	*Olivella biplicata*
20.4/703	N.C.	13.0	10.0	(1.2)	—	(3.2)	(0.3)	*Olivella biplicata*
20.4/805	II	11.3	10.2	(1.2)	—	(2.2)	(0.3)	*Olivella biplicata*
20.4/849	II	9.1	8.1	1.2	—	2.1	0.2	*Olivella biplicata*
20.4/1325	II	10.1	(9.8)	1.2	—	(2.5)	(0.3)	*Olivella biplicata*
Type F2a, Full Saddle *Olivella* Beads:								
20.4/577	N.C.	8.8	9.7	1.3	—	2.0	0.8	*Olivella biplicata*
20.4/982	I	9.9	(10.0)	1.1	—	2.0	(0.9)	*Olivella biplicata*
Type G1, Tiny *Olivella* Saucer Beads:								
20.4/438	III	—	—	1.1	3.3	1.3	0.1	*Olivella biplicata*
Type G2a, Small *Olivella* Saucer Beads:								
1-1B-731	IV	—	—	1.5	6.8	1.8	0.15	*Olivella biplicata*
1-1B-1024	I	—	—	1.5	6.5	1.9	0.2	*Olivella biplicata*
20.4/822	II	—	—	1.0	6.4	2.2	0.1	*Olivella biplicata*
Type G2b, Large *Olivella* Saucer Beads:								
1-1B-287	II	—	—	1.0	8.5	2.5	0.2	*Olivella biplicata*
1-1B-291	II	—	—	0.5	7.8	1.4	0.3	*Olivella biplicata*
20.4/1243	II	—	—	1.1	8.0	2.3	0.15	*Olivella biplicata*
20.4/1608	N.C.	—	—	1.0	7.8	2.5	0.15	*Olivella biplicata*
Type G3b, Large *Olivella* Ring Beads:								
1-1B-23	II	—	—	1.1	10.2	3.2	0.3	*Olivella biplicata*
Type L2b, Small, Plain, Thick, Rectangle *Olivella* Beads:								
20.3/9773	N.C.	7.2	4.8	0.9	—	2.5	0.2	*Olivella biplicata*

TABLE 60—(*Continued*)

Specimen Number	Stratum	Length (mm.)	Width (mm.)	Thickness (mm.)	Perforation Diameter (mm.)	Perforation Diameter (mm.)	Weight (grams)	Species
20.3/9903	N.C.	7.5	4.3	1.1	—	1.9	0.2	*Olivella biplicata*
20.4/465	IV	6.9	4.7	1.0	—	1.2	0.3	*Olivella biplicata*
20.4/467	V	8.4	5.7	1.2	—	1.8	0.3	*Olivella biplicata*
20.4/468	V	8.1	5.2	1.2	—	1.8	0.3	*Olivella biplicata*
20.4/988	I	7.2	4.3	1.1	—	1.2	0.1	*Olivella biplicata*
20.4/1255	V	7.7	5.6	1.3	—	2.0	0.1	*Olivella biplicata*
20.4/1639	II	6.7	4.6	1.4	—	1.4	0.1	*Olivella biplicata*
20.4/1737	N.C.	7.9	5.5	1.5	—	1.6	0.1	*Olivella biplicata*
20.4/1738	IV	7.4	4.6	1.4	—	1.8	0.1	*Olivella biplicata*

Specimen Number	Stratum	Length (mm.)	Width (mm.)	Thickness (mm.)	Perforation Length (mm.)	Perforation Width (mm.)	Groove Width (mm.)	Weight (grams)	Subtype	Species
Class N, Grooved Rectangle *Olivella* Beads:										
20.3/9996	N.C.	10.9	8.1	1.2	0.8	3.3	6.6	0.3	N1	*Olivella biplicata*
20.3/9997	N.C.	10.9	8.6	1.4	—	2.8	—	0.3	N1	*Olivella biplicata*
20.4/706	N.C.	20.1	11.8	1.5	1.0	2.9	—	0.8	N1	*Olivella biplicata*
20.4/932	I/II	16.5	9.7	1.3	0.8	2.5	6.8	0.5	N1	*Olivella biplicata*
20.4/1227	III	11.1	7.5	2.6	1.7	3.1	6.6	0.2	N1	*Olivella biplicata*
20.4/1425	III	13.1	8.0	1.1	1.1	3.9	6.6	0.2	N1	*Olivella biplicata*
20.4/1471	V	10.1	7.3	2.0	1.2	4.0	6.0	0.15	N1	*Olivella biplicata*
20.4/1514	IV	17.2	11.1	2.9	1.6	2.9	7.8	0.7	N1	*Olivella biplicata*
20.4/1680	IV	14.8	11.1	1.8	1.6	4.8	8.2	0.5	N1	*Olivella biplicata*
20.4/1681	IV	12.9	8.6	1.2	1.4	3.2	6.7	0.2	N1	*Olivella biplicata*
20.4/1682	N.C.	14.4	9.0	1.5	1.6	3.7	6.9	0.3	N1	*Olivella biplicata*
20.4/1683	N.C.	14.5	9.6	1.5	1.7	4.5	7.2	0.3	N1	*Olivella biplicata*
20.4/1684	N.C.	15.5	11.0	1.9	1.5	3.1	8.6	0.5	N1	*Olivella biplicata*
20.4/1685	N.C.	11.7	7.9	1.4	1.6	3.1	6.4	0.2	N1	*Olivella biplicata*
20.4/1686	N.C.	8.8	6.2	1.0	0.9	2.3	5.2	0.1	N2	*Olivella biplicata*
20.4/1709	V	12.2	7.9	2.0	0.8	3.2	6.9	0.2	N1	*Olivella biplicata*
20.4/1710	V	(15.0)	9.1	2.2	1.4	3.6	6.6	—	N1	*Olivella biplicata*

bulk of the drilling, which was initiated from the ventral surface, resulted in a deep cone surrounding the perforation. The perforation on the ventral face is surrounded by a shallow cone, which probably resulted from finishing the perforation. The margins have been ground, and both faces are iridescent.

20.4/1184 (FIG. 79g); TYPE uH.PA3j: This is the distal portion of a trapezoid pendant, with ground margins and a polished dorsal face. The cross section is concavo-convex, and the pendant is quite thin.

20.4/1671 (FIG. 79h); TYPE uH.CA2j: This pendant consists of half of a rough chipped simple *Haliotis* Disc. The cross section is flat, and it was broken through the central perforation.

COMMENTS: Five *Haliotis* Square beads were found in Horizon 8 at Gatecliff Shelter, which dates approximately 1350 B.C. to 1300 B.C. They have also been recovered from early Lovelock and early Karlo contexts (Bennyhoff and Hughes, ms.). A pendant similar to 20.4/931 was recovered from Horizon 5 at Gatecliff (Bennyhoff and Hughes, 1983), which dates to approximately A.D. 1 (Thom-

TABLE 61
Attributes of Clam Beads from Hidden Cave

Specimen Number	Stratum	Length (mm.)	Width (mm.)	Thickness (mm.)	Diameter (mm.)	Perforation Diameter (mm.)	Weight (grams)	Material
1-1B-810	II	—	—	3.7	9.6	2.7	1.1	*Saxidomus* sp.
1-1B-976	I	—	—	1.5	6.6	1.6	0.1	*Macoma* sp.
1-1B-976	I	—	—	1.6	6.8	1.5	0.1	*Macoma* sp.
1-1B-996	I	—	—	1.6	6.8	1.6	0.1	*Macoma* sp.
2/32477	II	—	—	3.7	9.6	2.7	1.5	*Saxidomus* sp.
20.3/9995	N.C.	—	—	1.9	7.3	1.7	0.2	*Macoma* sp.
20.4/445	III	—	—	1.5	4.3	1.9	0.2	*Tivela* sp.
20.4/773	N.C.	—	—	1.7	6.5	1.8	0.1	*Macoma* sp.
20.4/891	IV	—	—	1.7	5.0	1.6	0.15	*Tivela* sp. or *Macoma* sp.
20.4/892	IV	—	—	1.4	5.2	1.6	0.1	*Tivela* sp. or *Macoma* sp.
20.4/893	IV	—	—	1.5	5.2	1.6	(0.1)	*Tivela* sp. or *Macoma* sp.
20.4/894	IV	—	—	1.4	5.1	1.6	0.1	*Tivela* sp. or *Macoma* sp.
20.4/895	IV	—	—	1.5	5.7	2.0	0.1	*Tivela* sp. or *Macoma* sp.
20.4/896	IV	—	—	1.8	5.6	1.5	0.1	*Tivela* sp. or *Macoma* sp.
20.4/897	IV	—	—	1.4	5.2	1.5	0.1	*Tivela* sp. or *Macoma* sp.
20.4/898	IV	—	—	1.6	4.8	1.6	0.1	*Tivela* sp. or *Macoma* sp.
20.4/899	IV	—	—	1.5	5.0	1.5	0.1	*Tivela* sp. or *Macoma* sp.
20.4/900	IV	—	—	1.5	3.8	1.0	0.1	*Tivela* sp. or *Macoma* sp.
20.4/901	IV	—	—	1.4	4.7	1.5	0.1	*Tivela* sp. or *Macoma* sp.
20.4/902	IV	—	—	1.2	4.5	1.7	0.1	*Tivela* sp. or *Macoma* sp.
20.4/903	IV	—	—	1.4	5.1	1.7	0.1	*Tivela* sp. or *Macoma* sp.
20.4/904	IV	—	—	1.5	4.5	1.6	0.1	*Tivela* sp. or *Macoma* sp.
20.4/942	IV	—	—	—	—	—	—	*Tivela* sp.
20.4/943	IV	—	—	1.6	6.2	1.9	0.2	*Tivela* sp.
20.4/983	I	—	—	1.5	6.5	1.5	0.15	*Macoma* sp.
20.4/1044	I	—	—	1.6	6.6	1.4	0.5	*Macoma* sp.
20.4/1511	N.C.	—	—	1.4	4.1	1.6	0.5	*Tivela* sp.

as, 1983b). *Haliotis* Discs similar to 20.4/1671) were found in Horizon 6 at Gatecliff, where they probably date somewhere between 1000 B.C. and 500 B.C. (Bennyhoff and Hughes, 1983).

Whelk Ornament

2/32630 (FIG. 80); TYPE .EB3j: By far, the largest shell artifact in the cave, 2/32630 is a wide triangular pendant, which is perforated in the center of the margin. The shell surface has been weathered and now appears somewhat chalky. The margins are smooth and were probably polished. Most of the epidermis has been obliterated, but several wavy epidermis lines remain intact. The longitudinal section is concavo-convex, as is the cross section. The ornament is manufactured from a *Busycon perversum* shell, which is a species of lefthanded whelk that originates in the Gulf of California.

COMMENTS: Gulf of California beads are extremely rare in Great Basin sites. Previously recovered Gulf shells include three *Olivella dama* Spire-lopped beads excavated at the Cottonwood Creek site and a site in Death Valley, both of which are located far to the south of Hidden Cave (Bennyhoff and Hughes, ms.).

SUMMARY OF HIDDEN CAVE BEAD CHRONOLOGY

The Hidden Cave beads suggest a rather different temporal story than do the projectile points from this site. Seventy-five percent of the Hidden Cave points fall within the Gate-

TABLE 62
Attributes of Miscellaneous Beads and Ornaments from Hidden Cave[a]

Specimen Number	Stratum	Length (mm.)	Width (mm.)	Thickness (mm.)	Perforation Diameter (mm.)	Weight (grams)	Material	Type
20.4/439	N.C.	4.8	3.9	1.1	1.9	0.2	Limpet	Round
20.4/440	N.C.	—	—	—	—	—	Limpet	Round
20.4/1465	IV	10.0	(12.0)	1.0	4.8	(0.2)	*Olivella biplicata*	F1 or G3
1-1B-1042	I	17.0	14.0	1.9	1.9	0.8	*Olivella biplicata*	(E2)
Ornaments								
1-1B-325	II	16.9	—	1.1	—	—	*Margaritifera* sp.	uM.BA1f
1-1B-642	V–IX	19.9	—	1.7	—	—	*Margaritifera* sp.	uM.AA1f
2/32630	(II)	100.0	57.4	5.8	4.1	35.1	*Busycon perversum*	.EB3j
20.4/401	N.C.	—	15.6	1.2	3.0	—	*Haliotis* sp.	uH.PA8j
20.4/578	N.C.	—	—	—	1.0	—	*Margaritifera* sp.	uM.BA3j
20.4/647	II	16.7	—	0.9	—	—	*Margaritifera* sp.	Serrated Spoon
20.4/657	II	—	9.9	0.6	(1.3)	—	*Haliotis* sp.	uH.1a Square
20.4/830	III	19.1	14.1	0.6	1.4 1.5 0.7	0.3	*Margaritifera* sp.	uM.PA2o
20.4/931	I	57.1	23.6	3.6	4.2	6.5	*Haliotis* sp.	uH.BB3j
20.4/1184	I	—	22.5	1.6	—	—	*Haliotis* sp.	uH.PA3j
20.4/1671	IV	17.6	(17.6)	1.2	3.8	(0.5)	*Haliotis* sp.	uH.CA2j

[a] Artifacts 1-1B-75, 1-1B-274, 1-1B-281, 1-1B-373 are untyped *Haliotis* pendants from the Wheeler collection which were unavailable for analysis.

cliff series, which dates between 3000 B.C. and 1300 B.C. (Thomas, 1981a, p. 22). By contrast, 70 percent of the bead types point to an Elko period date (1300 B.C. to A.D. 700, Thomas, 1981a, p. 20).

The Oblique Spire-lopped and End-ground beads have been recovered elsewhere in primarily early contexts (2500 B.C. to 1500 B.C.), but the End-ground beads do persist into Elko times (at least until 1100 B.C.).

Several other bead types, particularly the *Saxidomus* clam and *Tivela* clam, have been recovered elsewhere in protohistoric contexts, but we must reiterate our cautious approach with the *Tivela* bead identifications from Hidden Cave. Their exact identification remains in some doubt, blurring their temporal placement as well. Furthermore, their stratigraphic position within the cave (cached in Stratum IV) makes a historic date rather unlikely.

Margaritifera ornaments, once considered historic, have not been recovered in particularly well-dated contexts; and the likelihood of local manufacture further clouds their dating. The limpet beads, which may also date to protohistoric times, are extremely rare in the Great Basin; their dating is based on minor occurrences in Owens Valley.

Excluding these few equivocal examples, the vast majority of the Hidden Cave beads have been cross-dated to Great Basin sites which range between 1500 B.C. and A.D. 500 (see table 59).

The apparent discrepancy between the projectile point and bead chronologies is discussed in chapter 26.

CHAPTER 18. MATERIAL CULTURE: ARTIFACTS OF WOOD

LORANN S. A. PENDLETON

The wooden artifacts from Hidden Cave are described in this chapter. These artifacts are generally grouped into functional categories such as weapon parts, fire-making apparatus, juniper seed beads, and so forth. Whenever the function of an object is unclear, it has been described in morphological terms (see table 63 for provenience summary data).

WEAPON PARTS

Sixty-three wooden artifacts from Hidden Cave seem to be weapon parts. These items have been subdivided into various categories, including foreshafts, mainshafts, and butts. However, 46 miscellaneous pointed wood fragments (which appear to have been foreshafts) and 28 miscellaneous cane fragments (which may have been midshafts) were too fragmentary for precise classification; they are discussed separately.

ATLATL

An atlatl fragment, 1-1B-303 (fig. 81), was found by Georgia Wheeler in the middle of a dense tule layer beneath Floor #1A, correlated to AMNH Stratum IV (Wheeler, n.d.a.). The distal atlatl fragment is made of hardwood, with an integral hook (or spur). This artifact is currently on display at the Nevada State Museum, Carson City.

The fragment is 104.9 mm. long, 12.1 mm. thick, and 17.8 mm. wide. The hook projects about 21.5 mm. from the distal end, and is elevated about 3.0 mm. from the bottom of the trough (which ranges in width from 11.5 mm. to 16.5 mm.).

Wheeler (n.d.a.) commented on the similarities between the Hidden Cave and Lovelock Cave atlatls (see Loud and Harrington, 1929, p. 110, fig. 18a). Mildner (1974) and Krause (1905) have termed similar atlatls "mixed" types, but Tuohy (1982, p. 100) suggests that the Hidden Cave specimen is a "male" atlatl.

The Kramer Cave atlatl (Hattori, 1982, p. 149), which is somewhat smaller than the Hidden Cave atlatl, is roughly contemporary, dating to approximately 1745 B.C. One atlatl from Stratum VI at Hogup Cave also resembles the Hidden Cave fragment (Dalley, 1970a, fig. 114b). Tuohy (1982) has reported an intact "mixed" atlatl from NC Cave (see Mildner [1974], and Tuohy [1982] for discussions of atlatl distribution in the Great Basin).

FORESHAFTS

Forty-eight complete foreshafts were recovered (see table 64 for metric and provenience data). They have been further subdivided on the basis of morphological characteristics (see Aikens [1970], and Tuohy [1982] for distributional data on Great Basin hardwood foreshafts).

UNNOTCHED FORESHAFTS (FIG. 82a–c)

Thirty unnotched foreshafts were recovered. Eight are unpolished bipointed foreshafts, with diagonal manufacturing cut marks near the tips. The remainder have been whittled into fairly sharp points and have gently rounded bases. The bark has been completely removed, and many of the highly polished tips appear burnished.

It is conceivable that the hardwood shafts could have functioned as awls, or they may have served both as awls and foreshafts. At any rate, the shafts are fairly long, and gently tapered, with diagonal cut marks on the proximal end. Many unnotched foreshafts were made of *Sarcobatus* ($n = 16$), but other materials include *Salix* ($n = 3$), *Artemisia* ($n = 8$), *Populus* ($n = 2$), and *Atriplex* ($n = 1$).

NOTCHED FORESHAFTS (FIG. 82d–e, h)

Eight unwrapped, notched foreshafts were recovered consisting of smooth, tapered wood from which the bark has been removed. The proximal ends are diagonally whittled into smooth rounded tips. Distal ends are notched for the insertion of a stone point.

TABLE 63
Provenience of Wood Artifacts from Hidden Cave

Type	*n*	Surface	I	I/II	II	II/III	III	III/IV	IV	IV/V	V	VII	IX/X	N.C.
Atlatl	1	—	—	—	—	—	—	—	1	—	—	—	—	—
Unnotched foreshafts	30	5	1	—	11	—	2	1	5	—	—	—	—	5
Notched foreshafts	8	—	2	1	—	1	—	—	—	—	—	—	—	4
Wrapped foreshafts	8	—	—	—	6	—	—	—	—	—	—	—	—	2
Tipped foreshafts[a]	2	—	—	1	—	—	—	—	—	—	—	—	—	—
Mainshaft fragments	7	3	—	—	1	—	—	—	1	—	—	—	—	2
Arrowshaft butts	2	1	—	—	1	—	—	—	—	—	—	—	—	—
Snare parts	5	2	—	—	—	—	—	—	—	—	—	—	—	3
Digging sticks	10	1	4	1	1	—	—	—	—	—	—	—	—	3
Fire drills	26	—	4	—	9	—	—	—	4	—	—	—	—	9
Fire hearths	8	1	—	—	2	—	1	—	3	—	—	—	—	1
Polished wood	2	—	—	—	1	—	—	—	—	—	—	—	—	1
Incised wood	1	—	—	—	—	—	—	—	—	—	—	—	—	1
Miscellaneous wrapped wood	7	1	—	—	1	—	—	—	1	—	—	—	—	4
Miscellaneous pointed wood	46	18	1	1	9	—	2	—	7	—	—	—	—	8
Miscellaneous cane	28	7	1	—	2	—	1	—	3	—	—	—	—	14
Juniper seed beads	61	1	1	—	16	—	—	—	40	—	—	—	—	3
Totals	252	40	14	4	60	1	6	1	65	—	—	—	—	60

[a] 1-1B-517 was recovered from Strata V–IX.

The Hidden Cave notched foreshafts were generally made from *Sarcobatus* ($n = 4$), but one was made of *Salix,* and three others from *Typha.*

One notched foreshaft is painted with a light green spiral design over half its length (2/32680, fig. 82e). The green spiral bands are 3.0 mm. wide, and taper down to the left at a 50° angle. Apparently, a small obsidian fragment which was once held within the notch of this artifact was lost after it was excavated in 1951 (Roust and Grosscup, n.d., p. 85). The designs which were applied to this foreshaft resemble several from Gypsum Cave (Harrington, 1933, frontispiece). The Gypsum Cave foreshafts notwithstanding, decorated foreshafts are relatively rare in the Great Basin, as decorative motifs are generally applied to mainshafts (Hattori, 1982, pp. 160–161).

Notched atlatl foreshafts have also been recovered from NC Cave, Winnemucca and Kramer caves, as well as from Lovelock Cave (Loud and Harrington, 1929, p. 100, pl. 47s; Tuohy, 1982).

WRAPPED FORESHAFTS [NOTCHED AND UNNOTCHED] (FIG. 82f, g, i–k)

Two notched foreshafts were wrapped with sinew near the distal end. The sinew wrapping appears similar to the wrapping on the hafted bifaces recovered from the cave (see chap. 14). One foreshaft, 1-1B-485 (fig. 82g), is made of *Salix* with diagonal whittling on the proximal end. The sinew wrap, which is divided into thirds, is 11.5 mm. long, beginning 5.0 mm. from the notch. The notch itself is V-shaped, 3.1 mm. wide, quite clearly intended for the insertion of a stone tip.

The other notched foreshaft, 2/32478 (fig. 82f), is a *Sarcobatus* stick cut to a length of 255 mm. One end has been sharpened and polished and perhaps fire-hardened. The notched end is wrapped with a small amount of sinew, some 5.0 mm. from the notch. The purpose of the notch is unclear on this specimen, which was apparently designed for use without a stone point.

Six of the unnotched hardwood foreshafts

are lashed with various materials including sinew, fur, *Apocynum,* and cordage. Three wrapped foreshafts are made of *Salix* (although one may be *Cercocarpus*), and the other three are made of *Sarcobatus.* The tips of these foreshafts are particularly sharp; they probably served as complete foreshafts (used without stone points), although they could have been used as fire drills as well.

Artifact 2/32682 is a 137.0 mm. length of *Salix* or *Cercocarpus* that has been split for approximately 80.0 mm. One end is pointed and charred to a black purplish sheen. The tip is diagonally blunted and worn. Although the shaft has been smoothed, several bark fibers have been retained along the margins. According to the 1951 field notes, cordage was once attached, but it has since been lost.

Artifact 2/32727 (fig. 82k) is nearly the same size as 2/32682. It is a length of willow or mountain mahogany that has been straightened, smoothed, and polished. The proximal end is rounded, and the distal portion has been sharpened to a smooth point. Approximately midway along the shaft, the wood is wrapped with a stiff, coated fiber for about 13.0 mm. The wrapping is two ply S spun, Z twist cordage with a twist angle of 30° and eight twists per centimeter.

Two long foreshafts have been joined to quill fragments. Artifact 1-1B-870 (fig. 82j) is a tapered, unpolished, bipointed *Sarcobatus* foreshaft which has been partially smoothed. An 85.0 mm. long quill has been attached to the foreshaft by means of an 80.0 mm. length of two ply Z spun S twist cordage, which has been wrapped nine times around the wood and tucked into the last wrap. The cordage has a 26° twist angle, and five twists per centimeter.

Another quill/wood foreshaft, 1-1B-441, has a small quill fragment attached to a long pointed *Salix* stick. The willow has been fire blackened on the rounded end. The tip is pointed and smooth, and the quill has been attached by 5.0 mm. of horizontally wrapped sinew about 18.0 mm. from the rounded end.

Artifact 1-1B-529 is a sharpened *Sarcobatus* foreshaft which has been wrapped with fur. It has been tapered into a fine point; the opposite end is blunted. A light tan, horizontally wrapped fur strip is attached about 50.0 mm. from the distal end. Some type of feathery down adhering to the rounded end appears to be miscellaneous midden debris.

FIG. 81. Atlatl (1-1B-303) *in situ.* Provenience: Stratum IV.

Artifact 1-1B-200 (fig. 82i) is a sharply pointed *Sarcobatus* foreshaft with lashing placed about half way down the shaft. This lashing consists of a stiff wrapped section of sinew and fiber, 5.4 mm. thick and 15.0 mm. long, which moves freely in either direction along the shaft. The sinew has been wrapped perpendicular to the shaft, then wrapped parallel, forming a bundle that extends from the shaft at a right angle. This artifact may have functioned as a snare part.

Unnotched foreshafts are generally lashed lower on the shaft than the notched foreshafts. Typically, the notched foreshafts were lashed near the distal notch, suggesting the wrapping functioned to secure a stone point within the notch. The lashing on the unnotched foreshafts, on the other hand, was placed closer to the proximal end, suggesting it functioned to secure the foreshaft/mainshaft juncture.

TIPPED FORESHAFTS

Two unnotched foreshafts are "shouldered," similar to those from Gypsum Cave (Harrington, 1933, p. 91, fig. 51k). Foreshaft 1-1B-517 (fig. 83a) is a 245.0 mm. long bipointed *Sarcobatus* shaft with a teardrop-shaped point at the distal end; the proximal end has been smoothed into a blunt point. The shaft resembles several ethnographic ar-

TABLE 64
Metric Attributes of Wooden Foreshafts from Hidden Cave

Specimen Number	Stratum	Length (mm.)	Width (mm.)	Thickness (mm.)	Maximum Diameter (mm.)	Weight (grams)	Material
Unnotched							
1-1B-15	Surface	255.0	—	—	9.7	12.1	*Sarcobatus*
1-1B-18	Surface	100.0	—	—	9.7	5.4	*Artemisia*
1-1B-185	II	150.0	—	—	9.3	6.3	*Populus*
1-1B-206	II	100.0	—	—	7.5	3.4	*Salix*
1-1B-220	II	45.0	—	—	9.5	2.2	*Sarcobatus*
1-1B-227	N.C.	160.0	—	—	4.0	1.4	*Sarcobatus*
1-1B-283	II	100.0	—	—	10.3	2.7	(*Populus*)
1-1B-288	II	85.0	—	—	10.0	3.2	*Artemisia*
1-1B-404	II	135.0	—	—	8.5	3.6	*Salix*
1-1B-433	II	85.0	—	—	8.8	2.9	*Artemisia*
1-1B-516	IV	230.0	—	—	11.0	12.0	*Sarcobatus*
1-1B-560	II	185.0	—	—	8.3	8.7	*Sarcobatus*
1-1B-778	IV	200.0	—	—	5.0	1.9	(*Artemisia*)
1-1B-848	III	150.0	—	—	8.6	4.8	*Salix*
1-1B-911a	Surface	70.0	—	—	9.0	3.5	*Sarcobatus*
1-1B-911b	Surface	135.0	—	—	9.5	6.8	*Sarcobatus*
1-1B-911c	Surface	110.0	—	—	4.4	6.7	*Sarcobatus*
2/32544a	N.C.	162.0	—	—	6.7	5.3	*Sarcobatus*
2/32564	III	165.0	—	—	9.5	7.2	*Sarcobatus*
2/32637	IV	110.0	—	—	5.0	—	*Sarcobatus*
2/32642	N.C.	200.0	—	—	5.3	4.9	*Sarcobatus*
2/32658	II	100.0	—	—	9.8	5.6	*Sarcobatus*
2/32732	III/IV	105.0	10.5	4.2	—	1.7	*Sarcobatus*
2/32745	II	93.0	—	—	9.1	5.3	—
20.4/325	N.C.	120.0	—	—	9.2	5.6	(*Artemisia*)
20.4/429	I	220.4	—	—	8.0	(10.0)	(*Artemisia*)
20.4/431	N.C.	190.0	—	—	9.1	8.0	*Sarcobatus*
20.4/503	IV	128.5	—	—	10.4	3.2	(*Artemisia*)
20.4/674	IV	125.3	—	—	3.4	(3.0)	(*Artemisia*)
20.4/1259	II	95.7	—	—	9.4	3.5	(*Sarcobatus*)

Specimen Number	Stratum	Length (mm.)	Notch Length (mm.)	Notch Width (mm.)	Maximum Diameter (mm.)	Weight (grams)	Material
Notched							
1-1B-14	I	235.0	6.0	2.3	6.8	—	*Sarcobatus*
1-1B-17	I	102.0	6.5	3.0	9.1	5.4	(*Sarcobatus*)
1-1B-485[a]	N.C.	150.0	15.0	3.1	8.9	5.2	*Salix*
2/32478[a]	II	(260.0)	(5.0)	—	6.7	6.9	*Sarcobatus*
2/32579	N.C.	(170.0)	(5.0)	—	8.0	5.8	*Sarcobatus*
2/32627	N.C.	(126.0)	(6.0)	—	6.5	1.7	*Typha*
2/32628	N.C.	133.0	9.1	4.4	8.7	1.9	*Typha*
2/32646	N.C.	157.0	10.9	—	5.7	4.4	*Sarcobatus*
2/32680	I/II	365.0	6.0	2.0	7.0	14.0	*Salix* or *Grayia*
2/32735	II/III	90.0	10.5	—	5.6	0.7	*Typha*

TABLE 64—(*Continued*)

Specimen Number	Stratum	Length (mm.)	Lash Length (mm.)	Notch Width (mm.)	Maximum Diameter (mm.)	Weight (grams)	Material
Wrapped							
1-1B-200	II	230.0	15.0	—	8.1	10.4	*Sarcobatus*/Sinew
1-1B-441	II	105.0	—	—	3.0	0.8	(*Salix*)/Sinew/Quill
1-1B-529	II	155.0	—	—	6.1	2.4	*Sarcobatus*/Fur
1-1B-870	N.C.	150.0	8.0	—	3.0	1.4	*Sarcobatus*/Quill
2/32682	II	137.0	—	—	5.3	1.8	Salix or *Cercocarpus*
2/32727	II	143.0	13.0	—	5.4	3.8	*Salix* or *Cercocarpus*/ Fiber
Tipped Foreshafts							
1-1B-517	V–IX	245.0	—	—	7.5	3.7	*Sarcobatus*
2/32789	I/II	—	—	—	8.4	1.3	*Sarcobatus*

[a] These specimens are discussed with the wrapped foreshafts.

row foreshafts—designed to be used without a stone point—but it is impossible to distinguish between arrow and atlatl foreshafts on the basis of size alone (Thomas, 1978; see also Tuohy, 1982, fig. 8, for illustrations of similar foreshafts).

Artifact 2/32789 is a 58.4 mm. long *Sarcobatus* foreshaft fragment, approximately 8.4 mm. in diameter, that has been carved into a bulbous tip. It probably served as a complete foreshaft, perhaps as a bunt used to hunt birds.

Mainshafts

Seven fragments of *Phragmites* were probably mainshafts. They are wrapped with either *Scirpus* and/or sinew, usually at a node.

Four of the fragments are lashed with *Scirpus*. Artifact 1-1B-610 is a 220.0 mm. length of *Phragmites*, with a maximum diameter of 16.5 mm. The stalk has been crushed and flattened, and both ends are broken. The cane has been cut and its outer sheath removed. Fiber wrapping covers a node 75.0 mm. from one end.

Artifact 1-1B-1042 is a 55.0 mm. long fragment of *Phragmites* which is 11.0 mm. in diameter. A *Scirpus* leaf was wrapped horizontally, then diagonally, then horizontally, for a distance of 22.0 mm. The *Scirpus* ends are tucked under the diagonal wrap, forming a knob along the margin. Because this knob might have hindered its flight as a projectile, it is possible that this fragment was not used as a mainshaft.

Artifact 2/32381 is a cane fragment (11.1 mm. diameter) that is wrapped both horizontally and diagonally for a distance of 30.0 mm. The lashing is folded over the top of the cane, forming a triangular loop. The loop was then wrapped with unidentified bark about 160.0 mm. long and 8.0 mm. wide.

Three *Phragmites* fragments were wrapped with sinew. Artifact 1-1B-13 consists of a small fragment of *Phragmites* which has been lashed with sinew to a small fragment of *Sarcobatus*. This artifact is probably the fragment of a foreshaft/mainshaft juncture.

Artifact 1-1B-12 is a sinew-wrapped cane fragment, 95.0 mm. long and 8.2 mm. in diameter. The sinew covers a node on the mainshaft; thin light green diagonal scratch marks were painted on the body of the mainshaft.

Arrowshaft Butts

Artifact 1-1B-41 (fig. 83b) is the butt portion of an arrowshaft. The 205.0 mm. segment of *Phragmites* has jagged breaks at the nodes on both ends. The cane is decorated with parallel brown and light green lines painted around the shaft at approximately 2.0 mm. intervals. Three quills (apparently split and about 120.0 mm. long), have been lashed to the shaft with sinew; these quills are separated by about 9.0 mm., and are attached to the shaft in a spiral design. The shaft diameter varies between 7.8 mm. and 7.4 mm. Similar artifacts were recovered at

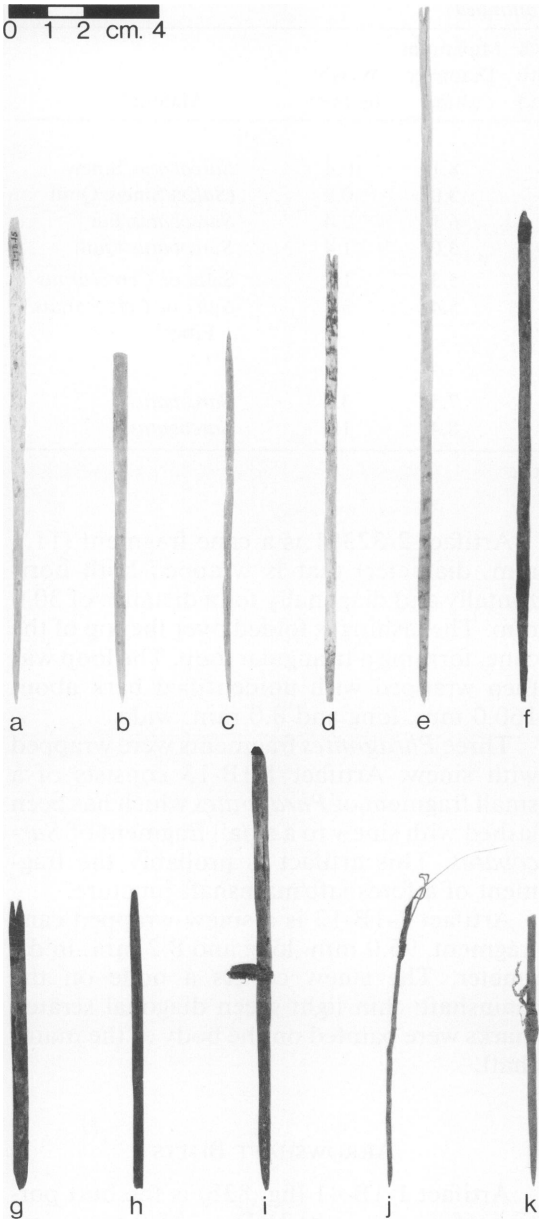

FIG. 82. Selected wood foreshafts from Hidden Cave. a. 1-1B-15; b. 1-1B-560; c. 1-1B-778; d. 1-1B-14; e. 2/32680; f. 2/32478; g. 1-1B-485; h. 2/32646; i. 1-1B-200; j. 1-1B-870; k. 2/32727. Unnotched foreshafts, a–c; notched foreshafts, d, e, h; wrapped foreshafts, f, g, i–k.

Provenience: Surface, a, d; Strata I/II, e; Stratum II, b, f, i–k; Stratum IV, c; not correlated (N.C.), g, h.

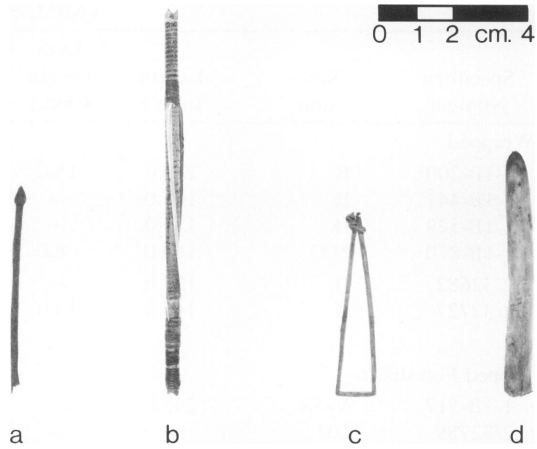

FIG. 83. Miscellaneous wood artifacts from Hidden Cave. a. 1-1B-517; b. 1-1B-41; c. 20.4/361; d. 1-1B-16. Triangular tipped foreshaft, a; arrowshaft butt, b; snare, c; digging stick, d.

Provenience: Surface, c, d; Stratum II, b; Strata V–IX, a.

Gypsum Cave (Harrington, 1933, frontispiece).

Another probable arrowshaft butt (1-1B-11) is a sinew wrapped cane fragment. One end is charred and broken on the diagonal, whereas the other is lashed with four sections of sinew. The lashed end appears to have the remnant of a nock.

SNARE PARTS

Five bent *Salix* sticks which were recovered from Hidden Cave are included for discussion with the weapons because they are probably parts of snares. Two were excavated from Stratum I, and the remainder came from the uncorrelated fill of the cave.

Two of the artifacts (20.4/344, 2/32546) consist of *Salix* overhand knots. Artifact 1-1B-133 is a small piece of *Salix* with one end curled and twisted around itself. Artifacts 20.4/361 (fig. 83c) and 20.3/9993 are bent pieces of *Salix* with pointed ends; both are probably snare parts. The Hidden Cave snares appear to be fragments from specimens similar to those illustrated from Lovelock Cave (Loud and Harrington, 1929, pls. 44a, 48b). Snare parts are fairly common in the Great

TABLE 65
Attributes of Digging Sticks from Hidden Cave

Specimen Number	Stratum	Length (mm.)	Width (mm.)	Thickness (mm.)	Maximum Diameter (mm.)	Weight (grams)	Material
1-1B-16	Surface	128.0	—	—	16.5	8.8	*Populus*
1-1B-909a	I	140.0	—	—	21.5	18.3	*Populus*
1-1B-909b	I	143.0	—	—	11.3	5.8	*Populus*
1-1B-909c	I	170.0	—	—	13.7	9.3	*Populus*
2/32423	I/II	—	1.2	8.5	—	—	—
2/32544b	N.C.	185.0	—	—	12.2	8.8	(*Populus*)
20.3/9787	N.C.	302.0	—	—	12.9	26.3	*Sarcobatus*
20.3/9788	N.C.	205.0	—	—	25.4	—	(*Artemisia*)
20.4/505	II	153.7	21.7	17.5	—	17.0	(*Artemisia*)
20.4/808	I	227.5	14.0	6.9	—	9.1	—

Basin (see Janetski [1979] for distributional data).

DIGGING STICKS

Ten large, bluntly pointed wooden artifacts which were probably digging sticks were recovered (fig. 83d). Most of the sticks have been broken, with lengths ranging from 110.0 mm. to 302.0 mm. They have tapered, smoothed shafts, round to flat cross sections, and many of the distal ends are stained, perhaps the result of use. Five digging sticks were made from *Populus,* two from *Sarcobatus,* and one from *Artemisia*; we were unable to identify the remainder of the wood (see table 65).

FIRE MAKING APPARATUS

Fire Drills

Twenty-six fire drills were recovered from Hidden Cave; seven of these were complete (fig. 84a). Although they resemble foreshafts, the fire drills had at least one fire-blackened end. They were made from *Sarcobatus* (n = 13), *Salix* (n = 4), *Populus* (n = 3), *Artemisia* (n = 2), and *Sambucus* (n = 1).

In plan view, the fire drills are smooth, rounded sticks, generally pointed at one end and broken on the other. Six of these have blunt or flat charred tips; one is bipointed. Many cross sections are flat or lenticular, and the tips vary between round and triangular.

Fire drill diameters seem to fall into one of three size ranges: 4–5 mm., 6–10 mm., or 15–32 mm. The two smaller sizes clearly seem to be fire drills, but the larger specimens may have been digging sticks that were reused as fire drills.

Fire Hearths

Eight fire hearths that were recovered from Hidden Cave have a wide ovate plan view with rounded ends. Usually, two or more charred drill holes have been started near one of the margins (fig. 84b). A vertical slot has been cut between the fire-blackened holes and the edge of the hearth, bisecting the drill pit. Cross sections of the hearths vary between ovate, triangular, concavo-convex, and flat. Three of the hearths were made from *Populus,* two from *Typha,* and three others were made from unidentifiable wood.

Hough (1928, p. 7) notes that fine-grained woods are the most desirable fire-making materials; hardwoods or new woods which contain high proportions of gums, resins, starches, or tannic acids are less desirable because they do not produce the fine, dry, inflammable powder required to kindle a fire. *Populus,* the best raw material according to Hough, is the most common hearth material

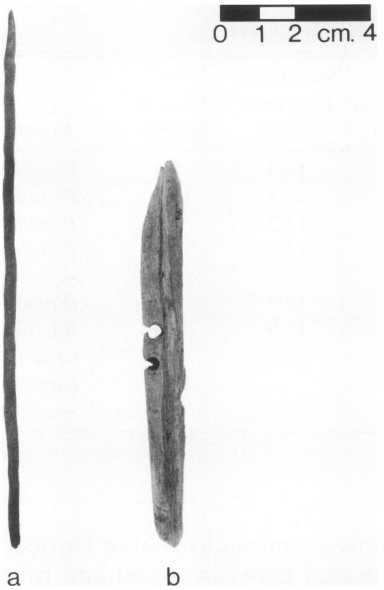

FIG. 84. Two-stick fire-making apparatus from Hidden Cave. a. 1-1B-667; b. 2/32666.
Provenience: Stratum II, a; not correlated (N.C.), b.

in Hidden Cave. Although Stewart (1941, p. 381) records *Artemisia* as a favored hearth wood among the Northern Paiute, no *Artemisia* hearths were recovered from the cave.

Fire hearths were wrapped or kept dry, and their effectiveness increased with use and age: "a stick and hearth that have been charred by the former making of fire in most cases yields the spark in half the time required for new apparatus. Another advantage is that the drill is softer from incipient decay" (Hough, 1928, p. 13).

Dry caves are excellent spots in which to store fire equipment, particularly in an otherwise damp marshy environment. Two hearths from Hidden Cave are identical with the examples in the collections of the National Museum of Natural History. Specimen 2/32666 (fig. 84b) is similar to an ethnographic Southern Paiute hearth from Utah, collected by J. W. Powell (Hough, 1928, fig. 7; see also Fowler and Matley, 1979, p. 74). It is a small, rounded, two-holed hearth which, for carrying convenience, was used with a shortened, spliced drill. Powell noted that this efficient combination was used by hunters who were away from their residence (Hough, 1928, p. 15).

Aboriginal North Americans developed several fire-making techniques: a four-part apparatus used with a mouthpiece, a two-hand drill, minerals such as pyrites and flints, and the simple two-stick method. The two-stick apparatus was the most universal (Hough, 1928, p. 9). Artifact 20.4/906 has all the attributes of the classic two-stick fire-making apparatus described by Hough (1928, p. 5): "We round the lower end of the drill and make a slight holding notch near the border of the hearth in which to start the drill rotating, and we cut a clean vertical slot from the notch down the edge of the hearth. This slot should be cut deep enough to divide the pit in which the drill operates nearly halfway."

The two-stick method—using a fire hearth and associated drill—was ubiquitous among ethnographic Great Basin groups. Steward (1941, p. 234), Stewart (1941, p. 381), and Hough (1928, pp. 15–16) note that only the Shoshone/Paiute and Navaho used a compound drill composed of a soft reed inset with hardwood (usually greasewood or sage). Curiously, five artifacts from Hidden Cave (1-1B-11, 1-1B-13, 1-1B-441, 2/32682, and 2/32813) consist of joined fragments of *Phragmites* cane inset with *Sarcobatus* and *Salix* wood, similar to the compound fire drills. Each artifact has one charred end, and it is certainly possible that they were parts of compound fire drills. But the majority of fire drills recovered from the cave were simple rather than compound types. The simple drill and hearth (fig. 84) was common among various California groups, including the Hupa (Hough, 1928, p. 13).

POLISHED WOOD

Two wooden artifacts were squared and polished. Artifact 2/32659 (fig. 85a), which was found in Stratum II during the 1951 excavations, was thought to be a "mesh gauge" (Roust and Grosscup, n.d., p. 86). It consists of a smooth square of wood, with two small nicks that shoulder the margins, 7.6 mm. below the proximal end. The distal end is worn and slightly tapered. The surface is light orange, and polishing has enhanced the grain.

The artifact is 18.8 mm. long, 17.4 mm. wide, and 4.5 mm. thick; it weighs 1.6 grams.

Artifact 20.4/545 was recovered from mixed deposits above the 32 Inch Midden (Strata I–IV). It appears to be made from *Sambucus cerulea* (elderberry). The artifact is rectilinear, with a round cross section. This small wooden cylinder is 31.6 mm. long and 9.2 mm. in diameter, and weighs 0.4 grams. A similar specimen, recovered from Hogup Cave, was thought to be a gaming counter (Dalley, 1970a, pp. 171–176, fig. 124h).

INCISED WOOD

It appears that artifact 20.4/326 (fig. 85b) may have been an effigy, consisting of a smooth oval, bipointed segment of unidentifiable wood with three small cuts on the distal dorsal left margin, and seven cuts on the proximal ventral right margin. Remnants of incising have been partially obliterated on the distal ventral left margin. The effigy is a deep brown color and has been softly polished. The polish is quite homogeneous and may have resulted from repeated handling.

MISCELLANEOUS WRAPPED WOOD

Seven wrapped wood artifacts of uncertain functions were recovered from Hidden Cave. Artifact 2/32583 consists of seven short lengths of blunted willow, bound to segments of two ply Z spun S twist cordage by a clove hitch knot. The cordage, with a length of over 50.0 mm., has been knotted with sheet bend knots, as well; this artifact may have been part of a net or a snare.

A blunted 130.0 mm. section of *Populus* (1-1B-764) was recovered from Stratum IV in association with a bone flaker. The wood, which is 14.2 mm. in diameter, is wrapped six times horizontally with an unidentified, hardened (perhaps pitch covered) S twisted fiber. *Populus* is a fairly soft wood, which seems an unlikely choice for a flaker handle. Therefore, we will not assign this artifact to a functional category.

A quill/wood artifact, 20.4/1630, consists of a quill between two pieces of *Salix,* bound by cordage. The sticks are 100.0 mm. and 95.0 mm. long, and 4.0 mm. in diameter. Both have split and pointed tips. The other ends are blunted, and the quill extends 110.0 mm. beyond the end of the sticks. One ply Z twist *Artemisia* cordage cross-wraps one of the sticks and the quill three times; a fourth loop binds the three elements into a unit. The artifact contains a total of 17 cordage wrappings, covering a 30.0 mm. area.

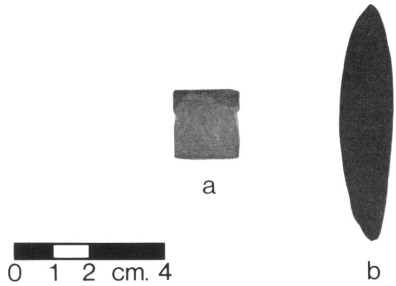

FIG. 85. Selected polished and incised wood from Hidden Cave. a. 2/32659; b. 20.4/326. Provenience: Stratum II, a; not correlated, (N.C.), b.

A willow shaft (2/32602), 130.0 mm. long and 4.0 mm. in diameter, is wrapped at the top with *Scirpus* culms for a length of 43.0 mm. The tule is tied with an overhand knot at the base of the bundle. A thick *Scirpus* leaf is also wrapped tightly around the base of the shaft, enclosing a quill fragment.

A broken willow (*Salix*) stick (1-1B-1007) is 97.0 mm. long and 2.7 mm. in diameter. A 2 mm. length of Z twisted *Apocynum* cordage is wrapped around its tip and continues diagonally to the midpoint.

Artifact 20.4/567 is an unidentifiable pointed wood fragment, 46.3 mm. long and 3.1 mm. in diameter. A 6.8 mm. length of cordage has been wrapped about its top and forms a knob some 5.1 mm. thick.

Artifact 20.3/9804 is also wrapped with cordage. It consists of a broken twig of unidentified (possibly *Grayia*) wood with *Apocynum* cordage girdling its circumference at the midpoint.

MISCELLANEOUS POINTED WOOD

Of the 46 miscellaneous pointed wood fragments recovered from the cave, 13 are *Sarcobatus,* eight are *Salix,* eight are *Arte-*

TABLE 66
Attributes of Juniper (*Juniperus osteosperma*) Seed Beads from Hidden Cave

Specimen Number	Stratum	Length (mm.)	Width (mm.)	Thickness (mm.)	Perforation Diameter (mm.)	Weight (grams)
1-1B-225	II	4.8	4.7	4.2	1.8	0.05
1-1B-225	II	4.6	4.2	3.7	1.5	0.05
1-1B-225	II	4.7	4.9	4.0	1.4	0.05
1-1B-225	II	4.6	4.7	3.8	1.4	0.05
1-1B-225	II	4.9	4.6	4.3	1.6	0.05
1-1B-225	II	4.4	4.5	4.2	1.5	0.05
1-1B-225	II	4.2	4.0	3.9	1.5	0.05
1-1B-225	II	4.6	4.5	4.2	1.8	0.05
1-1B-225	II	4.3	4.6	4.2	1.5	0.05
1-1B-225	II	5.2	4.8	4.6	1.6	0.05
1-1B-225	II	5.0	4.6	4.4	1.5	0.05
1-1B-225	II	5.3	4.8	4.8	1.5	0.05
1-1B-225	II	5.4	4.4	4.2	1.7	0.05
1-1B-978	Surface	5.7	4.4	4.3	1.5	0.05
20.4/256	N.C.	5.7	5.5	5.2	2.5	0.05
20.4/455	IV	5.9	5.1	4.4	2.1	0.05
20.4/456	IV	6.2	5.1	—	2.2	0.05
20.4/506	IV	4.7	5.0	4.0	—	—
20.4/582	N.C.	4.8	5.3	4.7	2.6	—
20.4/649	II	6.2	4.9	—	2.1	—
20.4/667	IV	5.2	4.9	4.2	1.8	0.5
20.4/739	IV	5.7	6.3	5.2	1.8	0.1
20.4/740	IV	5.4	5.0	4.6	2.0	0.1
20.4/741	IV	—	—	—	—	—
20.4/819	I	5.2	4.0	—	1.8	—
20.4/823	II	5.9	5.1	4.9	2.2	0.1
20.4/871–890[a]	IV	28	—	—	—	—
20.4/1522	N.C.	5.5	4.4	—	1.9	0.05
20.4/1653	II	5.4	5.3	—	2.2	0.1
20.4/1670a	IV	4.4	4.5	3.5	1.2	0.3
20.4/1670b	IV	3.0	4.5	4.0	2.4	0.3
20.4/1670c	IV	4.5	4.2	4.0	1.3	0.3
20.4/1670d	IV	5.9	4.6	4.4	1.5	0.3
20.4/1670e	IV	4.7	4.5	3.9	1.6	0.3

[a] Beads, too fragile to measure. Burned.

misia, seven are *Populus,* and one is *Typha*; the remainder are unidentifiable.

The sticks are generally long (range: 30.0 mm.–425.0 mm.), between 5.0 mm. and 10.5 mm. in diameter, and sharply pointed on one end. They are whittled smooth and straight, and some of the manufacturing marks are preserved. The bulk of the fragments appear to have been parts of foreshafts, but it is impossible to fix their exact function.

Two bent pointed wood artifacts (1-1B-711, 1-1B-981) may have been used as awls. Both are made from *Sarcobatus* sticks ranging between 5.0 mm. and 220.0 mm. long, with diameters of 4.3 mm. and 7.0 mm., respectively. Both are bipointed and neither has been charred. They are probably not foreshafts, as they are aerodynamically unsound.

MISCELLANEOUS CANE ARTIFACTS

Twenty-eight cane fragments (from 20.0 mm. to 240.0 mm. long) probably functioned as mainshafts, but were too fragmentary to categorize. The diameters range between 5.7

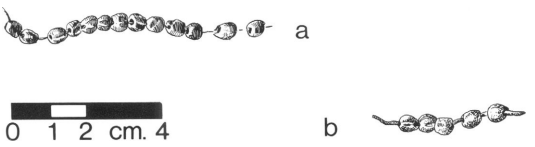

FIG. 86. Strung juniper seed beads from Hidden Cave. a. 1-1B-978; b. 20.4/1670.
Provenience: Surface, a; Stratum IV, b.

mm. and 14.8 mm.; five are *Typha,* and the others are *Phragmites.* Twelve fragments are charred.

JUNIPER SEED BEADS

Juniper seed beads, a rare item in Great Basin archaeological contexts, were recovered in bulk from Hidden Cave ($n = 61$). The nearest source for *Juniperus osteosperma* is in the higher reaches of the Stillwater Mountains, within 15 km. of the cave (see table 66 for metric and provenience data).

The beads are a rich shiny dark brown, suggesting color enhancement. They have a central, longitudinal perforation. The proximal and distal ends are ground and slightly concave, indicative of surface attrition from necklace contact.

Two strung bead segments were excavated from the cave. Artifact 1-1B-978 (fig. 86a) consists of 13 juniper beads strung on twisted sinew. In artifact 20.4/1670 (fig. 86b), five color-enhanced and polished juniper berry beads were strung together on one ply twisted sinew. The longitudinally drilled beads were strung with the proximal end of one bead touching the distal end of the adjacent bead. The method of stringing is identical to that for 97 percent of the strung juniper beads from Kramer Cave (Hattori, 1982, p. 60). The Kramer Cave beads were strung with cordage made from either sinew or *Apocynum.*

Juniper seed beads are rarely reported from archaeological contexts. Other than the several thousand beads from Kramer Cave (Hattori, 1982, pp. 55, 59–60, figs. 17, 18), only nine other juniper beads have been reported—they were strung with six bone tubes at Hogup Cave (Aikens, 1970, p. 90, fig. 52c).

Davis (1961, p. 25) reports that the Karok received juniper seed beads as trade items from the Shasta. "Some of the Californian tribes used great quantities of juniper-seeds for necklaces and for fringes of their ceremonial dresses. . . . Similar seeds were used for necklaces by the Zuñi of New Mexico from ancient times until a couple of generations ago" (Orchard, 1929, p. 74).

CHAPTER 19. MATERIAL CULTURE: BASKETRY AND FIBER ARTIFACTS

STACY GOODMAN[1]

This is the last chapter dealing with the material culture from Hidden Cave, and the remaining perishable artifacts are described in detail. A synopsis of the perishable categories follows the descriptive data. Description and classification of basketry follows Adovasio (1977), cordage terminology is taken from Hurley (1979), and netting and knot descriptions follow Shaw (1972) and Emery (1966).

All specimens were minimally cleaned before analysis, and measurements were taken with Forestry Suppliers dial calipers and a Wards contact goniometer. The identification of raw materials was based on macroscopic and microscopic comparison with a modern control sample, but some caution is in order here. Because of the extensive modification of the raw materials, in many cases it was impossible to identify the materials as to species. Rather than guess incorrectly, we follow a conservative course and identify only those raw materials for which we can make positive identification.

BASKETRY

A total of 122 basketry fragments were recovered from Hidden Cave, and these can be divided into twined, coiled, and plaited categories. Basketry provenience is listed on table 67. Table 70 (at the end of this chapter) lists individual basketry specimens.

Twined Basketry

Type I: Close Simple Twining, Z Twist Weft (fig. 87a)

Number of Specimens: Three.

Type of Specimens: Wall fragment and side selvage (2), wall fragment (1).

Number of Individual Forms Represented: Three.

Type of Forms Represented: Sandals, matting.

Technique and Comments: This technique involves plain twined weaving over single warps. The warps are bunched, consisting of whole sedge stalks in two specimens and decorticated rods in the wall fragment. Wefts are single paired Z twisted stalks. Artifact 1-1B-716 has a simple side selvage intact on one edge, with the wefts looped around final warp elements. Weft rows at both ends extend to form free standing Z twists that resemble a handle or loop. The second side selvage fragment consists of an extended weft row running parallel to the warp; this specimen is possibly a sandal fragment with continuous weft selvage that acts as a loop for cross-binding. The extended Z twist weft crosses the final warp on an S twist (down to the left) diagonal creating a strong, compact edge. Weft rows are closely spaced with small exposure of warp units. Specimens lack decoration, and wear is evident on the convex side of the selvage fragments, possibly indicative of use as sandals.

Measurements: Range in diameter of warps, 3.5–11.2 mm.; mean warp diameter, 6.90 mm.; range of weft diameter, 2.5–11.0 mm.; mean weft diameter, 6.33 mm.; range of warps per cm., 1.25–2.0; mean warps per cm., 1.41; range of wefts per cm., 1.0–2.0; mean wefts per cm., 1.50; range in gap between weft rows, 0–3.0 mm.; mean gap between weft rows, 1.83 mm.

Type II: Close Simple Twining, S Twist Weft (figs. 87b–d)

Number of Specimens: Eighteen.

Type of Specimens: Wall fragments (16); wall fragment with center (1); wall fragment with selvage (1).

Number of Individual Forms Represented: Eighteen.

Type of Forms Represented: Circular trays, shallow containers (?).

Technique and Comments: Type II twining involves a plain twined weave over single warps. The warps are single whole rods or compacted stems, evident in 11 rigid and sev-

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en semiflexible fragments. One specimen with a center is made with a nonintersecting, closely spaced V pattern, with twining proceeding outward from the center in a radial fashion. Five other specimens have the same radial formation of the warp units, and probably also have the nonintersecting, closely spaced V center. One specimen exhibits simple twined end selvage. No other selvages are present in the sample.

The wefts are paired split and compacted fibers, usually sedge. Weft rows are closely spaced, concealing the warp units, with the exception of deteriorated and worn specimens in which warp elements are exposed. Addition of new warp units is accomplished by inserting the warp element adjacent to the exhausted warp with the end tucked under the weft crossing. One specimen has a gray matte residue on both sides (perhaps pitch); this piece also has four weft rows which indicate plain twined overlay by the addition of twisted fibers appearing on alternate weft crossings. All other specimens lack decoration or residual materials.

MEASUREMENTS: Range in fragment size, (10.0 × 10.0 mm.)–(120.0 × 165.0 mm.), mean fragment size 45.09 × 100.89 mm.; range in warp diameter, 1.5–4.0 mm.; mean warp diameter, 2.55 mm.; range in weft diameter, 1.0–3.2 mm.; mean weft diameter, 2.11 mm.; range in warps per cm., 2.0–4.0; mean warps per cm., 2.61; range in wefts per cm., 3.0–5.0; mean wefts per cm., 3.98; range in gap between weft rows, 0–2.0 mm.; mean gap between weft rows, 0.35 mm.

TYPE III: OPEN SIMPLE TWINING, Z TWIST WEFT (figs. 88 and 89)

NUMBER OF SPECIMENS: Twenty-eight.[2]

TYPE OF SPECIMENS: Whole conical bags (5), bag and base fragments (12), bag center (1), flat mats with selvage (1), flat mat fragments (9).

NUMBER OF INDIVIDUAL FORMS REPRESENTED: Bags (18), mats (10).

TYPE OF FORMS REPRESENTED: Conical bags, flat mats.

TECHNIQUE AND COMMENTS: Bags are manufactured with plain twined weaving over single or doubled warps. Twelve specimens have single warps, five have two warps functioning as a unit. The warps are whole, crushed stalks, which are folded in a V shape at the base weft row, either radiating to the adjacent weft crossing, or radiating in the succeeding weft row.

Weft rows are paired, whole, bunched stalks, Z twisted in a continuous spiral creating deliberate spacing between weft rows and occasional gaps between warp units. Z twist wefts form a continuous spiral from the base upward in a right to left direction. New warps are folded over and inserted through a weft crossing, repeating the V shape base formation. Additional weft elements are laid adjacent and tucked into exhausted wefts. Handle formations are present as Z twist segments in two bags, consisting of extended warp units tied in an overhand knot or warps intertwined with the extended weft row.

Ten open twined matting fragments are made with plain twined weaving over single to multiple element warps. Three of these have whole, bunched stalks, four specimens have two whole and split stalks, and three were made with two to 12 whole bunched stalks functioning as a unit. Paired wefts consist of whole bunched Z twisted stalks. Artifact 2/32460 has a side selvage of a Z twist loop, indicating continuous weft formation. Weft crossings are tightly woven, eliminating any gap between warp elements—with the exception of two loosely twined specimens. Addition of warps and wefts is effected by laying new elements adjacent to exhausted units.

Artifact 1-1B-117 is the flattened center of an open twined bag. Paired, whole and bunched Z twist stalks comprise a continuous spiral forming two weft circuits. Warps are whole, bunched stalks that are folded into a V shape, radiating to the adjacent weft crossings. Twining is compact, exhibiting no gaps between warps.

[2] The National Museum of Natural History (Smithsonian Institution) contains two additional tule artifacts (accessioned under catalog no. 377993) which probably came from Hidden Cave, as part of the C. McRiley collection. One is a rather finely manufactured tule bag, measuring 150 mm. by 260 mm. The other is a coarse-weave tule bag, roughly the same size as the first, but incomplete. Because of the uncertain provenience, these items are not included in the tabulations listed in this chapter.

TABLE 67
Provenience of Perishable Artifacts from Hidden Cave

Type	*n*	Surface	I	I/II	II	II/III	III	III/IV	IV	V	VII	V–IX	VII–XII	N.C.
BASKETRY														
Twining														
Type I	3	—	—	—	—	—	—	—	2	—	—	—	—	1
Type II	18	2	—	—	6	—	—	—	6	—	—	—	—	4
Type III	28	2	—	—	10	—	—	—	10	—	—	—	—	6
Type IV	14	1	—	—	4	—	—	—	3	—	—	—	—	6
Type V	1	—	—	—	—	—	—	—	1	—	—	—	—	—
Coiling														
Type VI	6	1	—	—	—	—	—	—	2	—	—	—	—	3
Type VII	2	—	—	—	2	—	—	—	—	—	—	—	—	—
Plaiting														
Type VIII	5	1	—	—	—	—	—	—	—	—	—	—	—	4
Twining Fragments	45	9	—	—	6	1	1	—	3	—	—	—	—	25
CORDAGE														
Unspun	6	—	—	—	1	—	—	—	2	—	—	—	—	3
Type I	14	—	—	—	3	—	—	—	3	—	—	—	—	8
Type II	7	—	1	—	1	—	—	—	1	—	—	—	—	4
Type III	930	158	41	26	206	6	15	9	131	12	1	4	—	321
Type IIIA	20	5	—	—	5	1	—	—	—	1	—	—	—	8
Type IV	49	5	2	—	14	—	—	—	10	2	—	—	—	16
Type V	10	1	1	—	3	—	—	—	2	—	—	—	—	3
Type VI	3	—	—	—	2	—	1	—	—	—	—	—	—	—
Unusual	10	2	—	—	3	—	1	—	—	—	—	—	—	4
Misc.	10	1	—	—	1	—	—	1	2	—	—	—	—	5
NETTING														
Group I	5	—	—	—	1	—	—	—	1	—	—	—	—	3
Group II	39	3	3	1	8	—	—	—	8	1	—	—	—	15
Net Frag.	21	1	1	—	3	—	—	—	3	1	—	—	—	12
TWISTS														
Type I	17	—	1	—	4	—	—	—	1	—	—	—	—	11
Type II	10	1	—	—	1	—	—	—	3	—	—	—	—	5
Type III	93	23	—	1	18	3	1	—	13	—	—	1	—	33
Type IV	6	1	—	—	2	—	—	—	2	—	—	—	—	1
Type V	72	22	—	—	20	—	—	—	10	—	—	1	—	19
KNOTS														
Group I	83	29	—	3	12	—	—	—	10	—	—	1	—	28
Group II	12	2	—	—	4	—	—	—	—	—	—	1	—	5
Group III	9	1	—	—	2	—	—	—	2	—	—	—	—	4
Group IV	20	8	—	2	6	—	—	—	1	—	—	1	—	2
Group V	4	1	—	—	—	—	—	—	1	—	—	—	—	2
Group VI	8	4	—	—	1	—	—	—	1	—	—	—	—	2
Group VII	13	6	—	—	2	—	—	—	1	—	—	—	—	4
WRAPPED FIBERS														
Group I	3	—	—	—	1	—	—	—	2	—	—	—	—	—
Group II	32	10	—	—	7	—	1	—	2	—	—	—	1	11
Group III	2	—	—	—	1	—	—	—	1	—	—	—	—	—
Group IV	1	—	—	—	—	—	—	—	—	—	—	—	—	1

TABLE 67—(*Continued*)

Type	*n*	Surface	I	I/II	II	II/III	III	III/IV	IV	V	VII	V–IX	VII–XII	N.C.
Rings/Loops	14	2	—	—	4	—	1	—	5	—	—	—	—	2
Braids	12	2	—	—	3	—	—	—	2	—	—	—	—	5
Misc. Fibers														
Group I	13	1	3	—	—	—	—	—	—	—	—	—	—	9
Group II	12	2	—	—	1	—	—	—	—	—	—	—	—	9
Group III	28	4	1	—	9	—	1	—	7	—	—	—	—	6
Group IV	5	—	—	—	3	—	—	—	2	—	—	—	—	—
Leather/Hide														
Group I	76	18	2	1	22	—	—	—	8	—	—	—	—	25
Group II	4	—	—	—	1	—	—	—	3	—	—	—	—	—
Group III	12	1	—	—	1	—	—	—	4	—	—	—	—	6
Skin/Fur														
Group I	64	21	—	1	6	—	—	—	16	—	—	1	—	19
Group II	69	3	1	1	19	—	5	—	25	—	—	—	—	15
Group III	33	1	—	1	5	—	5	—	7	—	—	—	—	14
Group IV	76	17	—	1	8	—	16	—	—	—	—	—	—	34
Quill/Cordage	8	1	—	—	3	—	1	—	1	—	—	—	—	2
Historic Fibers	8	—	—	—	—	—	—	—	—	—	—	—	—	8
Total Artifacts	2066	374	57	38	445	11	49	10	320	17	1	10	1	733
Quids	318	36	8	5	43	1	3	2	56	3	—	—	—	161

Texture of all specimens is semiflexible, although the matting and bag centers are more rigid because of the tightness of twining. None are decorated or show signs of adhering pitch.

Measurements: Range in complete bag size, (260 × 160 mm.)–(470 × 160 mm.); mean size of complete bags, 362.00 × 190.00 mm.; range in size of bag fragments, (140 × 220 mm.)–(450 × 215 mm.); mean bag fragment size, 256.66 × 142.50 mm.; range in mat fragment size, (80 × 50 mm.)–(580 × 100 mm.); mean mat fragment size, 222.60 × 105.00 mm.; range and mean size of bag center, 300 × 220 mm.; range in warp diameter (bags and mats), 4.0–17.0 mm.; mean warp diameter, 10.19 mm.; range in weft diameter, 2.5–15.0 mm.; mean weft diameter, 7.83 mm.; range in warps per cm., 0.75–2.0; mean warps per cm., 1.09; range in wefts per cm., 0.5–1.0; mean wefts per cm., 0.98; range in gap between weft rows, 25.0–110.0 mm.; mean gap between weft rows, 54.75 mm.; range in gap between warps, 3.5–15.0 mm.; mean gap between warps, 7.35 mm.

Type IV: Open Diagonal Twining, Z Twist Weft (figs. 90, 91a, b)

Number of Specimens: Fourteen.

Type of Specimens: Body fragments (4), body fragments with selvage (10).

Number of Individual Forms Represented: Fourteen.

Type of Forms Represented: Mats, bags (?), sandals.

Technique and Comments: This type is formed by diagonal twined weaving over paired warps. The warps are whole bunched or split and shredded stalks that are alternately separated and joined in succeeding weft rows. One specimen exhibits occasional shift from simple to diagonal twining in succeeding weft rows. Four specimens have end selvages consisting of warp elements bent 180° to the adjacent warp column. The paired wefts are whole, bunched Z twisted stalks. Ten body fragments with side selvages of Z twist loops represent a simple side selvage of the continuous weft formation. Four of these are prob-

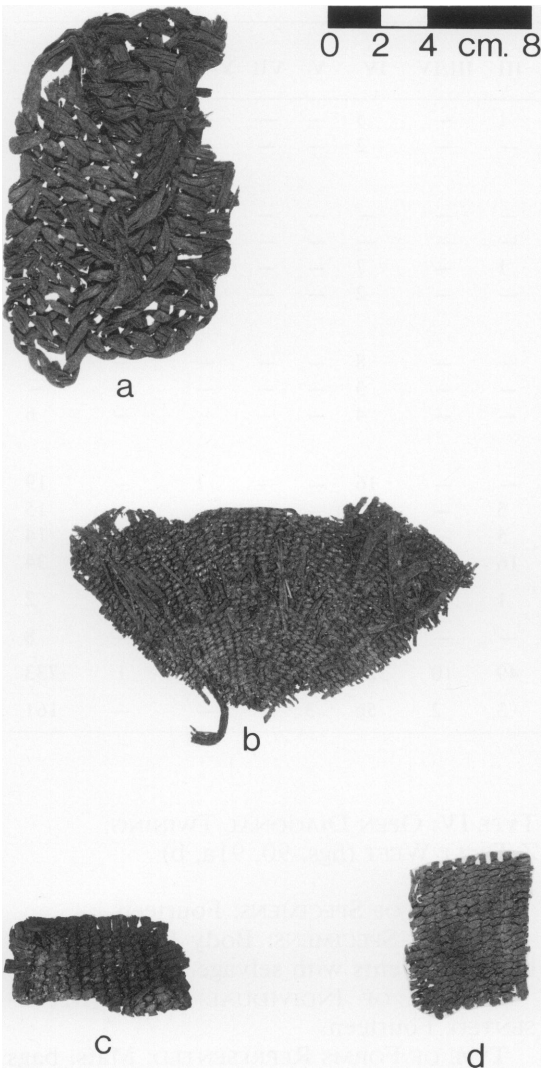

FIG. 87. Twined basketry from Hidden Cave (Type I, a; Type II, b–d). a. 1-1B-716; b. 1-1B-626; c. 1-1B-725; d. 2/32563.
Provenience: Stratum II, b, d; Stratum IV, a, c.

ably sandals termed "multiple warp" in the Cressman (1942, p. 58) typology.

Artifact 2/32671 and an uncatalogued specimen recovered in 1940 have continuous Z twist wefts forming side loops. The first artifact has four such loops; the other has three. In addition, both artifacts have separate Z twist extensions on each side which could have been used with the loops to form bindings. The sandal excavated in 1940 has extended warp elements folded 180°, covering half of the artifact; the bottom of this sandal is extremely worn.

Artifact 2/32736 is distinguished by a curved, bowl shape and rigid texture. The warp elements also show the V shape in the end selvage. Another specimen is badly deteriorated, but shows the selvage and shape similar to that of the other sandals.

Twining is tighter in the sandals, resulting in smaller gaps between weft rows. Mat fragments have triangular gaps between warp units—averaging 11.5 mm.—due to the diagonal twining pattern. The new warp and weft elements are laid in adjacent to the exhausted unit. All artifacts in this category are semiflexible, except where noted above. None are decorated.

MEASUREMENTS: Range in sandal fragment size, (80 × 70 mm.)–(230 × 135 mm.); mean sandal size, 171.25 × 101.25 mm.; range in mat/bag fragment size, (50 × 20 mm.)–(500 × 320 mm.); mean mat/bag fragment size, 194.10 × 113.30 mm.; range in warp diameter, 4.0–14.5 mm.; mean warp diameter, 9.35 mm.; range of weft diameter, 3.5–10.5 mm.; mean weft diameter, 6.63 mm.; range in warps per cm., 0.75–2.0; mean warps per cm., 1.14; range in wefts per cm., 0.5–1.75; mean wefts per cm., 1.01; range in gap between weft rows (sandals), 6.0–45.0 mm.; mean gap between weft rows, 14.75 mm.; range in gap between weft rows (mats/bags), 10.0–80.0 mm.; mean gap between weft rows, 40.00 mm.

TYPE V: OPEN AND CLOSE DIAGONAL TWINING, Z TWIST WEFT (fig. 91c)

NUMBER OF SPECIMENS: One.

TYPE OF SPECIMEN: Bag (or possibly matting).

NUMBER OF INDIVIDUAL FORMS REPRESENTED: One.

TYPE OF FORM REPRESENTED: Body and base.

TECHNIQUE AND COMMENTS: The single Type V twined specimen consists of open diagonal twining over paired warps in the body, changing to close diagonal twining over paired warps in the base section. The warps are bunched and shredded stalks producing

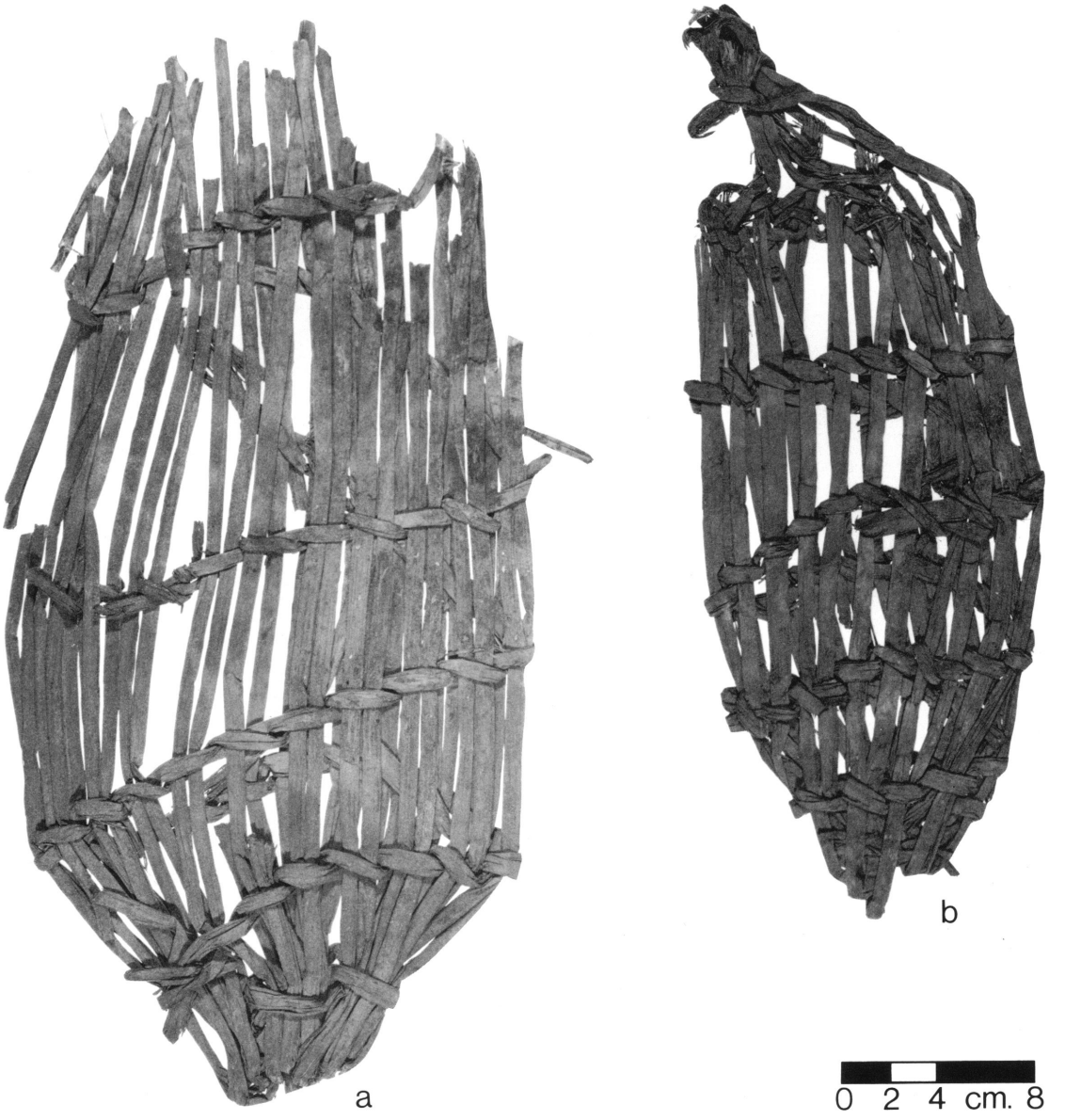

FIG. 88. Type III twined bags from Hidden Cave. a. 1-1B-546; b. 1/46168. Provenience: Stratum II, a; N.C., b.

a soft, compact surface, without gaps in the open twined body. Warps consist of whole, bunched stalks in the closely twined base. Wefts are single, paired tightly Z twisted stalks in the open twining, shifting to whole stalks paired in the base. Weft rows terminate in simple knots and are folded parallel to the terminal warp unit. End selvage consists of warps folded 180°, and engaged in the adjacent weft crossing. Specimen is semiflexible and lacks decoration.

MEASUREMENTS: Body size, 195 × 180 mm. (base width 70 mm.); range in warp diameter, 6.5–8.0 mm.; mean warp diameter, 7.25 mm.; range in weft diameter, 4.5–6.0 mm.; mean weft diameter, 5.25 mm.; range

in warps per cm., 1.0–1.5; mean warps per cm., 1.25; range in gap between weft rows, 44.5–45.0 mm.; mean gap between weft rows, 44.75 mm.

Coiled Basketry

Type VI: Close Coiling, Three Rod Bunched, Non-Interlocking Stitches (fig. 92a–h)

Number of Specimens: Six.[3]

Type of Specimens: Wall fragments (4), wall fragments with center (1), wall fragments with rim (2).

Number of Individual Forms Represented: Six.

Type of Forms Represented: Trays, shallow containers.

Work Direction: Right to left.

Technique and Comments: Three whole rods are arranged in a triangle and sewn with noninterlocking stitches with occasional piercing of the apex rod in four specimens. Stitches are split on the nonwork surface in five fragments, and accidentally split on the work surface in two pieces. Stitches are arranged in vertical columns which exhibit slight gaps between stitches in two specimens; the remaining fragments have randomly arranged stitches. Fag and moving ends could not be clearly detected. Work direction is right to left in all specimens, and the work surface is concave. All specimens have a rigid texture. Two fragments have rim sections intact, exhibiting self rim construction. One specimen has a normal center with stitches sewn around the rod and bent into a circle. Two specimens are charred with a black substance adhering to the stitches.

Measurements: Range in coil diameter, 3.9–6.0 mm.; mean coil diameter, 5.06 mm.; range in stitch width, 2.2–3.5 mm.; mean stitch width, 2.61 mm.; range in gap between stitches, 0–1.5 mm.; mean gap between stitches, 0.58 mm.; range in coils per cm., 2.0–3.0; mean coils per cm., 2.71; range in stitches per cm., 3.0–4.0; mean stitches per cm., 3.33.

[3] Number represents individual catalog numbers. Two artifacts are very fragmented. Artifact 2/32756 is noted as complete at time of excavation and was in over 50 pieces when analyzed. The second specimen 2/32647 is approximately 15 pieces with additional splintered sections.

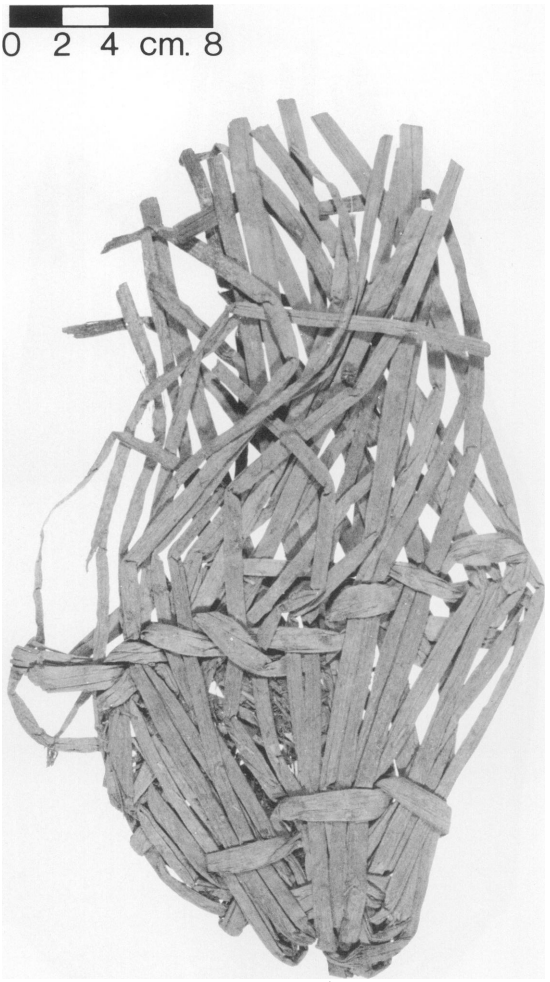

Fig. 89. Type III twined bag from Hidden Cave (1-1B-547/593).
Provenience: Stratum II.

Type VII: Close Coiling, Two Rod and Welt Bunched (fig. 92i)

Number of Specimens: Two (1 piece in 4 fragments).

Type of Specimen: Wall fragments (3), wall fragment with rim (1), center (1).

Number of Individual Forms Represented: Two.

Type of Forms Represented: Tray, shallow container (?).

Work Direction: Right to left.

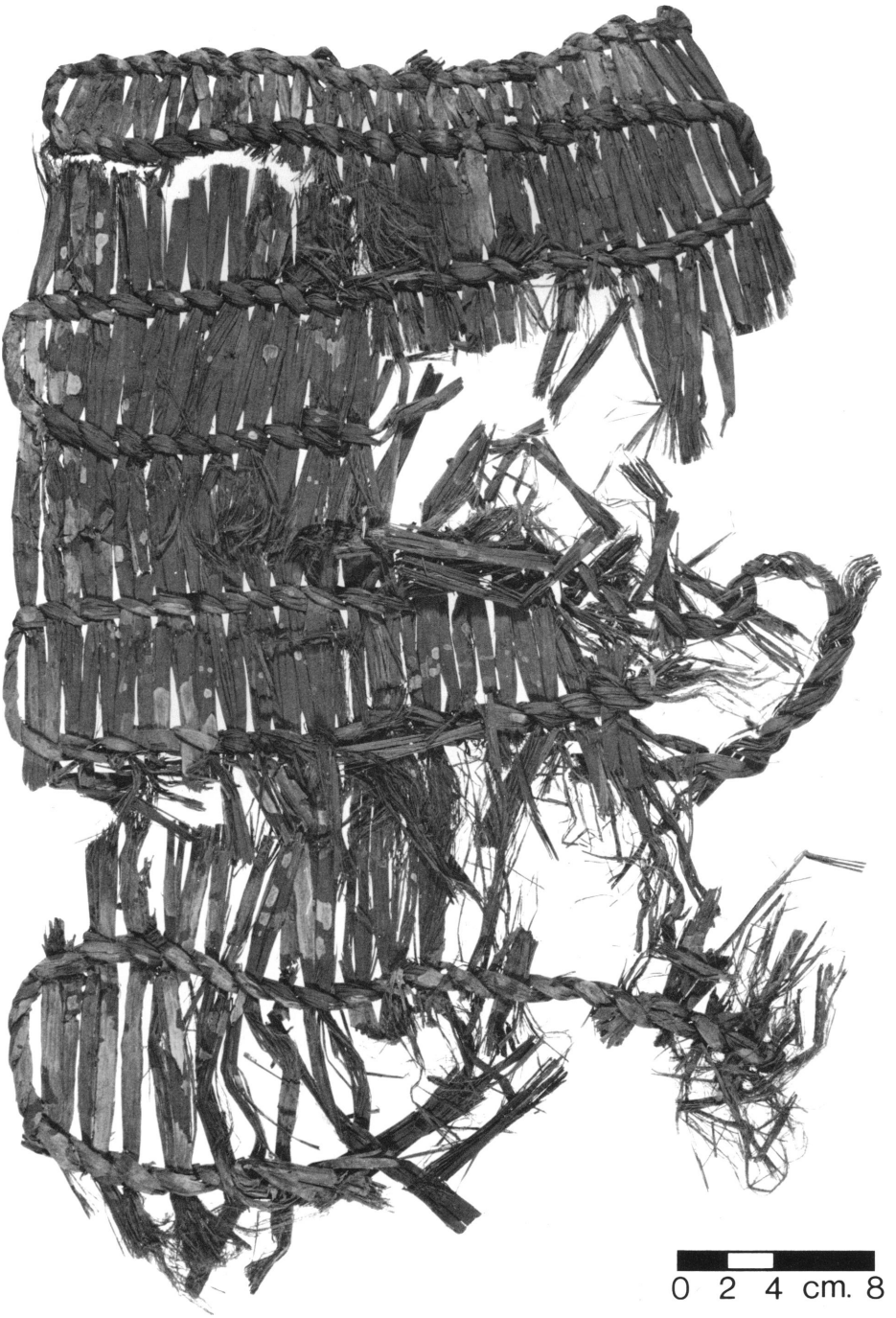

FIG. 90. Type IV twined matting from Hidden Cave (2/32479).
Provenience: N.C.

TECHNIQUE AND COMMENTS: Type VII coiling is made with two whole rods arranged horizontally and surmounted with welt, sewn with stitches split on the nonwork (convex)

FIG. 91. Twined mat, sandal, and bag pieces from Hidden Cave (Type IV, a, b; Type V, c). a. 20.4/478; b. 2/32736; c. 2/32432.
Provenience: Stratum II, b; Stratum IV, c; N.C., a.

side. Rods are undecorticated, and texture of all specimens is rigid. Fag and moving ends in one specimen are clipped short to body. One specimen has a self rim and slight gaps

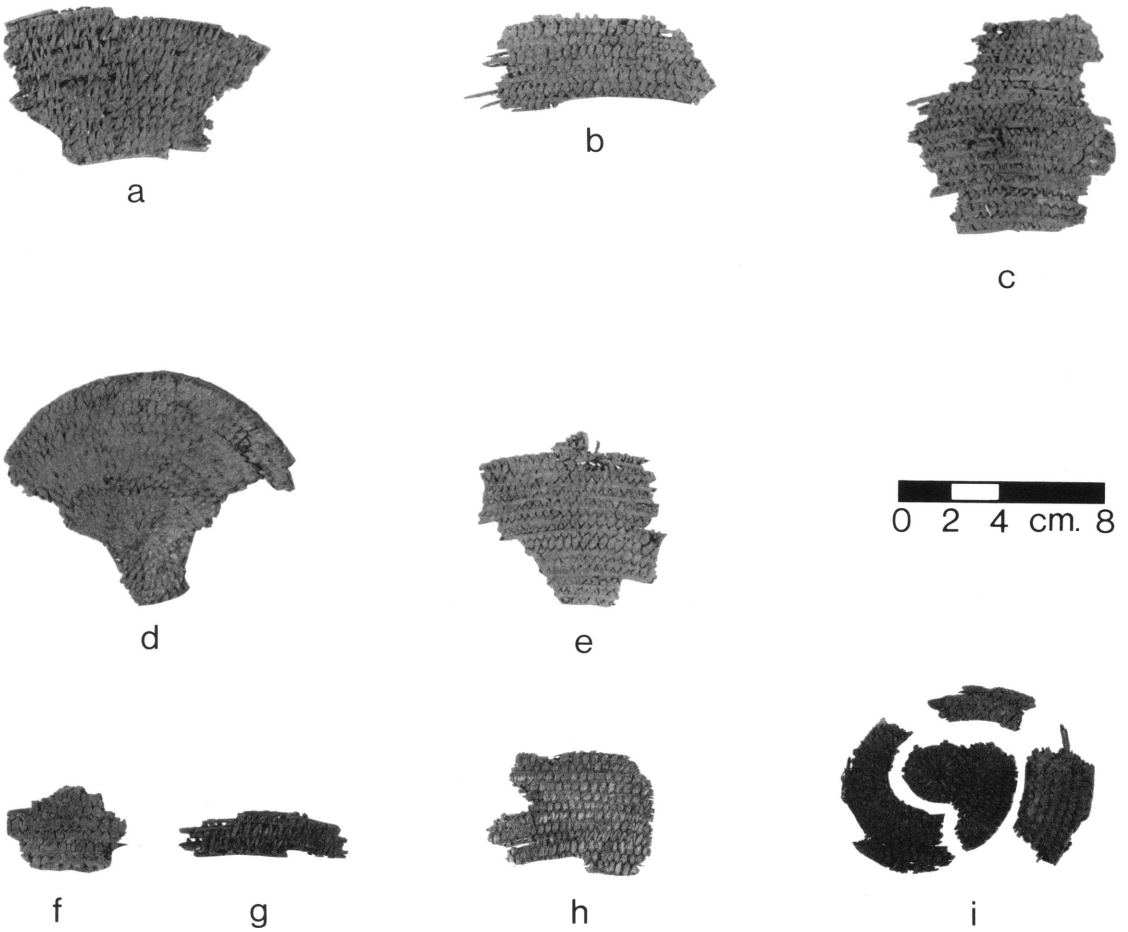

FIG. 92. Coiled basketry from Hidden Cave (Type VI, a–h; Type VII, i). a–e. 2/32756; f., g. 2/32647; h. 2/32439; i. 2/32394.
Provenience: Stratum II, i; Stratum IV, a–g; N.C., h.

between stitches. One piece of artifact 2/32394 is a center fragment exhibiting a normal start (stitches sewn around the foundation and bent into a circle). None of the specimens are pitched, decorated, or charred.[4]

MEASUREMENTS: Range in diameter of coils, 5.0–6.5 mm.; coil diameter, 5.75 mm.; range in width of stitches, 2.0–5.0 mm.; mean stitch width, 3.50 mm.; range in gap between stitches, 0.0–1.6 mm.; mean gap between stitches, 0.8 mm.; range in coils per cm., 1.75–3.0; mean coils per cm., 2.37; range in stitches per cm., 2.0–4.0; mean stitches per cm., 3.0.

[4] One additional basketry fragment, probably from Hidden Cave, is accessioned in the National Museum of Natural History (Smithsonian Institution) as artifact 377994 (part of the C. McRiley collection). This item is a coiled basketry fragment with split stitch, bundle foundation (160 mm. by 35 mm.). Because of the uncertain provenience, this artifact is not included in the basketry tabulations.

PLAITING

TYPE VIII: SIMPLE PLAITING, 1/1 INTERVAL (fig. 93)

NUMBER OF SPECIMENS: Five.

TYPE OF SPECIMENS: Rigid containers (3), matting (2).

NUMBER OF INDIVIDUAL FORMS REPRESENTED: Four.

TYPE OF FORMS REPRESENTED: Baskets, mat.

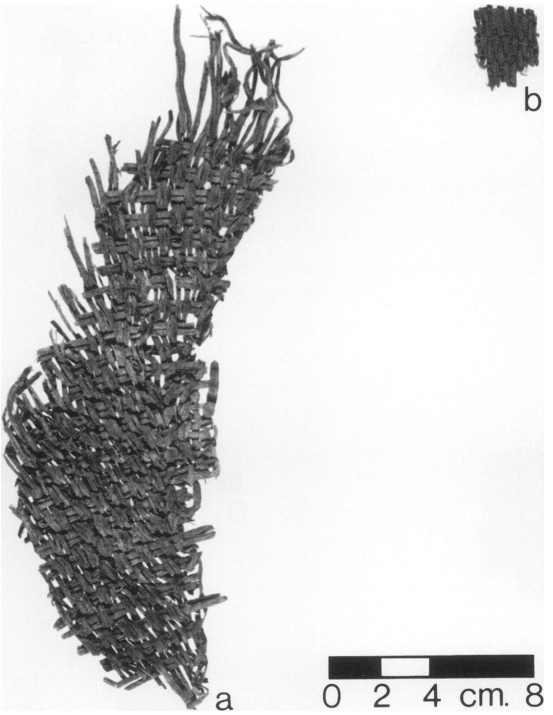

FIG. 93. Type VIII plaited basketry from Hidden Cave (a. is rigid; b. is semi-flexible). a. 2/57827; b. 2/30350.
Provenience: N.C., a, b.

TECHNIQUE AND COMMENTS: Three of the Hidden Cave specimens are manufactured by rigid plaiting (wickerware), and two others are semiflexible plaiting. One of the rigid specimens consists of four fragments with single elements passing over each other at 1/1 interval. Elements consist of decorticated willow rods, approximately 35 mm. in length, engaged by a single willow strip. The two other rigid specimens are manufactured with single elements passing over each other in a 1/1 interval, each element consisting of two decorticated willow rods. Artifact 2/57827 retains a crescent shape, indicating the rim portion, although the entire end selvage is not intact. The double element warp and weft composition on the rim section is a characteristic of Lovelock Wickerware. No shifts were noted in either of the rigid specimens.

Elements in these rigid specimens are of nearly equal width, passing each other at a 90° angle. Decoration is absent.

Two pieces of semiflexible plaiting probably are from the same mat; each fragment is approximately 25 by 30 mm. Components consist of paired Type IV fiber cordage (two ply S spun Z twist, diameter ranging 0.5–1.0 mm.) passing over and under single crushed *Juncus* elements at a 90° angle. The cordage weft elements are spaced approximately 2.0–2.5 mm. apart, with 6.0–9.5 mm. separating each set. The paired cordage passing over and under sedge elements produces a distinctive oblong/diamond pattern similar to the plaited matting recovered in the Winnemucca Caves (Rozaire, 1974, p. 69). Both specimens are small, light tan-orange colored fragments. No selvage or shifts were present.

MEASUREMENTS (rigid specimens only): Range in fragment size, (75 × 250 mm.)–(60 × 65 mm.); mean fragment size, 67.50 × 157.50 mm.; range in diameter of plaiting elements, 3.4–5.5 mm.; mean diameter of plaiting elements, 4.45 mm.; range and mean angle of crossing plaited elements, 90°.

OPEN TWINING FRAGMENTS

Hidden Cave contained 45 fragments of open twining work, consisting of 19 warp and weft units, 14 warp segments, seven selvages, and five bag bases. Although the specimens are obviously open twined, it is impossible to determine whether the weaving is simple or diagonal. The warp-weft fragments are all Z twist weft crossings, engaging warp units consisting of one to three whole, crushed or split sedge stalks. The 14 warp fragments are single, whole, crushed stalks with distinct indentions made from previous weft crossings. The gaps between these indentions range between 35 and 60 mm.

Two of the four end selvages consist of a Z twist weft, engaging warps folded over to the second weft crossing as opposed to the adjacent weft. The two remaining end selvages are Z twist wefts engaging warps folded over to the adjacent weft crossing. All four end selvages exhibit warps consisting of double whole, crushed stalks. The side selvage fragments—probably flat mats—have simple, continuous Z twist weft, forming a loop on the edge of the mat, extending 45 to 55

TABLE 68
Distribution of Basketry Types at Hidden Cave

	Total	Surface	II	II/III	III	IV	N.C.	%
TWINING								
Close Simple, Z Twist Weft	3	—	—	—	—	2	1	2
Close Simple, S Twist Weft	18	2	6	—	—	6	4	17
Open Simple, Z Twist Weft	28	2	10	—	—	10	6	26
Open Diagonal, Z Twist Weft	14	1	4	—	—	3	6	13
Open and Close Diagonal, Z Twist Weft	1	—	—	—	—	1	—	0.9
Twining Fragments	45	9	6	1	1	3	25	41
Total	109	14	26	1	1	25	42	99.9
COILING								
Close, Three Rod Bunched	6	1	—	—	—	2	3	75
Close, Two Rod and Welt	2	—	2	—	—	—	—	25
Total	8	1	2	—	—	2	3	100
PLAITING								
Simple, 1/1 Interval	5	1	—	—	—	—	4	100
Total	5	1	—	—	—	—	4	100
Grand Total	122	16 (13%)	28 (23%)	1 (0.8%)	1 (0.8%)	27 (22%)	49 (40%)	

mm. Warp units consist of one to three whole, crushed stalks, and wefts are paired Z twisted stalks.

The remaining twined fragments are bag bases indicated by the V shape folded warp elements engaged by a Z twist weft row.

These fragments may represent cylindrical bags, flat mats, and sandals. Identifiable raw materials are *Scirpus* sp., *Typha* sp., *Juncus* sp., and *Artemisia* sp.

DISCUSSION

Basketry comprises a very small proportion of the Hidden Cave collection: 122 specimens represent only 5 percent of the perishable assemblage. Twining is the dominant technique (89%), followed by coiling and plaiting (see table 69).

Individual specimens that cannot be correlated to specific strata comprise nearly 40 percent of the assemblage, but it is interesting to note that there is an even distribution of the total basketry assemblage between Strata II and IV, representing 23 percent and 22 percent, respectively. Table 68 provides a summary of basketry types by provenience.

The largest group of twined basketry is open twining fragments with Z twist wefts (probably representing matting). Some fragments retain the end and side selvages.

Of the five distinct twining types, Type III: Open Simple twining, Z twist weft is most common (26%), followed by Type II: Close Simple twining, S twist weft (17%), and Type IV: Open Diagonal twining, Z twist weft (13%). Most of the pieces are flexible to semiflexible, the most widely used material being *Scirpus* sp. and *Typha* sp. The stalks are usually whole and prepared for use by crushing to make them pliable.

Sedges are twined to make mats, bags, and baskets. Steward describes the Owens Valley Paiute using shallow tule baskets to store a dried candy made from cane (*Phragmites communis*). The tule was preferred to willow because "it preserves the sugar but does not give it taste nor change its color" (Steward, 1933, pp. 245–246).

Manufacture of tule bags is described by Wheat (1967) for the Northern Paiute. Bags were made quickly and were not meant for repeated use. The size depended on what was being collected, usually marsh bird eggs, or

small water fowl (Wheat, 1967, pp. 84–85). The only complete twined specimens from Hidden Cave are five conical bags manufactured in the predominant technique of Open Simple twining, with Z twist wefts. The average size is 362 mm. by 190 mm.

Semiflexible matting is made by both Open Simple and Open Diagonal twining, both with Z twist wefts. Similar to the continuous spiral of Z twist wefts forming handles on the bags, the weft rows in matting end in simple side selvages forming loops (in at least 10 pieces). Matting is noted ethnographically as clothing, the mat being loosely worn around the legs, waist, or shoulders (Wheat, 1967, p. 75). Four Open Diagonal specimens are probably sandals made in the "multiple warp" technique (Cressman, 1942, p. 58). This type of sandal is noted in the top levels of Lovelock Cave (Loud and Harrington, 1929, pp. 54–56).

The second most common twining technique is Close Simple twining with S twist wefts, featured in rigid and semiflexible circular trays and shallow containers. Here we find the only clear example of decoration as a plain twined overlay evident on a circular tray fragment from Stratum II (1-1B-284A). A gray coating, possibly pitch, also is seen on both sides of the artifact.

Coiling and plaiting techniques occur in small quantities at Hidden Cave (6% and 4%, respectively). These two techniques are also equally distributed between Strata II and IV.

The prevalent coiling technique is a three rod bunched foundation; the apex rod is split in four of the specimens. The two rod and welt foundation occurs in two specimens from Stratum II. The work direction is right to left, and the stitching technique is noninterlocking, with stitches split on the nonwork surface and occasionally split on the work surface. The specimens with centers show the normal start with stitches sewn around a curved foundation rod.

Coiled items were made into containers and trays. Bowl-shaped coiled baskets can be used as watertight containers, and the flat, circular parching trays are particularly associated with small seed processing. Rarely can we tell the original shape of the Hidden Cave coiled fragments, but at the time of excavation, Roust and Grosscup noted that at the bottom of Cache Pit 11 (see chap. 20) was a complete coiled roasting tray (Grosscup, n.d., p. 120).

The Hidden Cave basketry assemblage contains two examples of particularly distinctive plaiting techniques, one rigid and the other semiflexible.

Three pieces of rigid plaiting, Lovelock Wickerware, were excavated. Only one specimen has the selvage portion intact, but all pieces exhibit the characteristic paired element composition. Unfortunately, these pieces cannot be correlated as to provenience.

The two semiflexible plaiting fragments are probably part of the same mat, distinguished by cordage wefts and rush warps. Two sets of Z twist cordage wefts are closely spaced (6–9.5 mm.) creating a diamond pattern with no gaps between vertical and horizontal elements.

This type of semiflexible matting occurs in the Winnemucca East Shore sites, at Crypt and Chimney caves (Rozaire, 1974, p. 69); similar specimens are attributed to the Late Lovelock phase (1 B.C. to A.D. 1000) in the Humboldt Sink sites of Lovelock, Humboldt, and Ocala caves. The distribution of plaited matting extends to the north at Roaring Springs Cave (Cressman, 1942, p. 54) and to the east at Danger Cave (Grosscup, 1960, p. 40; see also Jennings, 1957, pp. 242–244).

Great Basin basketry is known to be of considerable antiquity, the western Great Basin having produced the oldest basketry known in North America. A piece of Open Simple twining from the northwest corner of Lake Winnemucca, Shinners Site A, dates to 9540 ± 120 B.P. (UCLA-675: Berger, Fergusson, and Libby, 1965).[5]

Great Basin basketry is conventionally di-

[5] A re-evaluation of radiocarbon data may be in order: ". . . the oldest and most widely accepted dates for basketry in the Western Great Basin derive from Fishbone Cave. Initially [1970], I suspected that the radiocarbon dated perishables from Fishbone Cave were not, in fact, ascribable to the 10th millennium B.C. Now, I see no reason to doubt the dates, particularly given the 10th millennium B.C. dates on cordage from Danger Cave, the 9th millennium dates on twining from points as far separated as the Highlands of South America and the Tennessee River Valley" (James Adovasio, personal commun.).

TABLE 69
Table of Distributions of Basketry Techniques from Hidden Cave and Other Selected Western Great Basin Sites[a]

Site	Plaiting		Twining		Coiling		Total
	n	(%)	*n*	(%)	*n*	(%)	
Falcon Hill Sites							
Kramer Cave	1	(1)	141	(97)	3	(2)	145
Empire Cave	4	(19)	6	(26)	11	(52)	21
Shinners Site A	1	(4)	16	(67)	7	(29)	24
Shinners Site C	209	(65)	6	(2)	106	(33)	321
Shinners Site F	1	(17)	0	—	5	(83)	6
Shinners Site I	2	(50)	2	(50)	0	—	4
East Shore Sites							
Horse Cave	38	(34)	31	(28)	43	(38)	112
Fishbone Cave	3	(13)	17	(74)	3	(13)	23
Stick Cave	25	(34)	22	(30)	26	(36)	73
Chimney Cave	3	(11)	13	(48)	11	(41)	47
Guano Cave	0	—	1	(7)	14	(93)	15
Crypt Cave	2	(3)	56	(80)	12	(17)	70
Cowbone Cave	1	(50)	0	—	1	(50)	2
Humboldt Sink Sites							
Ocala Cave	8	(16)	10	(41)	21	(43)	49
Humboldt Cave	1566	(76)	54	(3)	438	(21)	2058
Lovelock Cave	1115	(73)	104	(7)	309	(20)	1528
Hidden Cave	5	(4)	109	(89)	8	(6)	122
Total	2984		588		1018		4600

[a] Information for Falcon Hill, Winnemucca Lake, and Humboldt Sink sites after Hattori, 1982, table 7.

vided into three major centers: western, northern, and eastern. The centers are correlated according to the three main basketry types (twining, coiling, and plaiting), but the regions have varying chronological sequences (Adovasio, 1970, 1974, p. 114).

Hidden Cave falls within the western Great Basin basketry center (table 69). Although this basketry assemblage does not contribute to defining the long-term archaeological sequence of basketry for the area, the Hidden Cave collection is quite important in defining the variability of specific basketry techniques within well-dated, relatively short-term, stratified components. Although there is some uncertainty about the specific temporal range of Strata IV and II at Hidden Cave (see chap. 26), it is safe to say that the Hidden Cave basketry assemblage clearly falls into Adovasio's Stages III and IV of the western Great Basin sequence, which ranges from 2000 B.C. to A.D. 1000 (Adovasio, 1974, p. 115).

Hidden Cave exhibits similarities to and differences from the traits characterizing the western Great Basin center. Hidden Cave is similar in the particular twined and coiled techniques that are the most common: Open Simple twining, Z twist weft; Close Simple twining, S twist weft; and the coiled foundation varieties of three rod triangular, and two rod and welt.

Hidden Cave also demonstrates the popularity of flexible warp twining, a trend noted at a number of other western sites, including Kramer Cave, the Winnemucca East Shore sites, and Lovelock Cave. But the flexible warp twining at Hidden Cave is *not* Catlow twining, a Close Simple weave technique. It may be that the flexible warp twining using the Open Simple, Z twist weft technique primarily for coarsely woven mats and bags is a specific variation of that type used at Hidden Cave.

There are additional differences between

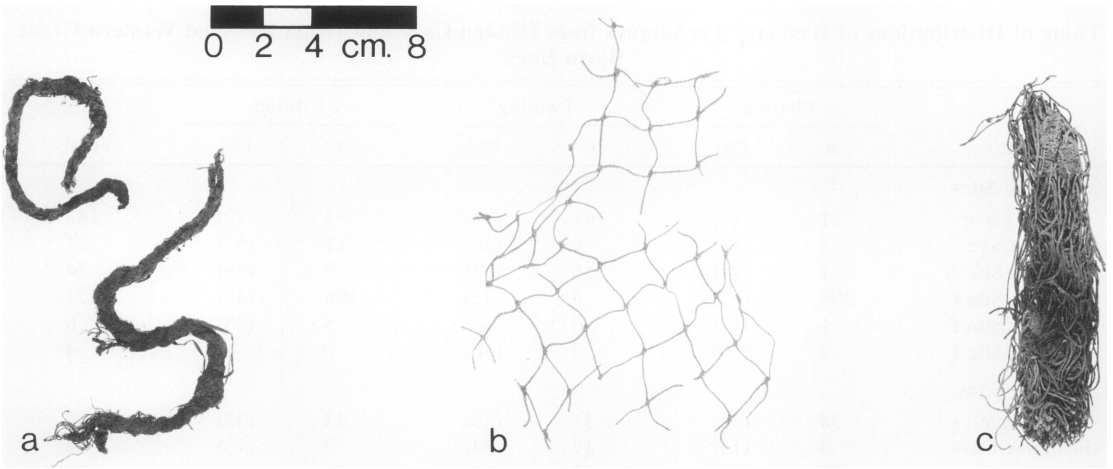

FIG. 94. Netting from Hidden Cave (Group I, a; Group II, b, c). a. 2/32802; b. and c. 1-1B-13G-6. Provenience: Stratum II, a; N.C., b, c.

the Hidden Cave assemblage and the Stage III/IV basketry complex in the western Great Basin. The western center is characterized at this time by an increasing proportion of coiled items and Lovelock Wickerware, and a corresponding decline in items using the twining techniques (Adovasio, 1974, p. 115; Hattori, 1982, pp. 96–97). Lovelock Wickerware occurs at Hidden Cave, but in relatively low frequencies; additionally, although the two popular coiling foundation techniques are present, they also appear in rather low proportions.

By contrast, the basketry assemblage at the Falcon Hill sites reflects the long-term trends described for the western Basin basketry chronology. The differences between Kramer Cave and Shinners Site C are particularly indicative of the shift from twining to coiling, with a corresponding increase in the popularity of Lovelock Wickerware (Hattori, 1982, pp. 96–97).

We do note, however, that Hidden Cave and Kramer Cave both have higher frequencies of twined basketry than any other styles. Even though Catlow twining is the prevalent flexible twining technique at Kramer Cave, both Hidden and Kramer caves have two other types that are significant in Adovasio's Stages III/IV: stiff, one rod, S twist weft twining and three rod bunched coiling.

Hidden Cave and Lovelock Cave share traits associated with the Early and Transitional Lovelock assemblage, from about 2000 B.C. to A.D. 1: the three rod bunched coiled foundation and plain flexible twining with S twist wefts for Early Lovelock, and the occurrence of Lovelock Wickerware and semiflexible matting with cordage wefts for the later period.

At the nearby Carson Desert caves, the test excavations did not yield basketry fragments (Napton, 1971b). The only perishables excavated were cordage, matting, and sandal lining fragments from Burnt, Fish, and Picnic caves (Napton, 1971b, pp. 1–20). These items were also found in abundance in Hidden Cave.

To summarize, the Hidden Cave basketry assemblage contains the wide variety of basketry styles found at other archaeological sites in the western Great Basin. The differences noted in the Hidden Cave assemblage might be specific variations representing regional adaptation or, perhaps, differing site functions.

Similarities between the northern Basin complex and the western Basin center can be noted at Hidden Cave, Falcon Hill, the Winnemucca East Shore sites, and Lovelock Cave. The eastern Basin complex does not particularly resemble the western Basin at this time, differing specifically in the dominance of coiling foundations and the absence of plaiting.

Hidden Cave is, however, rather similar to sites in the eastern Basin with respect to the additional perishable artifacts discussed below.

The remaining perishable artifacts have been separated as cordage, netting, fiber construction, and miscellaneous modified perishables. These groups represent a substantial portion of the assemblage, constituting 94 percent (1936 of 2066) of the Hidden Cave perishable collection.

Perishable artifacts such as these are subject to postdepositional damage and disturbance, particularly by rodents. Although there is a large quantity of perishable items, we believe it should be noted that the actual number of individual forms represented is undoubtedly less than the number of catalogued items.

CORDAGE

Approximately 1060 pieces of fiber cordage were recovered from Hidden Cave, including unspun fibers, two ply twists with variations, and unusual braided specimens. Cordage constructions could have been used for netting, snare bindings, and parts of basketry. Provenience is listed on table 67.

Unspun Fibers

Six specimens of unspun fibrous material seem to represent raw construction materials, probably destined for cordage manufacture. Specimens consist of strips or shredded masses, ranging in length from 15.0 to 65 mm. and varying in diameter from 1.0 to 5.0 mm. Indentifiable materials are *Apocynum* and *Artemisia.*

Cordage Type I. One Ply, Z Spun (n = 14)

Description and Comments: The technique is to loosely Z spin single strands of bunched fibers. Fragments represent both individual plies of Type III cordage, and twisted fibrous materials intended for cordage production. Specimens range in length from 28 to 110 mm. Identifiable raw materials are *Apocynum* (n = 11), *Scirpus* (n = 1), and *Asclepias* (n = 2).

Measurements: Range in diameter, 0.2–3.8 mm.; mean diameter, 1.22 mm.

Cordage Type II: One Ply, S Spun (n = 7)

Description and Comments: This kind of cordage is manufactured from loosely S spun single strands of bunched fibers. As noted for Type I, specimens represent individual plies of two ply cordage, as well as construction material. No knots are present. Lengths range from 10 to 60 mm. Identifiable raw materials are *Apocynum* (n = 2), *Scirpus* (n = 4), *Asclepias* (n = 1).

Measurements: Range in diameter, 0.8–3.7 mm.; mean diameter, 1.92 mm.

Cordage Type III: Two Ply, Z Spun, S Twist (n = 930; n = 950 if Type IIIA is included)

Description and Comments: This is the most common type of cordage at Hidden Cave, and the sample size could be considered to be much greater, since many catalog entries contained more than one piece. Similarly, Type III cordage could easily be subdivided according to diameter and angle of twist correlations, but there seems to be no reason to do so at this point.

By this technique, two bunches of fibrous materials are initially Z spun and then S twisted together. At least eight specimens exhibit rattailing or charring; four pieces have down fragments entwined. Splicing was accomplished by laying additional fibers into exhausted plies.

A minimum of 335 knots are present in Type III cordage: single cords with overhand/figure eight knots (n = 134), single cords with knots forming loops (n = 56), specimens of two or more cords joined by knots (n = 98), crown (?) knots (n = 25), and unidentifiable constructions (n = 22). Multiple overhand knots were also occasionally tied to form bulky knobs. Loops were formed by either square/bow knots or a combination of noose/half hitch. Loop-size ranges from small buttonholes of 6.0–10.0 mm. to larger loops of 10.0–90 mm. Two or more cords were joined with sheet bends, square knots, half hitches, half carrick, and clove hitch/granny. Crown

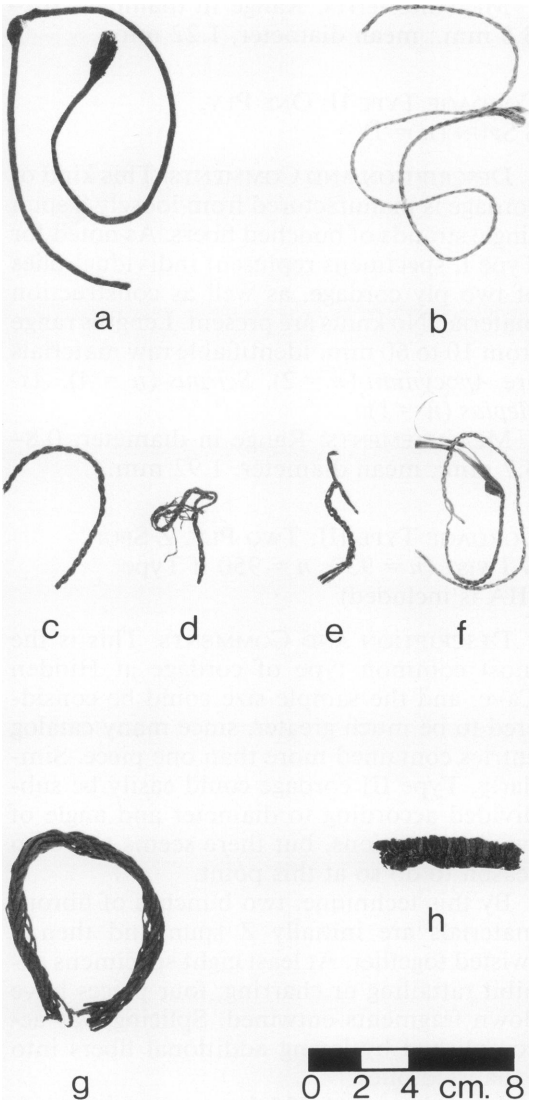

FIG. 95. Cordage from Hidden Cave (Type III, a–d; Type IV, e, f; Unusual specimens, g, h). a. 2/32699; b. 1/39997; c–e. 1-1B-918; f. 2/32710; g. 20.4/964; h. 20.4/369.

Provenience: Surface, c–e; Stratum II, a, f, g; N.C., b, h.

knots were also noted as small knots binding plies at one end of the specimens. At least four specimens with knots spaced between 10.0 to 30.0 mm. apart may be netting material.

Texture ranges from soft, very pliable pieces to coarser, stiff specimens. Most of the pieces have frayed ends. Lengths range from 10.0 to 1005 mm. Identifiable materials are *Apocynum* ($n = 637$), *Scirpus* ($n = 63$), *Artemisia* ($n = 42$), *Asclepias* ($n = 67$), and human hair ($n = 1$).

We also define a Type IIIA to account for 20 specimens of cordage that appear to have three plies instead of two. An additional Z spun fiber is present as a frayed element appearing between major segments. Although this additional piece does not appear to be a third supplemental cord, the fiber could be a deteriorated section of the two main Z spun fibers. Lengths of Type IIIA cordage range between 20 and 243 mm.

MEASUREMENTS (Type III): Range in diameter, 0.3–7.5 mm.; mean diameter, 1.64 mm.; range in angle of twist, 12° to 65°; mean angle of twist, 39.71°; range in twists per cm., 1–16; mean twists per cm., 4.74.

MEASUREMENTS (Type IIIA): Range in diameter, 1.2–3.2 mm.; mean diameter, 1.94 mm.; range in angle of twist, 23–54°; mean angle of twist, 39.40°; range in twists per cm., 2–6; mean twists per cm., 3.95.

CORDAGE TYPE IV: TWO PLY, S SPUN, Z TWIST ($n = 49$)

DESCRIPTION AND COMMENTS: Type IV cordage consists of one or two bunches of fibers first S spun, then Z twisted together. Specimens with intact ends show that the single S spun element was folded over with the resulting two plies Z twisted. Two specimens show more than two plies, one being Type III cordage Z twisted with a single ply of S twisted cord. Five specimens are coarse fibers, Z twisted without initial S spin. Ten specimens are bent and retain a U shape; the remaining examples are semiflexible. Approximately 14 knots were noted in Type IV cordage: overhand ($n = 8$), knots forming loops ($n = 4$), knots joining two cords in a sheet bend ($n = 1$), and a crown knot ($n = 1$). Loop-size ranges from 10 to 60 mm. Artifact 1-1B-794 was noted by Wheeler as being a shaft wrapping; it shows two overhand knots forming a loop. This specimen retains a coiled position, forming three circles of approxi-

mately 8.0 mm. in diameter. Lengths of Type IV cordage range from 10.0 to 350 mm. Identifiable raw materials are *Apocynum* ($n = 10$), *Scirpus* ($n = 15$), *Artemisia* ($n = 14$), and human hair ($n = 2$).

MEASUREMENTS: Range in diameter, 0.5–7.5 mm.; mean diameter, 2.98 mm.; range in angle of twist, 15 to 50°; mean angle of twist, 31.04°; range in twists per cm., 1.0–8.0; mean twists per cm., 3.10.

CORDAGE TYPE V: TWO PLY, Z SPUN, S TWIST, FOLDED AND Z TWISTED ($n = 10$)

DESCRIPTION AND COMMENTS: Type V cordage is a variation of Type III, consisting of two independent cords or a single cord, folded over, of Type III cordage, with a final Z twist combination. Five specimens exhibit knots: overhand ($n = 3$), knot forming a loop approximately 20 mm. long ($n = 1$), and those exhibiting additional cords attached by hitches ($n = 2$). Artifact 20.4/1563 is a knotted construction with Type V cords extending 16 mm. on either side of a center knot; one set of the extending cords is knotted to form a loop.

Three specimens seem to be a variation of Type V cordage. Artifact 20.3/9980 consists of four pieces of Type III cordage united by knots at either end and loosely Z twisted. Artifact 1-1B-920 consists of approximately 15 Type III cords folded over and Z twisted. Artifact 1-1B-233 is a single piece of Type III cordage, folded over and S (rather than Z) twisted; this piece measures 220 by 3.5 mm., with a 31° twist angle and three twists per cm.

Texture of Type V cordage is flexible to semiflexible and the raw material is *Apocynum.* Lengths range from 20.0 to 180 mm.

MEASUREMENTS: Range in diameter, 1.4–4.3 mm.; mean diameter, 2.34 mm.; range in angle of twist, 20 to 56°; mean angle of twist, 33.66°; range in twists per cm., 2–7; mean twists per cm., 3.22.

CORDAGE TYPE VI: TWO PLY, S SPUN, Z TWIST, FOLDED AND S TWISTED ($n = 3$)

DESCRIPTIONS AND COMMENTS: Type VI is a variation of Type IV cordage in which single folded over or two separate Type IV cords are S twisted. No knots were present. Texture on all specimens is stiff to semiflexible. Lengths range from 60.0 to 130 mm.

MEASUREMENTS: Range in diameter, 2.1–6.0 mm.; mean diameter, 3.8 mm.; range in angle of twist, 15 to 23°; mean angle of twist, 20.33°; range in twists per cm., 1–3; mean twists per cm., 2.

UNUSUAL CORDAGE PIECES

Ten pieces of cordage from Hidden Cave seem to defy classification by the criteria outlined above.

Artifact 20.4/1170 is basically a Type III cord, but contains four Z spun plies instead of two. The ends are charred and there is one half hitch with a separate cord of similar manufacture. The specimen is 140 by 1.9 mm., has a 28° angle of twist, with six twists per cm. The material is a tan pliable fiber, probably *Asclepias.*

Artifact 1-1B-994 contains eight plies forming four Type III cords S twisted together. The final combination is the same (rather than the opposite) direction of twist, but the cords hold the twist because of irregular entwining. The entire construction measures 210 by 3.0 mm., with individual Type III cords measuring 0.9 mm. in diameter. It has a 40° angle of twist with approximately two twists per cm. This *Apocynum* specimen is disengaged and flexible.

Artifact 1-1B-279 consists of a maximum of 12 plies, forming six units of Type III cordage. The six units are combined into three S twist pairs which are united by a final Z twist. One additional single S twist ply is noted as a supplemental cord, Z twisted around the entire construction. Specimen is semiflexible, measuring 90 mm. by 4.3 mm.; it has a 40° angle of twist with 3.5 twists per cm. Raw material is either *Artemisia* or *Apocynum.*

Two specimens are compound constructions that resemble basketry selvages. Artifact 2/32805 is a small piece measuring 10.3 by 3.3 mm. It consists of two *Scirpus* (?) units, one S twisted and cross-wrapped seven times around a core strand.

Artifact 20.4/369 (fig. 95h) is a more elaborate piece, measuring 58 by 12 mm., and 6.8 mm. thick. The rim spine is a Type III

fiber that is wrapped with seven groups of Type III cordage. Each group consists of three circuits of cordage that are secured around the spine by a binding segment of Type III cordage. The binding segments at the base of each group run parallel to the rim spine and give a twined appearance. The groups of cordage are able to slide along the rim and form an even surface. Texture is soft but semiflexible; material is *Apocynum.*

Five residual specimens are braided and looped cords, all apparently made of *Apocynum*; the texture is flexible. Artifact 1-1B-898 is a Type III cord doubled over with a second cord inserted through the loop. The resulting interlooped cords have a braided, chained appearance. The specimen is 240 mm. long and 2.0 mm. in diameter.

Artifact 1-1B-916 has a herringbone pattern consisting of three pieces of Type III cordage doubled over and interlooped forming a braid. One end has three intact loops, and the opposite end is frayed. The specimen measures 275 by 4.0 mm.

Artifact 20.4/511 consists of two pieces of Type III cordage that are doubled over and interlooped forming a cord with both a herringbone and a chained pattern. It measures 145 by 2.8 mm., and contains two knots. The knot at one end resembles a crown knot; the second knot is a figure eight, approximately 40 mm. from the end.

The two remaining artifacts each consist of six pieces of Type III cordage that are intricately interlooped. Each cord is doubled over and looped through the previous section; the continuous looping with alternating cords forms a strong and uniform segment. Specific manufacturing technique is not clear, but the specimens are remarkable for their detail and execution. Artifact 20.4/964 measures 200 by 5.0 mm.; individual Type III cords measure 1.1 mm. in diameter (fig. 95g). Artifact 20.4/1739 is a short fragment, 20.0 mm. long by 5.8 mm. in diameter (individual cords are 1.8 mm. in diameter); it has a stiff texture.

Miscellaneous Cordage

Hidden Cave contained 10 miscellaneous constructions of cordage bundles and knots. Six of these contain Type III cords, one consists of Type IV, one contains a mixture of unspun Type III and Type IV cords, and one is a small knot of unidentified cordage. Specimens range from self-wrapped, compact bundles to knotted masses. Three specimens are probably netting material since they exhibit small knots regularly spaced at 8.0 mm. or are made of fine cordage, 0.2 to 0.5 mm. in diameter. Size of bundles ranges from 13.5 to 100 mm. in length, by 8.5 to 20 mm. in width. The only identifiable raw material is *Apocynum.*

Discussion

Cordage is a multipurpose item that can be used for netting, snares, binding, lashing, matting, clothing, and blankets. Particularly well-made items such as netting are noted ethnographically as being valued items that were passed on to younger generations (Wheat, 1967, p. 59).

Although cordage has a wide range of applications, this artifact category is a frequently neglected item in the archaeological inventory of Great Basin sites. This bias is well expressed in the Humboldt Cave report:

> No attempt is made in this paper to analyze the several hundred specimens which may be variously termed ropes, braids, cords, and so on, both plain and knotted .... It appears to us that a careful study and depth tabulation of these objects (aside from knots) is a waste of time unless their functional association can be determined .... In Humboldt Cave, there were about four hundred pieces of twisted and braided rush of one kind or another, which are merely fragments of wefts from baskets, mats, bags, and the like and can offer nothing new in the way of information (Heizer and Krieger, 1956, p. 62).

Although we sympathize with these authors' impatience in dealing with such a large, seemingly homogeneous assemblage, we continue to think that additional investigation into this ubiquitous category will repay the effort expended.

Cordage artifacts comprise roughly 50 percent (1060 of 2066) of the total perishable assemblage from Hidden Cave. The large quantity of cordage undoubtedly reflects the problems of postdepositional disturbance. Nevertheless, this artifact category remains noteworthy because of its size and relative uniformity of construction.

As shown on table 67, 22 percent (239 of

1060) of the cordage was excavated from Stratum II, but there does not seem to be any significant difference by stratigraphy in preferred cordage manufacture technique.

The Hidden Cave cordage has been grouped into six types, as discussed above. The predominant technological combination is Type III (two ply, Z spun, S twist), constituting 88 percent (930 of 1060) of the assemblage.

All of the various cordage types contained knotted specimens, and the dominant raw materials were the soft inner bast fibers of *Apocynum* and *Asclepias*. In general, the coarser outer fibers of *Artemisia* and *Scirpus* or *Typha* were used for cords with diameters larger than about 2.0 mm. and have a final Z twist combination.

In addition to the six varieties of cordage, there are 10 unusual specimens exhibiting remarkable technical dexterity.

The compositions are based on simple braiding and looping techniques, but we are unaware of similar examples in the Great Basin literature. The function of these complicated pieces remains uncertain.

Cordage manufacture in the northern Great Basin is noted as a conservative and stable industry, due primarily to the utilitarian nature of the artifact (Adovasio, Andrews, and Carlisle, 1977, p. 14). There is a dominance of Z twist plies in this center, differing from the S twist so common at Hidden Cave. However, when the nature of the respective materials is considered, there is a concurrence of Z twist combinations in conjunction with strands made from coarser bark fibers (Adovasio, Andrews, and Carlisle, 1977, p. 9). The relationship of Z twist strands with stiff, thicker fibers is also noted at Tommy Tucker Cave in the extreme western part of the Great Basin (Fenenga and Riddell, 1949, p. 207). Thicker diameter cordage is similarly associated with the woody plants *Artemisia* and *Juniperus* at Hogup Cave, in the eastern Great Basin (Aikens, 1970, p. 127). The definitive relationship between raw materials and cordage technology awaits more detailed investigation, but we think the correlation is certainly worth examining.

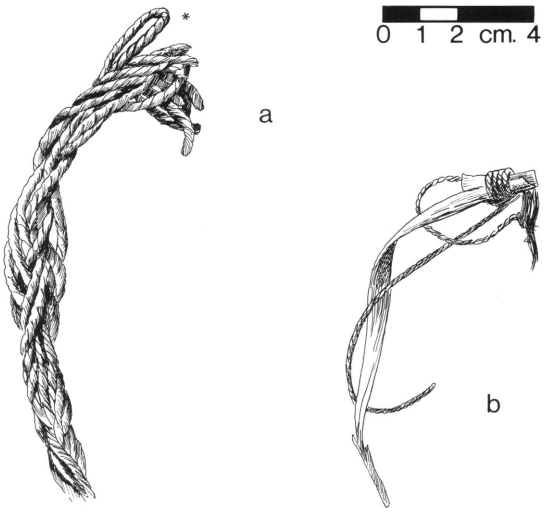

FIG. 96. Cordage constructions from Hidden Cave. a. detail of unusual cordage, drawn to twice actual scale (20.4/964); b. quill and cordage (1-1B-353).

Provenience: Stratum II, a; Stratum IV, b.

NETTING

Forty-four netting fragments were recovered from Hidden Cave, and these can be divided into Group I (net "rope" bundles) and Group II categories. All specimens were made from Type III (two ply Z spun, S twist) cordage and all have quadrilateral mesh units, manufactured with sheet bend knots. These knots are fixed, characterized by dissimilar faces and consecutive rows with alternative obverse and reverse faces. Identifiable raw materials are *Apocynum* and *Asclepias*.

Group I contains five netting fragments (although one artifact consists of 14 different pieces). In all, from eight to 25 individual pieces of Type III cordage have been bound into S twisted rope segments. The lengths range between 15 and 360 mm., and diameters range between 5.0 and 20 mm. Two specimens contain oblong knot bundles at the end of the segments. Mesh diameters range between 20.0 and 35 mm.; cordage diameter ranges between 0.2 and 0.5 mm.; angle of twist in the cordage ranges between 24° and 40°; there are between eight and 30 twists per cm.

Group II consists of 39 fragments of netting, which can be further subdivided into three groups according to mesh size. Group IIA contains 10 specimens, with mesh sizes as small as 5.5 mm. Artifact 20.4/1602 is a

large fragment with over 100 individual knots. The overall dimensions are 200 mm. by 70 mm. There are two net sections which are joined by a separate cord looped through adjacent mesh units. The joining is not uniform, all adjacent units are not connected, and mesh units do not line up when the net is stretched. A selvage section is indicated by triangular mesh units along one edge. The other nine specimens range from 20 mm. to 40 mm. in length, by 10 mm. to 40 mm. in width with six to 22 knots per cm. The cordage diameter ranges from 0.4 to 1.3 mm.; angle of cordage twist ranges from 25° to 30°; twists per cm. range between six and 14.

Group IIB cordage consists of 13 specimens, with mesh size ranging between 11 and 20 mm. Artifact 2/32728 measures approximately 500 by 300 mm. with mended areas of separate cordage joining broken mesh units with an overhand (?) knot. The netting fragment still retains a springy texture. Artifact 1-1B-13G-b consists of three compact bundles and two body fragments, with lengths ranging from 80 to 330 mm., widths ranging from 55 to 70 mm. Over 400 knots are present in this fragment, and the mesh size averages 18.6 mm. Remaining specimens measure 16.0–150 mm. in length by 20 to 60 mm. in width. Cordage diameter ranges between 0.4 and 1.0 mm.; the angle of cordage twist ranges from 30° to 50°, and twists per cm. range between four and 20.

Group IIC contains 15 specimens of net fragments with mesh sizes as large as 90 mm. Specimens have between two and 50 knots, in segments ranging in length from 24–230 mm. by 12.0–80 mm. in width. Cordage diameter ranges between 0.2–3.0 mm., angle of cordage twist ranges between 20° and 60°, and there are between six and 18 twists per cm. No selvages were noted, and one specimen has been mended with an unidentifiable knot joining mesh units.

One Group IIC specimen (1-1B-13G-7) has quadrilateral mesh units with two sizes. The fragment (75 × 80 mm.) contains two sections of mesh averaging 3.6 mm., separated by 22–25 mm. of cordage forming rectangular mesh units. The cordage diameter of this fragment ranges between 0.8 and 1.4 mm., angle of cordage twist is approximately 30°, with an average of seven twists per cm. This specimen is stiff, with no intact selvage.

There are also 21 pieces of cordage with sheet bend knots, and it is probable that these are also net fragments. When present, the mesh size ranges between 15 and 50 mm., with a cordage diameter between 0.3 and 1.7 mm., angle of twist between 30° and 51° and between three and 20 twists per cm. All specimens are of Type III cordage, except for a single specimen of Type IV cordage (two ply S spun Z twist), measuring 62 by 0.2 mm., with a 25° twist angle and 18 twists per cm.

Provenience of netting fragments is provided on table 67.

Discussion

Netting from Hidden Cave ranges from bundles of folded netting to isolated mesh fragments and knotted cordage. All 65 specimens are knotted with sheet bend knots forming quadrilateral mesh units and are made from fine diameter Type III cordage (diameter averaging 0.4–1.5 mm.). Sixty percent of these artifacts (39 of 65) are Group II netting fragments, exhibiting a variety of mesh sizes. Mesh units range from as small as 5.5 mm. to large units up to 90 mm. with the average mesh size approximately 25 mm.

Two archaeological sites in the western Great Basin contain comparable net artifacts. Netting from nearby Hanging Rock Shelter is strikingly similar to Hidden Cave specimens in manufacturing technique and mesh size (Tuohy, 1969a, p. 42). Netting excavated at Lovelock Cave included 74 specimens with a consistently smaller mesh size (Grosscup, 1960, p. 51). The eastern Basin likewise contains comparable examples of complete nets and net bags at Hogup and Danger caves (Aikens, 1970, p. 125; Jennings, 1957, pp. 227–230).

Although netting can be used for slings, carrying containers, and hair nets, the primary application is for trapping rabbits, fish, and waterfowl. A variety of lake fishing techniques is recorded for the Northern Paiute, including set lines and gill nets (Fowler and Bath, 1981, p. 184). Of particular relevance to the Hidden Cave assemblage is the specificity of mesh size for the desired catch and

the use of tule floats for securing the tops of the nets.

FIBER CONSTRUCTIONS

A total of 469 pieces of various fiber constructions was recovered from Hidden Cave, and these artifacts can be grouped into the following categories: twists, knotted and wrapped fibers, rings/loops, braids, and miscellaneous fiber constructions. Provenience for these categories is presented on table 67.

Twists

The 198 twisted fiber segments can further be subdivided into five groups, defined according to direction of twist and number of elements involved. This typology is based largely on cordage attributes, discussed previously. For both cordage and twists, the initial turn of the fiber is generally opposite to the final main twist; the manufacturing process essentially increases the stability of the construction. Twists and cordage are distinguished by size and also by the fact that cordage is generally begun by spinning, whereas twists are begun by flattening the fiber.

Type I: One Ply Z Twist

Number of Specimens: Seventeen.

Type of Specimens: Bag handle, body fragment, cordage and basketry material (?).

Number of Individual Forms: Seventeen.

Technique and Comments: There are 13 examples in which single, whole, or split pieces of sedge culms and/or leaves have been crushed or flattened, then twisted. Most artifacts exhibit a slight curve and were probably used—or intended for use—with another twisted element. One example consists of a thin willow strip, and three others are made of shredded sagebrush bark that is twisted as a single element. One of the sedge twists has a loose overhand knot at one end. None of the pieces have been charred or otherwise modified. Identifiable raw materials are *Scirpus* sp., *Typha* sp., and *Juncus balticus.*

Measurements: Range in length, 10–220 mm.; mean length, 62.35 mm.; range in diameter, 1.4–15 mm.; mean diameter, 5.81 mm.

Type II. One Ply S Twist

Number of Specimens: Ten.

Type of Specimens: Bag handles, rope (?).

Number of Individual Forms: Ten.

Technique and Comments: Eight of the specimens consist of whole sedge stems or leaves that have been crushed or flattened, then twisted. Two twists are made of sagebrush bark; one of these is partially shredded and straight, whereas the other remains flat with twisted bark fiber. One twist is an oval ring (30 by 20 mm.), formed by two plies joined by two sheet bend knots. The other twists were probably used with another twist similar to Type I. Identifiable raw materials are *Typha* sp., *Scirpus* sp., *Juncus* sp., and *Artemisia* sp.

Measurements: Range in length, 30–130 mm.; mean length, 75.77 mm.; range in diameter, 1.2–20.0 mm.; mean diameter, 6.49 mm.

Type III. Two Ply Z Twist (fig. 97a, b)

Number of Specimens: Ninety-three.

Type of Specimens: Bag handle, body fragments, mat weft or selvage fragment, rope.

Number of Individual Forms: Ninety-three.

Technique and Comments: This type is characterized by two distinct fiber elements having been initially twisted (or crushed), and joined in a Z twist. Often one fiber is folded over; a single element can thus function as two construction units. The tightness of twist ranges somewhat, from very loose Z twists to the 47 specimens in which there are uniform, regular twist intervals per centimeter. Fibers consist of whole or split stems or leaves, crushed and flattened in the twisting process. Most specimens are curved into a U shape, possibly indicating that they are remnants of simple continuous side selvages or handles. Other segments are straight, or bent into a V, an oval, or self-wrapped folded units. One unusual specimen consists of a two ply S twist that is folded over and loosely Z twisted. There is a loop created in the bend, and the main Z twist is interrupted with five overhand

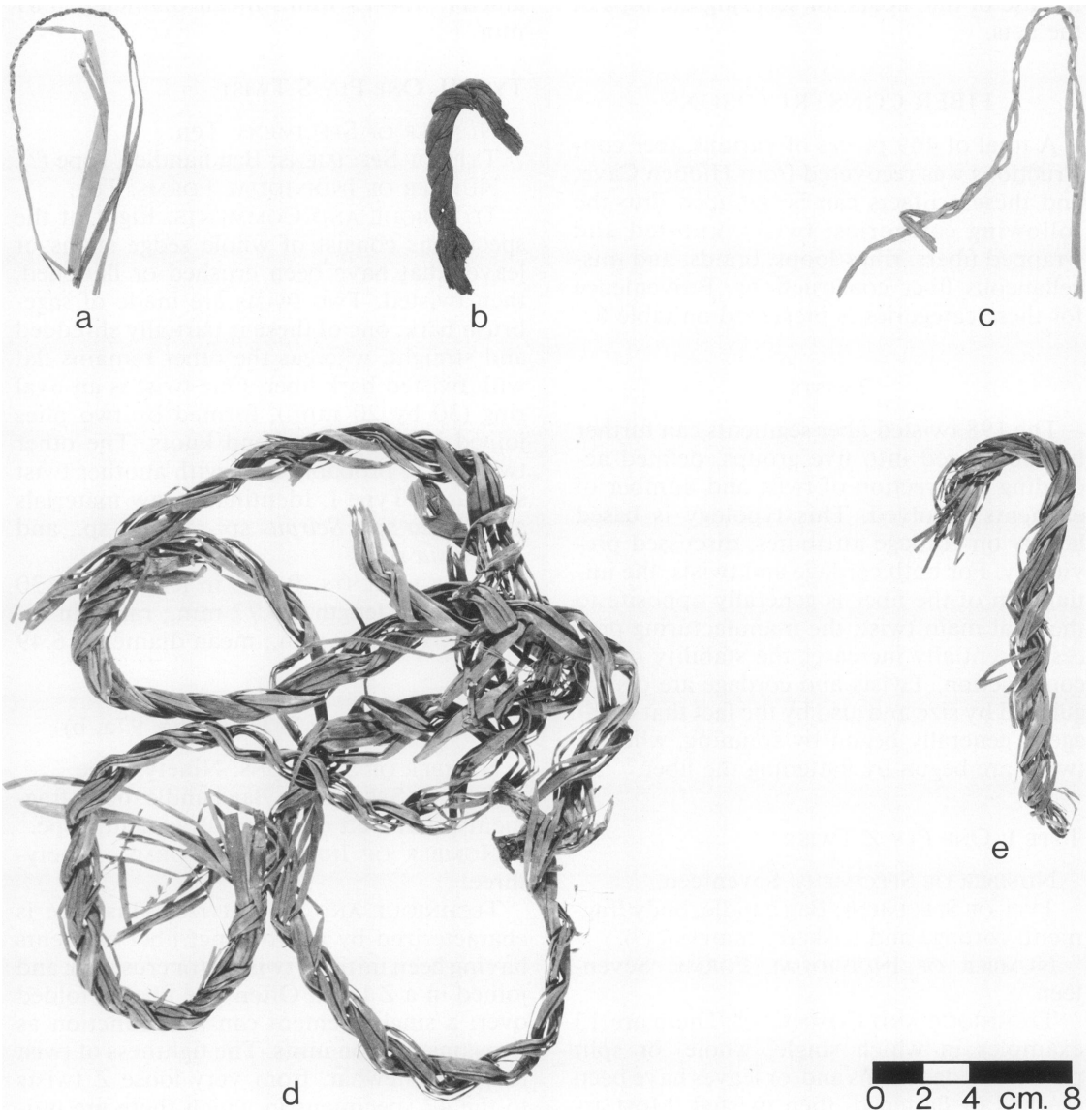

FIG. 97. Twisted fiber constructions from Hidden Cave (Type III, a, b; Type IV, c; Type V, d, e). a. 2/32498; b. 2/32801; c. 1-1B-399; d. 1-1B-13G-16; e. 20.4/362.
Provenience: Surface, b, d, e; Stratum IV, c; N.C., a.

knots. Eleven other specimens have overhand knots, and two are knotted at the end, creating a knot (crown knot?). The texture ranges from a rigid *Salix* sp. twist to semiflexible specimens of *Typha* sp., *Scirpus* sp., *Juncus* sp., *Artemisia* sp., and *Apocynum* sp.

MEASUREMENTS: Range in length, 20.0–720 mm.; mean length, 136.09 mm.; range in diameter, 1.5–50 mm.; mean diameter, 10.12 mm.; range in the angle of twist, 12° to 45°; mean angle of twist, 28.58°; range in twists per cm., 0.4–3.0; mean twists per cm., 1.25.

Type IV: Two Ply S Twist (fig. 97c)

Number of Specimens: Six.

Type of Specimens: Bag handles and body fragments, rope.

Number of Individual Forms: Six.

Technique and Comments: Four specimens are made of two whole, flattened stems with an initial Z twist crushing and a final S twist. Two artifacts are single stems or leaves, split longitudinally, then folded over, forming two plies. The split stem specimen has a separate fiber ply, cross-wrapped at the base, which keeps the twist stable. Four specimens are bent and curved, and one has an overhand knot. Twist angles are more uniform than in Type III specimens, and there are more twists per centimeter. No charring is noted, and the texture is uniformly semiflexible. Identifiable raw materials are *Typha* sp., *Scirpus* sp., and *Juncus* sp.

Measurements: Range in length, 70–130 mm.; mean length, 104.16 mm.; range in diameter, 2.5–5.8 mm.; mean diameter, 3.65 mm.; range in angle of twist, 20° to 30°; mean angle of twist, 26.40°; range in twists per cm., 0.75–3.0; mean twists per cm., 2.15.

Type V: Two+ Ply Z Twist (fig. 97d, e)

Number of Specimens: Seventy-two.

Type of Specimens: Bag handles, matting or weft fragments (?), rope.

Number of Individual Forms: Seventy-two.

Technique and Comments: This type is second in quantity to Type III (two ply Z twist). The major difference is that Type V uses multiple elements for each ply unit. Two Type V techniques are evident, the first consisting of two whole or crushed stems (or leaves) wrapped with a third fiber; in the second technique each ply contains two to eight crushed stems that function as a single unit. Specimens have shapes ranging from loosely wrapped straight and/or curved segments with fraying brittle ends to straight and/or bent, uniformly twisted pieces. Four specimens are knotted, three with overhand knots and one with an additional fiber joined in a half hitch. One of the overhand knots forms a loop with a separate sedge stem inserted (possibly a bag or matting section). The artifact with the half hitch is a large, curved, uniformly twisted rope associated with the matting fragments in Cache Pit 22. More than half of the Type V specimens have regularly twisted elements with the initial flattening turn opposite to the final twist.

Also included in this type is one specimen of three ply S twist. This piece is made of separate sagebrush fibers 70 mm. in length by 3.8 mm. in diameter, loosely S twisted and bent into a U shape about 30 mm. in diameter. This specimen probably represents construction material.

The texture of all pieces is semiflexible, and no charring is apparent. Identifiable raw materials are *Typha* sp., *Scirpus* sp., and *Juncus* sp.

Measurements: Range in length, 22–400 mm.; mean length, 144.94 mm.; range in diameter, 5.0–20 mm.; mean diameter, 10.80 mm.; range in angle of twist, 20° to 45°; mean angle of twist, 31.88°; range in twists per cm., 0.3–2.0; mean twists per cm., 0.91.

Knotted Fibers

The 149 knotted fiber specimens from Hidden Cave can be divided into seven groups, depending on the kind of knots involved. Knot identification is based on criteria provided by Shaw (1972), as well as replication. In some cases, it would have been impossible to determine the knot type without destroying the construction; in such cases, the knots were simply termed unidentifiable.

Group I: Overhand and Figure Eight (fig. 98a)

This first group consists of 83 knots, 47 of which involve one element and 36 involving two or more elements. Thirty-six of the single element specimens are overhand knots, 11 are figure eight. Both knot types are made of whole, crushed, or partially shredded stems or bark fibers. The knots are generally tightened, with the extending fibers untwisted. In three specimens, the knot has been formed at one end of the fiber, creating a knob. Three other fragments show two or three successive overhand knots tied along a 20 to 60 mm.

length. These artifacts range from oblong and narrow, to rectangular, rather bulky fiber bundles.

The multiple element knots are generally overhand; only three are figure eight. Both types are made of two to eight whole or split stems that have been flattened and function as a single element. Three examples have extended fibers that are slightly Z twisted. One knot is charred, and another contains three successive knots within 97 mm.

Lengths of these constructions range between 15 and 250 mm., and the widths vary from 3.5 to 150 mm. Identifiable raw materials are *Scirpus* sp., *Typha* sp., *Juncus* sp., and *Artemisia* sp.

Group II: Half Hitch

Twelve specimens consist of split or whole stems joined by turning one element over the second, forming a half hitch. The knots are generally formed in the middle of the construction, except for 1-1B-218, which contains two half hitches at the opposite ends of an unsplit sedge stem. One end of this piece is unshredded and uniform, the opposite end is shredded, forming a bulky knob. Specimen 1-1B-561, recovered from Cache Pit 6, is a curved, split *Typha* sp. leaf with a separate split fiber wrapped in two successive half hitches at the bend. Other specimens are worn, but none are charred. Overall lengths of construction range between 40 to 180 mm., and widths vary between 8.0 and 30 mm. Identifiable raw materials are *Typha* sp. and *Scirpus* sp.

Group III: Clove Hitch and Granny (fig. 98b)

This category contains seven clove hitches and two granny knots. Two clove hitches are tied on single, whole sedge stems with the ends manipulated in successive half hitches. These pieces form an open loop, about 60 mm. in diameter. The other clove hitches are tied with constructions that have two to three fibers per element; one small specimen is made of sagebrush; other identifiable materials are split *Scirpus* sp. or *Typha* sp. stems. These knots occur on T-shaped or rectangular bundles, between 30 to 250 mm. long and from 4 to 60 mm. wide.

Two granny knots are tied on whole, flattened *Typha* sp. stems, roughly 100 mm. long and 30–60 mm wide. One specimen contains two and four fibers per element; the other has two single fiber elements loosely tied.

Group IV: Sheet Bend

Sheet bend knots ($n = 20$) are distinguished from grannies because the ends are crossed in a bight, lying ultimately on opposite sides of the bight; in a granny, the ends are not crossed in either bight. Essentially, sheet bends are a combination of a loop and a half hitch, useful for securing elements of different widths.

Knots are tied on one to four whole or split fibers, forming rectangular knotted areas. Two have slightly twisted extended fibers, and one has an untightened bight forming a loop. The texture ranges from semiflexible to rigid, and no charring was noted. The lengths range from 30 to 130 mm. and widths vary between 4.0 and 30 mm. Identifiable raw materials are *Scirpus* sp., *Typha* sp., *Juncus* sp., and *Artemisia* sp.

Group V: Square and Bow

Two square knotted specimens are 50 to 60 mm. long by 10 mm. wide, made of flattened whole *Scirpus* stems. One of these is made with two fibers per element. A third specimen is a small knot made from a split sedge leaf (20 by 3.7 mm.). Extended fibers are not twisted in any of the square knots.

The single bow knot consists of two flattened sedge fibers tied with the bights forming the characteristic bow configuration (60 by 10 mm.). Bow knots are also discussed under Wrapped Fiber Constructions.

Group VI: Knots Forming Loops (fig. 98c)

Eight specimens made of twisted sedge fibers are bent over with a knot securing a loop. Three are two ply Z twist, one is a single ply S twist, one is a two ply Z spun, S twist, and three are single, whole flattened stalks. Knots securing the loops are simple overhand constructions with additional wrapping of the ends around the extended line. The specimens range from 47 to 100 mm. in length,

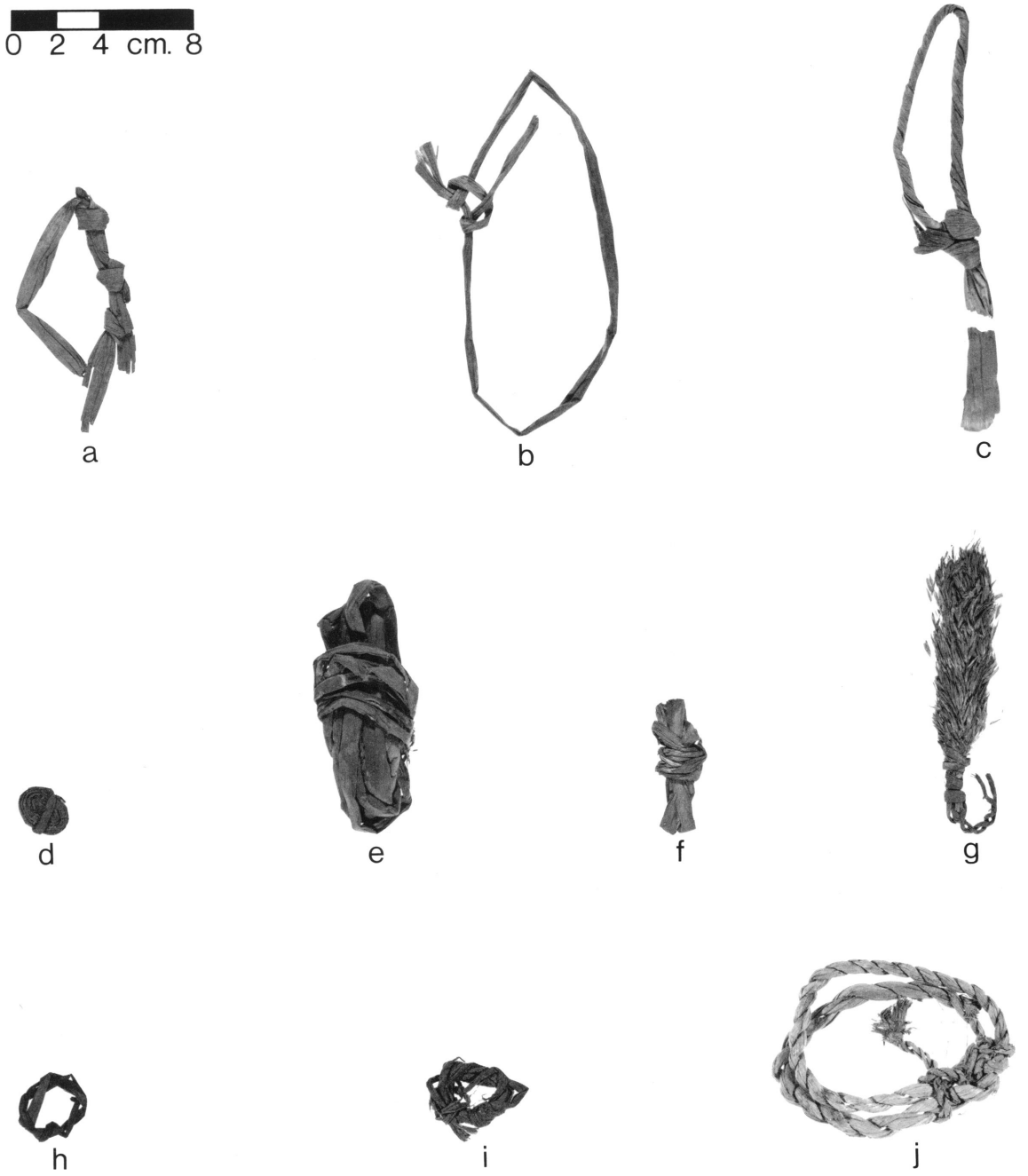

FIG. 98. Various fiber constructions from Hidden Cave. Knot Group I: a. 2/32528; Knot Group III: b. 1-1B-808; Knot Group VI: c. 1-1B-385; Wrapped Group I: d. 2/32724; Wrapped Group II: e. 1-1B-901; f. 1-1B-942; Wrapped Group III: g. 1-1B-635; Rings/loops: h. 1-1B-347; i. 2/32597; j. 2/32599. Provenience: Surface, f; Stratum II, a, c, g, h; Stratum III, e; Stratum IV, b, d, i, j.

with loops ranging in size from 18 to 40 mm. in diameter. The twist diameters range from 2.9 to 10.0 mm. Identifiable raw materials are *Typha* sp., *Scirpus* sp., and *Juncus* sp.

Group VII: Unidentifiable Knotted Constructions

These items consist primarily of disengaged, damaged specimens, as well as unidentifiable bundles. Seven of these bundles are made of two or more *Scirpus* or *Typha* stems or split leaves, ranging in length from 20 to 100 mm. and varying in width from 20 to 40 mm. Possible knot types include the half carrick, sheet bend, and multiple overhand knots. The other specimens consist of loose, isolated constructions of two or three fibers per element. Lengths range from 40 to 70 mm.; widths vary from 14.5 to 70 mm.

Wrapped Fibers

Thirty-eight wrapped fiber artifacts from Hidden Cave can be divided into three analytical groups: circular/oval pieces; folded, rectangular units; wrapped plumes; and a single fiber wrapped stone. These fiber-wrapped artifacts might be used in the construction of objects requiring compact, oval, or rectangular elements, but most appear to be fragments of materials for bags, matting, clothing, or perhaps even decoys.

Group I: Circular/Oval Wrapped Fibers (fig. 98d)

These three pieces are small, uniformly coiled and cross-wrapped fiber constructions. Two are made of continuous *Scirpus/Typha* leaves forming an oval, with the end of the leaf wrapped one to three times, then tucked under the wrapping (length, 20.6 and 40 mm.; width, 25 and 27 mm.; thickness, approximately 8 mm.). The third specimen is a continuous piece of shredded sagebrush bark, forming a compact circle (43 × 46.5 mm. in diameter, 3.0 mm. thick). This artifact is cross-wrapped once with a separate fiber that forms a small knob at the top with an overhand knot. Texture of this specimen is soft and flexible; the others are semiflexible. All pieces seem to be very carefully constructed.

Group II: Folded, Rectangular Wrapped Fibers (fig. 98e, f)

Thirty-two artifacts are grouped into this category. One (20.4/999) is a single, whole *Scirpus/Typha* stalk (65.0 mm. long, with a diameter of 6.8 mm.), wrapped with a soft piece of shredded bark. The wrapping is unknotted, the proximal end being charred and beveled.

Seven artifacts in this group are single or multiple sedge stalks that are folded lengthwise and cross-wrapped with three to eight circuits of separate fibers (the ends of which are generally tucked under the wrapping). All but one of these form discrete oblong segments ranging in length from 30.3 to 130 mm., 7 to 20 mm. in width, and averaging 10.0 mm. in thickness. The other specimen is bent into a U shape (44 × 20 mm.) which is secured by a slightly Z twisted fiber that wraps the entire segment.

The rest of the specimens in this group (n = 24) are compact bundles of stems and leaves of sedge and grass, cross-wrapped or wrapped lengthwise with separate fibers. Bundle sizes range from 30 by 18.0 mm. to large rectangles 240 by 70 mm. Two of these specimens are secured with bow knots, and two others have overhand knots joining ends of the wrapping fiber. One artifact has a Z twist wrapping unit, and an additional bundle of bark fibers is wrapped diagonally with willow strips to form a compact bundle (30 × 10 mm.). Identifiable raw materials are *Elymus* sp., *Distichlis* sp., *Eleocharis* sp., *Scirpus* sp., *Typha* sp., and *Juncus* sp.

Group III: Wrapped Plumes (fig. 98g)

Included in this group are two specimens, each made up of multiple spikes of *Phragmites australis* (David Sutherland, personal commun.). In each case, a small loop is created at the base by the folded stems; it is then bound with a separate flattened leaf. Artifact 1-1B-635 has a Z twist wrapping (4.0 mm. in diameter) which is bent into a small hook or handle. Under 10× magnification, the worn and blunted tips of the inflorescences are evident. The plumes range in length between 125 and 130 mm., are 35–40 mm. in width, and the base is 7.3–7.5 mm. wide. Both artifacts closely resemble whisk brooms, and the wear is consistent with this usage.

Group IV: Fiber Wrapped Stone

Artifact 20.4/234 is an oval stone, one end of which is slightly pointed (40 by 30 mm.). It has been wrapped four times with a split

Scirpus leaf. A piece of white feather down lies beneath the wrapping. The specimen weighs 12.7 grams, and could perhaps have been used as a net weight.

Rings and Loops (fig. 98h–j)

Fourteen fiber constructions are either compact or open rings, or else overlapping loops which are secured with a knot. Twelve of these loops are constructed as coiled fibers. One of these is a single sedge fiber forming an oval (24.5 by 45.5 mm. and 0.5 mm. thick). This piece is exactly like the wrapped compact oval described previously, except that this artifact lacks the wrapping. Another compact ring is made of *Artemisia* bark coiled into a circle (30 by 20 mm.).

Ten rings are of open construction. Five of these are made of willow bark, coiled in open rings; one is a two element Z twist ring. The size ranges from 10.0 to 46.3 mm. in diameter. Four coils are made of whole, flattened sedge stalks and leaves, coiled into open rings ranging between 30 and 70 mm. in diameter. The remaining specimen is made of overlapping grasses, secured with an overhand knot joining the ends.

The collection also contains two artifacts consisting of overlapping circles, tied together with overhand knots. Both pieces were recovered from cache pits. Artifact 20.4/1724, from Cache Pit 22, is a Type V twist (four element Z twist) coiled in three overlapping loops. The other artifact, 2/32599 from Artifact Concentration 1 consists of a double loop of Type III twist (two ply Z twist fiber, 8.0 mm. in diameter), tied with a piece of Type IV cordage (two ply S spun Z twist, 3.7 mm. in diameter), in an overhand knot around the loop. The specimens range from 50 to 90 mm. in length by 40–63 mm. in diameter.

These ring and loop units could have been packages of raw materials, especially the bark segments which were generally used in making basketry.

Braids (fig. 99a–c)

Twelve braided artifacts were recovered at Hidden Cave. Artifact 2/32585 from Cache Pit 12 (1951 Feature #10) is a finely executed braided rope, measuring 740 mm. long by 10.5–19.4 mm. in diameter. *Scirpus* stems

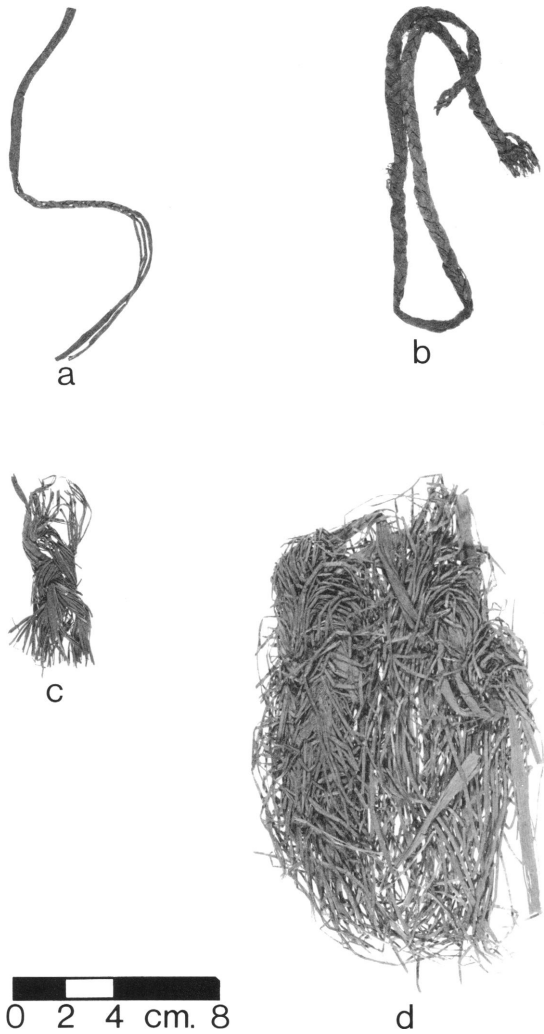

Fig. 99. Braided and miscellaneous fiber constructions from Hidden Cave. a. 1-1B-1006; b. 2/32514; c. 2/32452; d. 1-1B-583.

Provenience: Surface, a; Stratum II, d; N.C., b, c.

have been secured by a crown (?) knot at one end, and the braiding extends for 470 mm. The base of the braid is doubled back and cross-wrapped with untwisted fibers 270 mm. long. Three other specimens are made of multiple sedge and grass stalks that function as a single unit; these artifacts have a stiff, whisk broomlike texture.

Remaining braids are constructed of whole, single sedge stalks that have been crushed or

split. One is a single stem split into three parts. Another is a two ply Z twist, braided with two other elements. A third specimen has an overhand knot at one end. Lengths vary from 25 to 160 mm., and diameters range between 4.5 and 25.0 mm. Identified raw materials are *Typha* sp., *Scirpus* sp., *Artemisia* sp., *Distichlis* sp., and *Eleocharis* sp.

Miscellaneous Fiber Constructions

The remaining 58 fiber artifacts can be grouped into four residual categories. Although these artifacts have been manufactured by folding, compacting, shredding, etc., these alterations do not seem to indicate a clear-cut morphological type.

Group I: Folded or Crossed Fibers

Thirteen artifacts have been made of single split or whole sedge/bark fibers, folded or crossed into constructions that were probably used for bags, matting, or cordage. Identifiable raw materials are *Salix* sp., *Artemisia* sp., *Scirpus* sp., and *Typha* sp. Lengths range from 10–240 mm., widths range from 5 to 13 mm.

Group II: Linear Fiber Constructions

Twelve specimens have been folded into a straight or V shape. These are made of single whole or crushed sedge stems; in one case, a flattened mass of split stems have been longitudinally aligned. These pieces could have been used as cylindrical bag centers or body sections. Fragment lengths range from 30 to 200 mm., and diameters range from 10.2 to 15.0 mm. Identifiable raw materials are *Typha* sp. and *Scirpus* sp.

Group III: Fiber Bundles (fig. 99d)

These artifacts ($n = 28$) seem to have been portions of "aprons," clothing, bedding, or matting. Twelve are small pieces of compacted sedges, grasses, or roots, ranging in length from 20 to 70 mm., between 25 and 70 mm. wide, and 10.5 to 15 mm. thick. The other Group III pieces are larger (length: 120–250 mm.; width: 25–140 mm.; thickness: 5–30 mm.). All of these items are oval to rectangular in outline, and have been flattened without wrapping or intertwined fibers. Identifiable raw materials are *Artemisia* sp., *Typha* sp., *Phragmites* sp., *Juncus* sp., *Eleocharis* sp., and various Gramineae.

Group IV: Bound Fiber Bundles

These five pieces tend to have a stabilizing twist built into the bundle, made of folded and compacted sedge roots, stems, and marsh grasses. Artifact 2/32822 is a bundle of *Artemisia* sp. fibers that have been charred and the ends cut. Specimen 2/32631 is a grass bundle containing a section of Type III cordage (diameter, 2.7 mm.) that is tied into the bundle. The other specimens have Z twists intertwined in the folds which help maintain the oval/rectangular shape, and could have served as a handle or belt if these bundles functioned as items of clothing. The fine diameter of the construction materials creates a rather soft surface, although the overall texture is semiflexible to brittle. Lengths range from 80 to 170 mm., widths vary from 70 to 140 mm., and thickness from 4.0 to 6.0 mm. Identifiable raw materials are *Typha* sp., *Eleocharis* sp., as well as *Scirpus* sp. roots.

Discussion

Fiber constructions comprise 23 percent (469 of 2066) of the perishable artifacts in the Hidden Cave assemblage. To determine the original form and function of these items is problematical. Excavated specimens vary in manufacturing stages from minimally modified raw material (such as shredded sagebrush) to finished compact sedge artifacts. Part of the observed variability of these artifacts is due to the postdepositional disturbances previously mentioned. But of more consequence is the rather wide range of known uses and morphology. As discussed in chapter 27, fiber constructions comprise a large proportion of the general utility tools, domestic equipment, and harvesting/procurement equipment recovered at Hidden Cave. In addition to general binding and lashing functions, sedge artifacts were used ethnographically as basketry and duck decoys, tule floats for netting, and clothing (Wheat, 1967; Fowler and Bath, 1981).

Preparation of fiber constructions generally

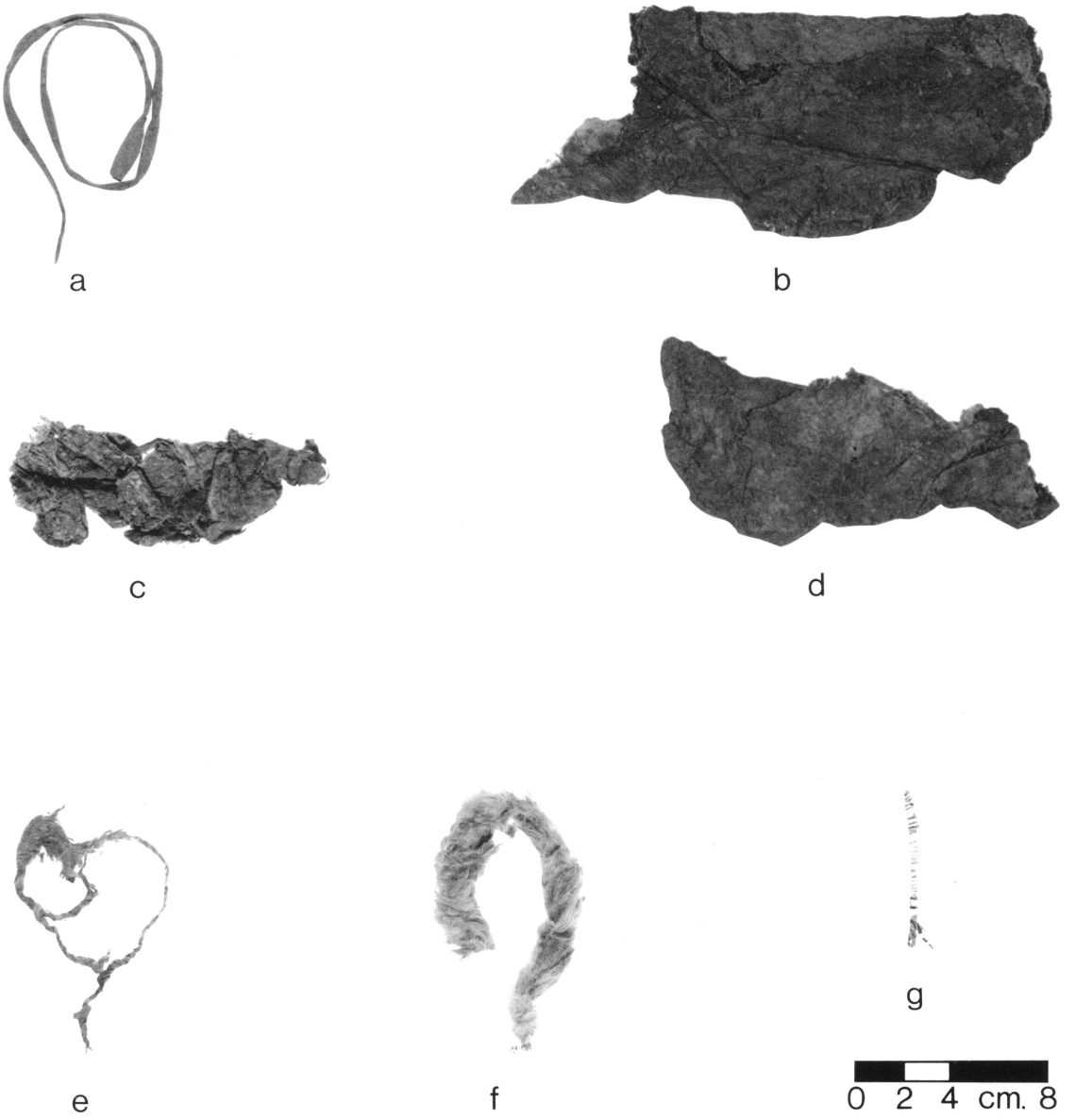

FIG. 100. Miscellaneous modified perishables from Hidden Cave. Leather Group I: a. 2/32673; Leather Group III: b–d. 1-1B-420; Skin/fur Group II: e. 2/32692; Skin/fur Group III: f. 20.4/1013; Quill/cordage: g. 1-1B-1033.
Provenience: Surface, g, Stratum II, a–f.

involved little more than crushing, shredding, or twisting of the raw material. Most of these artifacts are simply twists and knotted fibers, and many of these are fragmentary, perhaps parts of baskets, mats, or bags. Over 90 percent (182 of 198) of the fibers are twisted in the Z (rather than S) direction. A preference for Z twisting was noted earlier for the wider diameter, coarser cordage types as well.

Wrapped fibers and rings/loops are generally found as loosely wrapped bundles of raw material as well as compact and highly

TABLE 70
Basketry from Hidden Cave

Type	Specimen	Stratum	Raw Materials	Comments
Type I				
Close Simple Twining, Z Twist Weft	1-1B-716[a]	IV	*Typha/Scirpus* sp.	mat, bag?
	20.4/460	IV	*Salix* sp.	—
	2/32461	N.C.[b]	*Typha* sp.	sandal fragment
Type II				
Close Simple Twining, S Twist Weft	1-1B-928	Surface	Warps *Salix* sp.	—
			Wefts *Typha* sp.	—
	1-1B-1045	Surface	Warps *Salix* sp.	—
			Wefts *Typha* sp.	—
	1-1B-284A	II	Warps *Salix* sp.	pitch coating
			Wefts *Typha* sp.?	—
	1-1B-448	II	Warps *Salix* sp.	—
			Wefts *Typha* sp.?	—
	1-1B-626	II	*Salix* sp.	—
	2/32518	II	*Salix* sp.	—
	2/32563	II	*Salix* sp.	—
	20.4/1322	II	*Salix* sp.	—
	1-1B-520	IV	*Salix* sp.	fragile
	1-1B-722	IV	Warps *Salix* sp.	—
			Wefts *Typha* sp.	
	1-1B-725	IV	*Typha* sp.	—
	1-1B-745	IV	Warps *Salix* sp.	fragile
			Wefts *Artemisia* sp.	
	20.4/1586	IV	*Salix* sp.	—
	20.4/1693	IV	*Salix* sp.	—
	1-46169	N.C.	*Salix* sp.?	—
	20.3/9905	N.C.	*Salix* sp.	—
	20.4/236	N.C.	*Typha/Scirpus* sp.	—
	20.4/1740	N.C.	*Typha/Scirpus* sp.	end selvage
Type III				
Open Simple Twining, Z Twist Weft	1-1B-116	Surface	Warps *Scirpus* sp.	mat fragment
			Wefts *Juncus* sp.	
	1-1B-117	Surface	*Scirpus/Typha* sp.	bag center
	1-1B-305	II	*Scirpus* sp.	bag fragment?
	1-1B-457	II	*Scirpus/Typha* sp.	whole bag
	1-1B-468	II	*Scirpus/Typha* sp.	bag fragment
	1-1B-546	II	*Typha* sp.	bag
	1-1B-547[c]	II	*Scirpus/Typha* sp.	bag
	1-1B-562	II	*Scirpus*	bag fragment
	1-1B-587	II	*Scirpus* sp.	bag fragment
	1-1B-805	II	*Typha* sp.	mat
	2/32566	II	*Scirpus* sp.	bag fragment
	2/32843	II	*Juncus/Scirpus* sp.	mat fragment
	1-1B-514	IV	*Scirpus* sp.?	mat fragment
	1-1B-518	IV	*Scirpus* sp.	mat fragment
	1-1B-625	IV	*Scirpus* sp.	bag fragment
	1-1B-647	IV	*Scirpus* sp.	bag fragment
	1-1B-716	IV	*Scirpus* sp.	bag fragment
	1-1B-736	IV	*Scirpus/Typha* sp.	mat fragment
	1-1B-742	IV	*Typha* sp.	bag fragment
	2/32740	IV	*Scirpus/Typha* sp.	bag fragment

TABLE 70—(*Continued*)

Type	Specimen	Stratum	Raw Materials	Comments
	2/32755	IV	Warps *Scirpus* sp. Wefts *Juncus* sp.	whole bag
	2/32757	IV	*Typha* sp.	mat fragment
	1-1B-13G-1	N.C.	*Scirpus/Juncus* sp.	whole bag
	1/46167	N.C.	*Scirpus* sp.	whole bag
	1/46168	N.C.	*Typha* sp.	whole bag
	2/32460	N.C.	*Juncus* sp.	mat fragment
	20.3/9881	N.C.	*Typha* sp.	mat fragment
	20.3/9897	N.C.	*Typha* sp.?	mat fragment
Type IV				
Open Diagonal Twining, Z Twist Weft	1-1B-999	Surface	*Juncus* sp.	mat fragment
	1-1B-161	II	*Typha* sp.?	bag?
	2/32635	II	*Artemisia* sp.?	mat fragment
	2/32736	II	*Typha/Gramineae*	sandal
	2/32744	II	*Typha* sp.	mat fragment
	1-1B-524	IV	*Scirpus* sp.	mat fragments
	1-1B-705	IV	*Artemisia* sp.?	sandal
	2/32671	IV	Warps *Typha* sp. Wefts *Juncus* sp.?	sandal
	1-1B-no #	N.C.	*Scirpus/Typha* sp.	sandal
	2/32462	N.C.	*Scirpus* sp.	mat fragment
	2/32479	N.C.	*Scirpus* sp.	mat fragment
	2/57828	N.C.	*Scirpus* sp.	mat/bag?
	20.3/9891	N.C.	*Scirpus/Typha* sp.	mat fragment
	20.4/478	N.C.	*Typha* sp.	mat fragment
Type V				
Open and Close, Diagonal Twining, Z Twist Weft	2/32432	IV	*Typha* sp.	bag?
Type VI				
Close Coiling, Three Rod Bunched, Non-Interlocking Stitches	1-1B-1032	Surface	*Salix* sp.	—
	2/32647	IV	*Salix* sp.	—
	2/32756	IV	*Salix* sp.?	1 center
	2/32439	N.C.	*Salix* sp.?	charred
	2/32441	N.C.	*Salix* sp.	—
	20.3/9790	N.C.	*Salix* sp.?	—
Type VII				
Close Coiling, Two Rod and Welt Bunched	2/32394	II	*Salix* sp.	four pieces
	20.4/425	II	*Salix* sp.	self rim
Type VIII				
Simple Plaiting, 1/1 Interval	1-1B-955	Surface	*Salix* sp.	fragments
	1-1B-1036	N.C.	*Salix* sp.	wickerware
	2/30349	N.C.	Warps *Juncus* sp. Wefts *Apocynum* sp.	semi-flexible
	2/30350	N.C.	Warps *Juncus* sp. Wefts *Apocynum* sp.	semi-flexible
	2/57827	N.C.	*Salix* sp.	wickerware, rim

[a] Two artifacts have the same catalog number.
[b] N.C. = no correlation.
[c] Catalog number may read 1-1B-593.

portable folded fibers. These items would seem to be intended for future use; they are generally smaller than the knots and twists, which seem to be fragments of larger artifacts.

Fiber constructions are found at most Great Basin sites mentioned previously. Unfortunately, most site inventories do not include detailed descriptions of these constructions, but the overall morphology and usage would seem comparable with that noted in the Hidden Cave assemblage. Of particular interest is the bundle of folded rectangular wrapped fibers found at Hidden Cave (fig. 98e, f) and the wrapped bundle found at Roaring Springs Cave (Cressman, 1942, p. 78, fig. 93h). Cressman suggested that this was a tule "ball" used for the ball and pin game.

MISCELLANEOUS MODIFIED PERISHABLES

Remaining perishable artifacts from Hidden Cave are divided by material: leather/hide, fur/skin, and quill/cordage constructions. Provenience for these groups is listed on table 67.

Leather/Hide

The 92 pieces of leather and hide from Hidden Cave can be conveniently described in three categories, based on complexity of construction. For present purposes, "hide" denotes pliable materials that are soft, as opposed to stiffer skin (and skin with attached fur strips).[6]

Group I: One Element Thongs (fig. 100a)

This category contains 76 pieces of single thong segments. Fifteen of these have Z twists; only one has a slight S twist. The thongs are flat, pliable to stiff segments, with blunted or broken ends. One specimen shows a wider, spatulate end, and another example has a bifurcate end. Four thongs have tapered ends, and two have perforations or notches (2.5 mm. in diameter). The thongs range in length between 10 and 410 mm.; width varies from 3.0 to 10.0 mm.; thickness ranges from 0.6 to 1.6 mm.

Ten thongs have additional fiber or sinew attached by knots or wrapping. Artifact 20.4/621 is a 190 by 10.5 mm. segment with two areas of sinew, spaced 20 mm. apart. The sinew is wrapped five to six times around the thongs, with the ends tucked underneath. In four additional thongs, cordage is knotted directly to the hide, or else tied through perforations. Artifact 1-1B-119 is the longest such complex thong, measuring over 710 cm. long, by 3 mm. wide. This artifact consists of four hide segments attached with sheet bend knots. A single line of Type III cordage (two ply Z spun S twist, 1 mm. diameter) measuring over 370 cm. is attached to the hide with a sheet bend knot. Two overhand knots are tied in the cordage segment, one at the end, and the other 31 cm. from the end. This specimen is a tan-orange color, and remains soft and pliable.

Artifact 1-1B-455 is a fiber/hide construction over 600 mm. in length, and 2.0 mm. in diameter. The thong is made of a single segment of hide, about 250 mm. long, tied with sheet bend knots to two segments of Type III cordage.

Artifact 1-1B-356 is made of two segments of Z twisted hide tied by square knots to Type III cordage (1.7 mm. in diameter).

Artifact 20.4/356 is also made of two hide segments (50 to 60 mm. long) joined through perforations at each end and by three short pieces of Type III cordage (1.2 mm. long, 0.7 mm. in diameter) inserted through the perforations with overhand knots functioning as stoppers.

Group II: Two Element Z Twisted Thongs

Four pieces of thong have been manufactured by Z twisting individual hide elements. One piece is disengaged and bent; another retains tufts of gray/tan fur. These pieces range

[6] One additional leather artifact, probably from Hidden Cave, is stored at the National Museum of Natural History (Smithsonian Institution) as artifact 377992. This item consists of four pieces of leather, sewn together, probably forming a sandal (120 mm. by 70 mm.). Two pieces of cordage form an "X" along the top surface. The artifact appears to be unworn, and one end has been deliberately cut off. Perhaps this is a child's sandal.

in length from 20 to 106 mm., and widths vary between 2.0 and 10.0 mm. Texture is semiflexible.

Group III: Rectangular Hide Segments (fig. 100b–d)

Of the 12 rectangular hide segments, three have been modified by cordage and perforations. Eight specimens are flat, folded, pliable to semiflexible segments ranging in size from 25 by 15 mm. to 95 by 45 mm. The average thickness is 1.3 mm.

One artifact is folded into a neat, envelope shape, and another has a gray-stained area surrounding a small notch on the edge.

Another Group III hide artifact (100 by 12.5 mm.) has a piece of Type III cordage (1.1 mm. in diameter) wrapped twice around the hide, and secured with a double overhand knot.

Two additional cordage and hide constructions are larger, oval/rectangular pieces, averaging 217 mm. in length by 160 mm. in width, 1.3 mm. thick. Artifact 1/39996 has one rounded edge with 15 small perforations scattered across the 90 mm. width. One perforation contains a cordage fragment with an overhand knot. A section of lacing 125 mm. below the rounded edge consists of three perforations on each side of a 20 mm. long cut. A piece of fiber 0.2 mm. in diameter is laced through these holes and secured with an overhand knot. Artifact 20.4/1487 from Cache Pit 20 (1979–1980 Feature #113) has ragged edges and is ripped. One edge is slit for 30 mm. It has seven perforations laced with Type III cordage (1.5 mm. in diameter), secured at the base with a double overhand knot.

One miscellaneous construction of fiber, hide, and cordage forms a bundle 60 by 20 mm. Two shredded segments of *Artemisia* bark form an X with a hide thong bound at the intersection with Type III cordage (1.8 mm. in diameter); this wrap secures the bundle and is tied with a figure eight knot.

Skin/Fur

The 242 pieces of modified fur and/or skin can be divided into four categories, based on the various combinations of materials. The function of these objects is problematical, but Groups I–III could easily have been used with fiber cordage for the manufacture of fur blankets. Textures range from semiflexible and elastic to stiff but strong. Although it was not possible to identify the fur conclusively, at least 19 pieces strongly resembled *Lepus californicus*.

Group I: Skin Without Fur

Hidden Cave contained 64 pieces of skin that had been stripped of fur. Thirty of these are single element Z twisted strips (length, 20–140 mm.; diameter, 1.5–19 mm.). Seven of these pieces have fiber additions. Either the fibers are binding strips of skin or skin is twisted around shredded *Artemisia* fibers.

The two-element strips ($n = 34$) are all Z twisted except for two S twisted fragments and a single specimen which is an oval swirl (30 by 20 mm.). The two-element strips range in length from 25 to 230 mm., and the diameters are from 0.8 to 4.2 mm.; the twists per cm. range from 3 to 6. Three strips are associated with fiber: two are made from skin twisted around unshredded plant fibers and one has skin connected to a fur clump with Type III cordage (1.2 mm. in diameter).

Group II: Skin with Fur (fig. 100e)

There were 69 pieces of skin that had not been stripped of fur. Roughly half of these ($n = 38$) are single element Z twists; the remainder are two-element S twists. Four specimens have fiber cordage attachments: in three of these, the fiber is wrapped around the thong, and in the other, the skin is Z twisted about the fiber. Specimens range in length from 20 to 300 mm. and vary from 0.8 to 4.8 mm. in diameter.

Group III: Fur (fig. 100f)

Hidden Cave contained 33 fur segments that were not connected to skin or hide. Most of these ($n = 27$) are untwisted; the remainder are Z twisted together. All specimens are still soft and easily loosened, and four have Type III cordage wrapped around the fur bundles. The lengths range from 10 to 230 mm., and diameters vary from 1.5 to 20 mm.

Group IV: Matted Segments of Fur and Skin

This group of fur and skin segments (n = 76) is distinguished from the Group III artifacts because of their flattened, folded, or curled (rather than twisted) configuration. The lengths vary from 20 to 230 mm. and from 8.0 to 50 mm. in width. Nineteen pieces are unidentified quill and feather fragments. Two Group IV pieces are attached to fiber cordage.

Quill/Cordage Artifacts

Eight Hidden Cave artifacts were manufactured of quill with fiber cordage. Four are quills wrapped with cordage; two are cordage wrapped with quill; the remainder are combinations of the two elements.

Artifact 2/32443 is a straight quill, 95 mm. long with the base folded over to form a loop. Unspun grass fibers secure the top of the loop by cross-wrapping the quill for approximately 10 mm.

Two other specimens—20.3/9904 and 20.4/1547—are folded quills with the cordage inserted through the resultant loop. The quills are 65 mm. and 50 mm. long, and both are secured with pieces of Type III (two ply Z spun S twisted) cordage. One has the cordage cross-wrapped once with an end tucked through the fold and knotted with an overhand knot. In the other artifact, the fibers are looped through the fold with the extended plies S twisted for 50 mm.

Artifact 1-1B-353 consists of a 110 mm. long quill extending from a folded leaf of *Phragmites* sp. (see fig. 96b). A section of Type III *Apocynum* cordage (1.2 mm. in diameter) is wrapped around the folded leaf base. The cordage is approximately 170 mm. long, and is wrapped four times around the fold.

There are also two specimens of quill wrapped around cordage. Artifact 1-1B-1033 (fig. 100g) is made of three pieces of Type III cordage (1.4 mm. diameter) which are loosely S twisted and encased by a segment of white, flat quill (porcupine?). This quill is tightly coiled around the cordage with six wrappings per cm.; the total artifact measures 64.1 by 3.5 mm.

Artifact 2/32746 (105 by 1.6 mm.) consists of a white quill cross-wrapped around two pieces of Type III cordage. A small section, approximately 15 mm., lacks such quill wrapping.

Two additional artifacts are made of quill and fiber cordage. One is a bundle, slightly Z twisted, measuring 87.3 by 12.9 mm. The second specimen, measuring 223.4 by 5 mm. has an irregular Z twist and is curved into an oval; one half hitch knot joins the quill and fiber elements.

Discussion

Artifacts made from animal and bird skin, often manufactured with additional fiber elements, comprise 17 percent of the total perishable assemblage at Hidden Cave. Unfortunately, the avifaunal and mammalian segments are generally too modified to allow species identification. But based on ethnographic and comparative data, we suggest that these items were commonly made of the skins of hares (*Lepus* sp.), marmots (*Marmota* sp.), and wood rats (*Neotoma* sp.). A wide variety of waterfowl bones were identified from the Hidden Cave deposits (Grayson, chap. 10, this volume), and several of these species could readily have been used for their plumage.

The skin and fur artifacts probably result from the manufacture and storage of fur blankets and clothing. Of the hide strips, roughly half were stripped of fur, the others retained the fur elements. All the strips are twisted, with a preference for Z twisting. This is particularly apparent in Group I, the two-element skin without fur pieces (62 of 64).

The remaining skin and fur artifacts contain some soft elements, occasionally as bundles of fur wrapped with cordage. Rigid artifacts of matted skin and fur are probably composite constructions of twisted skin strips. The presence of quill and feather fragments in the rigid, matted segments also suggests the birdskin covers used in making tule decoys.

Leather and hide artifacts represent 27 percent (92 of 342) of the miscellaneous modified perishables. Most of these artifacts are semiflexible to stiff, single element thongs; only 15 show any twisting modification. Ten leather thongs were tied to fiber cordage to create longer segments with varied tensile

strength. One particularly well-preserved and pliable artifact (1-1B-119) of hide and Type III cordage is over 70 cm. long and only 3 mm. in diameter. Additional modifications on hide thongs include tapered or blunted ends and perforated or notched edges.

Rectangular hide segments (probably artiodactyl) comprise 13 percent of the leather and hide artifacts. The regularly spaced perforations, cordage lacing, and modified edges suggest that these may be parts of moccasins or other clothing.

A few quill and cordage artifacts were also found. Most of these (6 of 8) are long quill sections with cordage attached through loops at the quill base. The other two are segments of cordage obscured by quills cross-wrapping the fibers. Quill and cordage artifacts are reported for the Oregon caves as used in the preparation of projectiles or costumes (Cressman, 1942, p. 77). These pieces are identical in construction with the Hidden Cave artifacts in that the base of a quill is folded back creating a loop for threading cordage.

Bird skin and fiber combinations, seemingly for clothing and ornamentation, have also been found in the western Great Basin. At Humboldt Cave, two bird skin robes were excavated from a so-called shaman's cache pit which also contained abundant modified avifauna and mammalian remains (Heizer and Krieger, 1956, pp. 64–67, 95). Lovelock Cave contained skin blankets of both rabbit and bird (Loud and Harrington, 1929, pp. 50–53; Grosscup, 1960, p. 52); Hanging Rock Cave also contained fragments of what may have been a rabbit skin blanket (Tuohy, 1969a, p. 45). Bird skin strips, probably originally with feathers attached, were associated with juniper seed beads and a strung necklace at Kramer Cave (Hattori, 1982, p. 42). Probable rabbit skin blankets are recorded in the northern and eastern Basin (Cressman, 1942, p. 76; Aikens, 1970, p. 109). Hide and leather artifacts are similarly distributed, with a particular abundance of distinctive moccasin types in the eastern Great Basin (e.g., Hogup Cave: Aikens, 1970, pp. 97–105).

HISTORIC FIBERS

Eight specimens of woven fibers are probably historic remains. Two are fragments of corduroy and wool, one is a 1/2 twill weave, three are 1/1 plain weave, and two are unspecified woven fibers. Two pieces are charred and one is a selvage fragment. None are from excavated proveniences. Sizes range from 6.5–100.0 mm. in length by 2.5–50.0 mm. in width.

QUIDS

More than 300 quids were recovered at Hidden Cave (table 67). A *quid* is generally considered to be the fibrous residue from chewing the leaves, stems, shoots, roots, or stalks of a variety of plants, including yucca, mescal, tule, cactus, maize, grasses, and numerous other common leafy or pulpy plants (Turner, 1967, p. 117).

All identifiable quids from Hidden Cave are *Scirpus* or *Typha.* Other inclusions are feather down, a *Juncus* inflorescence, small and unidentifiable bulbous pods, fragments of *Distichlis* and *Eleocharis.* The quids from Hidden Cave are of a uniform size (averaging 40 mm. by 20 mm.), and several show clear dental impressions.

Quids are particularly common in Strata II and IV, as expected. We systematically saved all quids during the 1979–1980 excavations, and the abundance of quids in the earlier collections suggests that most quids were saved during the earlier excavations as well.

CONCLUDING REMARKS

The wide variety of perishable items at Hidden Cave exhibits all stages of processing of raw materials, from minimally modified fibers to carefully prepared, aesthetic items. The perishable inventory encompasses utilitarian and domestic items as well as pieces that may have been valued for ceremonial purposes and personal ornamentation.

These artifacts demonstrate the potential of lacustrine resources as raw material, and the apparent storage of items underscores the need to insure and extend this resource base for future use and transport.

Basketry, the most diagnostic of perishables, has received considerable attention as a tool for monitoring temporal and spatial continuities and changes in the Great Basin (Rozaire, 1974; Adovasio, 1970, 1974; Hattori, 1982). Although basketry is not over abun-

dant at Hidden Cave, the sample is indeed representative of the various techniques known to occur in the western Basin, especially the twined varieties.

The perishable cordage, netting, and modified fibers are more difficult to interpret and have been relatively neglected in the literature of the western Great Basin. We hope that future research will more equitably balance emphasis across all perishable categories, particularly as concerns the nature of raw materials and the various modifications employed.

CHAPTER 20. CULTURAL FEATURES AT HIDDEN CAVE

DAVID HURST THOMAS

Twenty-six cultural features were excavated during the four decades of research at Hidden Cave. All features are plotted on figure 101, a plan view of the site with grid systems superimposed from the 1940, 1951, and the 1979–1980 excavations. The features have been renumbered for descriptive purposes, but original field numbers are provided below. All artifacts found in feature-fill have been previously described; see chapters 14–19 for details regarding artifact morphology, typology, condition, and material. Items marked (#) were unavailable for study.

CACHE PIT 1 (STORAGE PIT NO. 1 [1940])[1]

LOCATION: E/7/2 (center: E/7-20/2-15)
STRATUM OF ORIGIN: Strata I/II
DEPTH FROM SURFACE TO TOP: 7.6 cm.
DEPTH FROM SURFACE TO BOTTOM: 17.8 cm.
DIMENSIONS: NW–SW, 27.9 cm.; NE–SE, 33.0 cm.
LINING: grass and tule
CONTENTS:
1-1B-162 fine percussion chert biface fragment
1-1B-317 cordage, Type III
1-1B-318 four feathers
1-1B-319 sample of pit fill
1-1b-390 cordage, Type III

[1] We have discovered a minor provenience problem while correlating the 1940 feature records. Wheeler correlated each feature to one of his seven strata (as discussed earlier in this volume); the artifacts contained within each feature should derive from the same stratum, and most were so correlated. But occasionally, Wheeler would assign a feature one stratum, but the artifacts contained therein into a separate stratum. We have found no explanation for this discrepancy in his writings, and do not understand the disparity. To minimize confusion, in this chapter we correlate features and artifacts *exactly as they appear in the 1940 field notes.* Fortunately, only a handful of artifacts were so correlated, and therefore the magnitude of the problem is not great.

CACHE PIT 2 (STORAGE PIT NO. 2 [1940])

LOCATION: E6/3, E6/4, E5/3, E5/4
STRATUM OF ORIGIN: Stratum II
DEPTH FROM SURFACE TO TOP: 18.3 cm.
DEPTH FROM SURFACE TO BOTTOM: 70.1 cm.
DEPTH FROM SURFACE TO UPPER LINING: 39.6 cm.
DIMENSIONS: circular, 58.4 cm. in diameter
LINING: grass, rush, and tule
CONTENTS:
1-1B-373 shell pendant (on display at the Nevada State Museum)
1-1B-374 cordage, Type III
1-1B-375 netting, Group II
1-1B-376 bone fragment (#)
1-1B-377 two feathers
1-1B-382 twist, Type V
1-1B-383 cordage (#)
1-1B-384 twist, Type V
1-1B-385 knot, Group VI (loop)
1-1B-386 knot, Group IV
1-1B-387 obsidian blade element, obliquely flaked
1-1B-388 feather
1-1B-389 feather (#)
1-1B-391 cordage, Type III
1-1B-392 cordage (#)
1-1B-393 three freshwater mussel fragments, unworked
1-1B-394 shell fragments (#)
COMMENTS: This pit appears to have been filled, then relined at a higher level.

CACHE PIT 3 (STORAGE PIT NO. 3 [1940])

LOCATION: E/8/5
STRATUM OF ORIGIN: dug through Stratum II; may be of much more recent date
DEPTH OF PIT FROM SURFACE: 9.1 cm.
DIMENSIONS: N–S, 27.9 cm.; E–W, 35.6 cm.
LINING: matted tule and grass
CONTENTS:
1-1B-359 two pieces of cordage, Type III

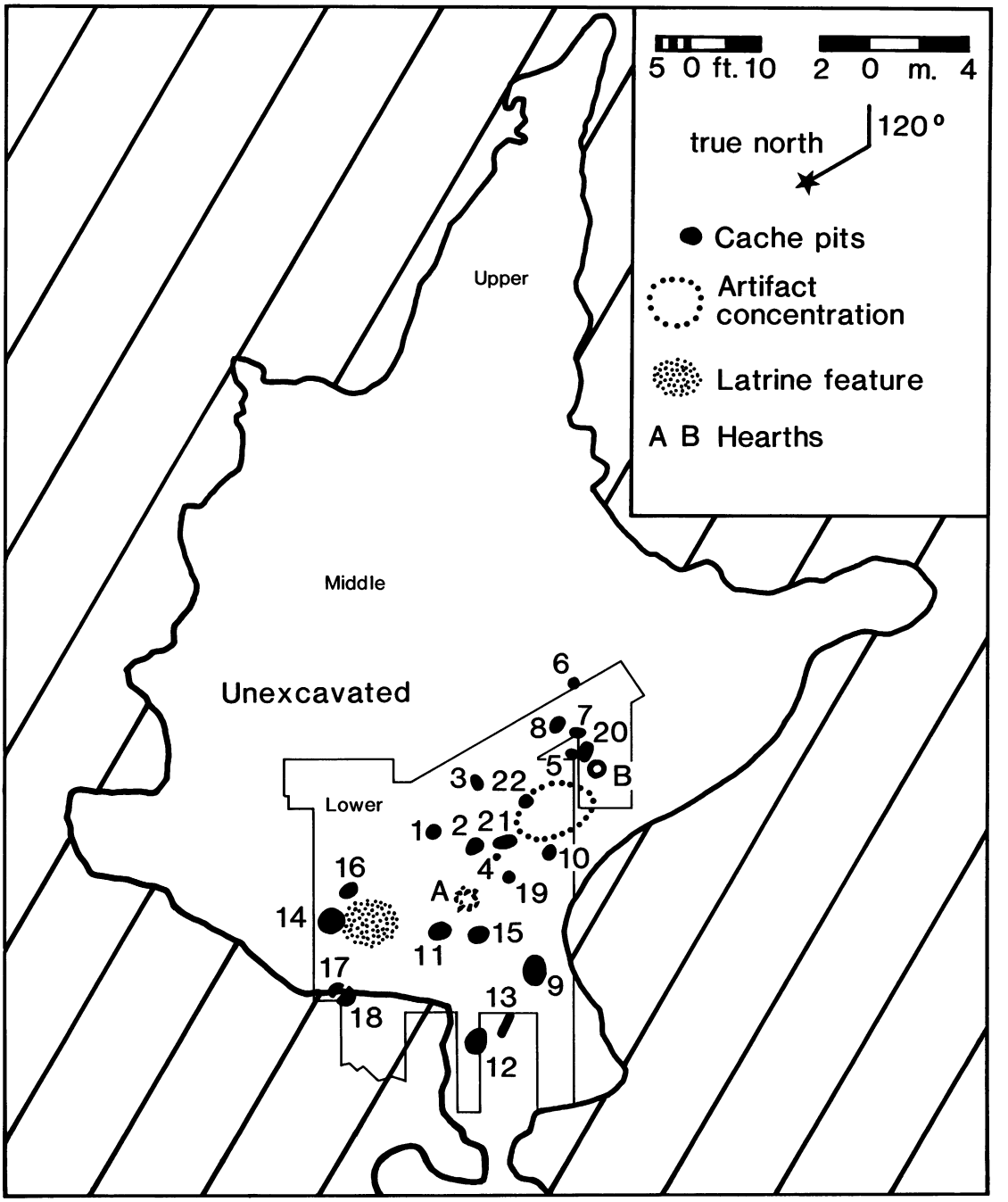

FIG. 101. Location of cultural features in Hidden Cave.

1-1B-360 shell fragment (#)
1-1B-361 two pieces of *Phragmites* (#)
1-1B-362 leather/hide, Group I
1-1B-363 two coprolites (#)
1-1B-364 bone fragment (#)
1-1B-383 twist, Type III

CACHE PIT 4 (STORAGE PIT NO. 4 [1940]; SEE FIG. 102)

LOCATION: E/4/4
STRATUM OF ORIGIN: Stratum II
DEPTH FROM SURFACE TO TOP: 12.9 cm.
DEPTH FROM SURFACE TO TOP LINING: 30.5 cm.
DEPTH FROM SURFACE TO MIDDLE LINING: 45.7 cm.
DEPTH FROM SURFACE TO BOTTOM: 54.9 cm.
DIMENSIONS: circular, 30.5 cm. in diameter.
LININGS: top layer—tule in excellent condition
middle layer—rotten tule
bottom layer—very rotten tule
CONTENTS:
1-1B-419 cordage (#)
1-1B-420 leather thong, Group I
1-1B-421 cordage, Type III
1-1B-422 quill
1-1B-423 sample of upper pit lining
1-1B-424 knot, Group I
1-1B-424a leather/hide, Group I
1-1B-424b leather/hide, Group I
COMMENTS: The lower portion of the pit contained a large rock, with the secondary lining above. Another rock was placed on this second lining; above this was a well-lined pit, of more recent origin (Stratum II).

CACHE PIT 5 (STORAGE PIT NO. 5 [1940])

LOCATION: center of E/7/9
STRATUM OF ORIGIN: unknown, since upper part of pit had been removed by guano miners (note: must be Stratum IV or higher)
DEPTH FROM SURFACE TO TOP: unknown
DEPTH FROM (EXISTING) SURFACE TO BOTTOM: 36.6 cm.
DIMENSIONS: circular, 39.6 cm. in diameter
LINING: grass
CONTENTS:
1-1B-485 notched foreshaft, with sinew wrapping near top
1-1B-486 cordage, Type III
1-1B-487 Type IV cordage
1-1B-488 leather thong, Group I
1-1B-489 twist, Type III

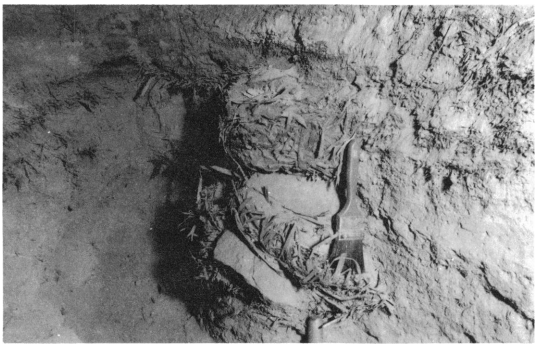

FIG. 102. Cache Pit 4 in cross-section (1940 photograph, west face of E/5/4; courtesy of the Nevada State Museum).

1-1B-490 twist, Type V
1-1B-491 twist, Type V
1-1B-492 cordage (#)
1-1B-493 grass sample
1-1B-494 sample of pit lining
1-1B-495 sample of pit lining
COMMENTS: Bottom of pit penetrated into soft rock of the cave floor.

CACHE PIT 6 (STORAGE PIT NO. 6 [1940])

LOCATION: F/10/1
DEPTH FROM SURFACE TO TOP: unknown
DEPTH FROM SURFACE TO BOTTOM: 12.7 cm.
DIMENSIONS: circular, 45.7 cm. in diameter
LINING: tule
CONTENTS:
1-1B-556 wrapped fiber bundle, Group II
1-1B-557 skin/fur, Group I
1-1B-558 spheroid (marble)
1-1B-559 unidentified bone (#)
1-1B-560 unnotched foreshaft
1-1B-561 knot, Group II
COMMENTS: A shallow pit that did not go through floor No. 2.

CACHE PIT 7 (STORAGE PIT NO. 7 [1940])

LOCATION: E/8/10
STRATUM OF ORIGIN: Stratum II
DEPTH FROM SURFACE TO TOP: 15.2 cm.
DEPTH FROM SURFACE TO BOTTOM: 36.6 cm.

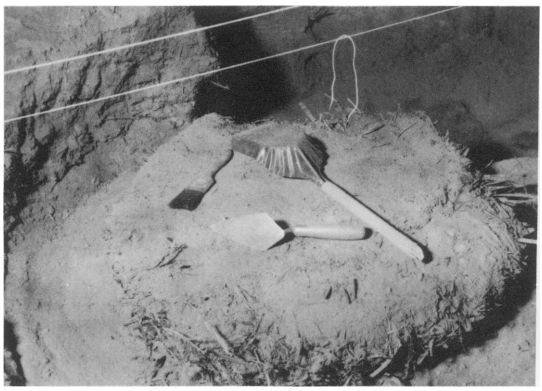

FIG. 103. Unidentified cache pit in Hidden Cave (1940 photograph; courtesy of the Nevada State Museum).

DIMENSIONS: NE–SW, 61 cm.; NW–SE, 40 cm.
LINING: tule and *Phragmites*
CONTENTS:
1-1B-589 cordage (#)
1-1B-590 cordage, Type III
1-1B-591 ground stone tablet, limestone (?)
1-1B-592 skin/fur, Group I

CACHE PIT 8 (STORAGE PIT NO. 8 [1940])

LOCATION: E/8/9
STRATUM OF ORIGIN: Stratum II
DEPTH FROM SURFACE TO TOP: unknown
DEPTH FROM SURFACE TO BOTTOM: unknown
DEPTH OF PIT: 45.7 cm.
DIMENSIONS: N–S, 43 cm.; E–W, 61 cm.
LINING: tule and grass
CONTENTS:
1-1B-622 cordage, Type III
1-1B-647 twining, Type III
1-1B-648 twist, Type V
1-1B-649 knot, Group I
1-1B-650 twist, Type III
1-1B-651 twist, Type V
1-1B-652 twist, Type III
1-1B-653 twist, Type V
1-1B-654 knot, Group I
1-1B-655 unidentified bone (#)
1-1B-656 coprolite (#)
1-1B-657 knot, Group I
1-1B-658 twist, Type V
1-1B-659 cordage, Type III
1-1B-660 cordage, Type III
1-1B-661 unidentified fur (#)
1-1B-662 unidentified fish vertebra (#)
1-1B-663 projectile point fragment (#)
1-1B-665 cordage, Type III

CACHE PIT 9 (FEATURE NO. 5 [1951])

LOCATION: Units K5, L5, and L6
STRATUM OF ORIGIN: Surface Midden (SII)
DIMENSIONS: rounded rectangle, 94.0 cm. by 40.6 cm.
DEPTH FROM SURFACE TO TOP: 5.8 cm.
DEPTH FROM SURFACE TO BOTTOM: 60 cm.
LINING: grass matting
CONTENTS:
2/32456 unmodified grass bundle
2/32457 mano (#)
2/32843 twining, Type III
COMMENTS: Probably cache pit previously covered with double thickness of flat rocks that covers entire pit (top of cover 20.3 cm. below surface).

CACHE PIT 10 (FEATURE NO. 6 [1951])

LOCATION: K9
STRATUM OF ORIGIN: unknown
DEPTH FROM SURFACE TO TOP: 35.6 cm.
DEPTH FROM SURFACE TO BOTTOM: unknown
DIMENSIONS: 61 cm. by 56 cm.
LINING: upper portions lined with *Scirpus* matting; underlying matting has probably disintegrated
CONTENTS:
— mano (#)
2/32461 twining, Type I
2/32462 twining, Type IV
2/32479 twining, Type IV
COMMENTS: Probable cache pit, covered with flat white rocks about 47.5 cm. thick by 38.1 cm. wide; placed at a slant on top of pit.

CACHE PIT 11 (FEATURE NO. 8 [1951])

LOCATION: N6
STRATUM OF ORIGIN: either Surface or 32 Inch Midden (Strata II or IV)
DEPTH FROM SURFACE TO TOP: unknown
DEPTH FROM SURFACE TO BOTTOM: *ca.* 99 cm.

DIMENSIONS: circular, 61 cm. in diameter
LINING: decomposing midden material
CONTENTS:
2/32647 coiled basketry, Type VI
2/32756 coiled basketry, Type VI
COMMENTS: Well-defined cache pit from 32 Inch Midden (Stratum IV), 8 cm. deep, and the exact size of the coiled roasting tray that forms the bottom of the pit.

CACHE PIT 12 (FEATURE NO. 10 [1951])

LOCATION: M3 and M4
STRATUM OF ORIGIN: probably Surface Midden (Stratum II)
DEPTH FROM SURFACE TO TOP: 17.8 cm.
DEPTH FROM SURFACE TO BOTTOM: 64 cm.
DIMENSIONS: hemispherical pit, with cave wall forming the side; maximum diameter, 107 cm.
LINING: largely decomposed *Scirpus* matting
CONTENTS:
2/32579 notched foreshaft (immediately below feature, according to field notes)
2/32584 Gatecliff Split Stem projectile point
2/32585 braid fragment
2/32565 incised bone whistle
2/32566 twining, Type III
2/32567 twist, Type III
2/32568 matting fragment, with cordage (#)
2/32691 twist, Type IV
2/32652 twist, Type V
2/32586 twist, Type III
2/32587 midden sample (#)

CACHE PIT 13 (FEATURE NO. 12 [1951])

LOCATION: L4
STRATUM OF ORIGIN: probably Surface Midden (Stratum II)
DEPTH FROM SURFACE TO TOP: 40.6 cm.
DEPTH FROM SURFACE TO BOTTOM: 40.6 cm.
DIMENSIONS: 12.7 cm. by 66 cm.
LINING: none
CONTENTS:
2/32650 three charred sticks, probably fire drills
COMMENTS: Feature occurs in midden just southeast of Cache Pit 12; apparently a fire drill cache, with large rock placed above one end of the artifacts.

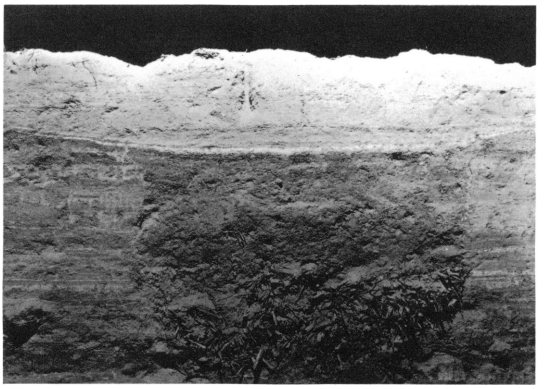

FIG. 104. Cache Pit 14 (1951 Feature 13). Note particularly the tephra lens draped across the top of the pit (courtesy of Gordon Grosscup).

CACHE PIT 14 (FEATURE NO. 13 [1951]; SEE FIG. 104)

LOCATION: P7, P8, Q7, and Q8
STRATUM OF ORIGIN: Surface Midden (pre-1500 B.P.)
DEPTH FROM SURFACE TO TOP: 17.8 cm. by 22.9 cm.
DEPTH FROM SURFACE TO BOTTOM: 64 cm.
DIMENSIONS: circular, 61 cm. in diameter
LINING: bottom contains decomposed *Scirpus*
CONTENTS: none
COMMENTS: This a clearly defined pit, dug from level of Surface Midden; subsequently, tephra settled into the depression. This tephra closely resembles the Turupah Flat Bed (Davis, 1978; chap. 7, this volume), and probably dates about 1500 B.P. Cache Pit 14 was clearly dug prior to that date.

CACHE PIT 15 (FEATURE 102 [1979–1980])

LOCATION: Kappa 7
STRATUM OF ORIGIN: unknown
DIMENSIONS: unknown
CONTENTS: unidentifiable fragments of decomposing tule bag (20.4/579).
COMMENTS: This feature was primarily removed by pothunters prior to the 1979–1980 excavations. The outlines of the tule bag frag-

ments (20.4/579) suggest the former presence of a pit.

CACHE PIT 16 (FEATURE 103 [1979–1980])

LOCATION: Lambda 13/Mu 13
STRATUM OF ORIGIN: Stratum II
DEPTH FROM DATUM TO TOP: 51.71 m.
DEPTH FROM DATUM TO BOTTOM: bottom not exposed
DIMENSIONS: circular, 94 cm. in diameter
LINING: none
CONTENTS:
20.4/866 cordage, Type I
COMMENTS: Fill is probably cave debris that accumulated in an empty cultural feature.

CACHE PIT 17 (FEATURE 105 [1979–1980])

LOCATION: Eta 13
STRATUM OF ORIGIN: Stratum II
DEPTH FROM DATUM TO TOP: 51.69 m.
DEPTH FROM DATUM TO BOTTOM: 52.14 m.
DIMENSIONS: 98 cm. across
LINING: decomposing organic debris
CONTENTS:
20.4/995 cordage, Type III
20.4/996 cordage, Type III
20.4/997 wrapped fiber, Group II
20.4/998 twist, Type V
20.4/999 wrapped sedge
20.4/1000 cordage, Type III
20.4/1001 cordage, Type III
20.4/1002 cordage, Type III
20.4/1003 cordage, Type III
20.4/1014 cordage, Type I
20.4/1015 cordage, Type III
20.4/1016 cordage, Type III
20.4/1017 bone awl fragment (#)
20.4/1021–20.4/1043 hollow reed fragments
COMMENTS: Probably an emptied cache pit.

CACHE PIT 18 (FEATURE 107 [1979–1980])

LOCATION: Eta 13
STRATUM OF ORIGIN: unknown
DEPTH FROM DATUM TO TOP: 51.67 m.
DEPTH FROM DATUM TO BOTTOM: 51.93 m.
DIMENSIONS: unknown
LINING: decomposing organic fill
CONTENTS:
20.4/1013 fur, Group III
20.4/1018 cordage, Type III
20.4/1019 cordage, Type III
20.4/1020 cordage, Type III
20.4/1488 cordage, Type III
COMMENTS: Probably an emptied cache pit. Cache Pit 17 seems to have intruded into Cache Pit 18, destroying much of the latter in the process.

CACHE PIT 19 (FEATURE 109 [1979–1980])

LOCATION: Mu 6
STRATUM OF ORIGIN: Stratum II
DEPTH FROM DATUM TO TOP: 51.33 m.
DEPTH FROM SURFACE TO BOTTOM: 51.68 m.
DIMENSIONS: circular, 30 cm. in diameter
LINING: organic debris, with shell, bones, feathers, and charcoal; rock lined
CONTENTS:
20.4/1259 unnotched atlatl foreshaft
20.4/1260 cordage, Type V
20.4/1261 cordage, Type III
20.4/1262 cordage, Type III
20.4/1263 cordage, Type III
20.4/1264 wrapped bundle
20.4/1265 cordage, Type III
20.4/1266 cordage, Type III
20.4/1267 cordage, Type III
20.4/1268 cordage, Type III
20.4/1269 cordage, Type III
20.4/1270 cordage, Type III
20.4/1271 leather thong, Group I
20.4/1479 miscellaneous fiber construction
COMMENTS: This feature was unrecognized by excavators until part of the upper fill had been removed. Much of the fill seems to be rodent materials, and the contents cannot be taken as indicative of the original fill of this cache pit.

CACHE PIT 20 (FEATURE 113 [1979–1980])

LOCATION: RS 2.7
STRATUM OF ORIGIN: probably Stratum IV
DEPTH FROM DATUM TO TOP: 51.70 m.
DEPTH FROM DATUM TO BOTTOM: 51.74 m.
DIMENSIONS: E–W, 95 cm.; N–S, 75 cm.
CONTENTS:
20.4/1481 knot, Type I
20.4/1482 feature fill
20.4/1483 feature fill
20.4/1484 cordage, Type III
20.4/1485 knot, Type I

20.4/1486 twist, Type V
20.4/1487 leather, Group III
20.4/1488 leather, Group I
20.4/1489 cordage, Type III
20.4/1490 skin/fur, Group I
20.4/1491 skin/fur, Group II
20.4/1492 fur, Group III
20.4/1493 skin/fur, Group II
20.4/1494 cordage, Type III
20.4/1495 cordage, Type III
20.4/1496 cordage, Type III
20.4/1497 net fragment
20.4/1498 cordage, Type III
20.4/1499 netting, Group II
20.4/1500 cordage, Type II
20.4/1544 twist, Type III
20.4/1584 cordage, Type III
20.4/1585 cordage, Type III
20.4/1586 twining, Type II
20.4/1587 large unworked tule (feature fill)

CACHE PIT 21 (FEATURE 114 [1979–1980])

LOCATION: Nu 6
STRATUM OF ORIGIN: Stratum IV (?)
DEPTH FROM DATUM TO TOP: 51.70 m.
DEPTH FROM DATUM TO BOTTOM: 52.09 m.
DIMENSIONS: E–W, 70 cm.; N–S, 30 cm.
LINING: decomposed organic debris
CONTENTS:
20.4/1473 cordage, Type III
20.4/1474 fire drill (?)
20.4/1475 skin/fur, Group IV
20.4/1476 cordage, Type III
20.4/1477 cordage, Type III
20.4/1478 cordage, Type III
COMMENTS: Probably an emptied cache pit.

CACHE PIT 22 (FEATURE 116 [1979–1980])

LOCATION: Pi 5
STRATUM OF ORIGIN: probably Stratum IV
DEPTH FROM DATUM TO TOP: 51.50 m.
DEPTH FROM DATUM TO BOTTOM: 51.65 m.
DIMENSIONS: circular, *ca.* 50 cm. in diameter
LINING: mostly decomposed matting
CONTENTS:
20.4/1712 cordage, Type III
20.4/1713 cordage, Type III
20.4/1714 cordage, Type III
20.4/1715 cordage, Type III
20.4/1716 cordage, Type III
20.4/1717 netting, Group II
20.4/1718 cordage, Type IV
20.4/1719 cordage, Type III
20.4/1720 cordage, Type III
20.4/1721 fur
20.4/1722 skin/fur, Group I
20.4/1723 cordage, Type II
20.4/1724 ring/loop
20.4/1725 skin/fur, Group IV
20.4/1727 wrapped fiber, Group II
20.4/1729 discoidal
20.4/1731 feature fill
20.4/1732 twist, Type V
20.4/1732a wrapped plume, Group III
20.4/1733 feature fill
COMMENTS: Pit fill appears to be stacked into three distinct layers, interspersed by thin inorganic and packrat debris.

LATRINE FEATURE (FEATURE NO. 11 [1951])

LOCATION: P7, with notable extensions into O7 and Q7
STRATUM OF ORIGIN: probably 32 Inch Midden (Stratum IV)
DEPTH FROM SURFACE TO TOP: 59 cm.
DEPTH FROM SURFACE TO BOTTOM: 76 cm.
DIMENSIONS: covers entire 5 ft. excavation square and extends into neighboring units as well
LINING: filled with rocks carried from outside of cave, generally about 25 cm. by about 13 cm.
CONTENTS: "coprolites in profusion" (see Roust, 1966).

ARTIFACT CONCENTRATION 1 (FEATURE NO. 9 [1951])

LOCATION: K10 and K11 (also extends slightly into J10, J11, and L11)
STRATUM OF ORIGIN: subsurface midden (in this area, clearly separated from Surface Midden [Stratum II])
DEPTH FROM SURFACE TO TOP: 13 cm.
DEPTH FROM SURFACE TO BOTTOM: 13 cm.
DIMENSIONS: irregular shape, about 16 cm. by about 107 cm.
LINING: primarily *Scirpus* "bedding"
CONTENTS:
2/32697 or 2/32752 basalt point (cannot correlate)
2/32632(?) bone awl
2/32593 wonderstone (#)

2/32599 ring/loop
2/32757 twining, Type III
2/32756 twist, Type V
2/32598 wrapped fiber, Group I
2/32588 midden sample
2/32574 skin/fur, Groups I and III
2/32571 skin/fur, Group II
2/32578 quids
2/32572 cordage, Type III
2/32575 cordage, Type III
2/32577 knotted tule (#)

COMMENTS: A *de facto* cache?

HEARTH A (FEATURE 108 [1979–1980])

LOCATION: Lambda 7/8
STRATUM OF ORIGIN: Stratum IV
DEPTH FROM DATUM TO TOP: 51.82 m.
DEPTH FROM DATUM TO BOTTOM: 52.26 m.
DIMENSIONS: *ca.* 50 cm. outside diameter; 20 cm. inside diameter
CONTENTS: charcoal dust inside rock circle
COMMENTS: Despite extensive rodent disturbance there is a concentration of small wood chips, charcoal flecks, and a few larger pieces of charcoal.

HEARTH B (FEATURE 115 [1979–1980])

LOCATION: RS 1.7
STRATUM OF ORIGIN: probably Strata II/IV
DEPTH FROM DATUM TO SURFACE: 50.83 m.
DIMENSIONS: N–S, 26 cm.; E–W, 15 cm.
CONTENTS: entire feature collected as Soil Sample No. 203
COMMENTS: Merely a charcoal stain.

CHAPTER 21. ANALYSIS OF HIDDEN CAVE FEATURE MORPHOLOGY

ERIC INGBAR[1]

We analyze the morphology of features within the two midden zones (Strata II and IV) at Hidden Cave in this chapter. Viewed strictly in terms of *contents,* these two strata do not reflect different uses of Hidden Cave. In this chapter and the next, we attempt to examine site function by looking at the differential distribution of items within the two midden strata. We search for differences in the arrangement of items that may reflect differences in the way the site was used.

This is not, however, to suggest that Strata II and IV are in any sense "little Pompeiis" (Binford, 1981) of some aspect of the Devils Gate lifeway. We think it much more probable that Hidden Cave was reused on many different occasions, and that Strata II and IV are composites of multiple occupations.

The present analysis intends to address the history of the use of the site. The proposition that Strata II and IV are the product of multiple visits to the site rather than pristine activity areas, raises two questions: What was the function of Hidden Cave? Was the site always used in the same way?

If the two major strata reflect similar site usage, then regardless of the temporal grain (Binford, 1979) of occupation, one might expect little change in the overall spatial distribution of items within each stratum. One might also expect little difference in the features that originate from each surface. This patterning can be addressed through morphological and spatial analysis.

Addressing site function—how a site was used—is more difficult, requiring that distributional patterns be interpreted, not just compared. Unfortunately, the distributions at Hidden Cave cannot be compared with patterns in other sites because we lack the detailed descriptive data for comparable sites. If, however, we take the structure of features (i.e., cache pits) to be a key indicator of site function for "cache caves," the Hidden Cave features can indeed be compared with features from other Great Basin sites where feature functions may be more confidently estimated.

We concentrate on the nonportable artifacts—features—recognized in Hidden Cave in this chapter. In the next we address similar issues using distributional data from the portable artifacts (chipped stone, bone, shell, and so forth). The results of these analyses are combined at the end of chapter 22.

FEATURES OF FEATURES

Features—constructions or excavations which cannot be moved without destroying their integrity—are literally "site furniture" (Binford, 1977), items that go with a place. Most Great Basin "cache caves" are defined simply by the presence of cache pits. Few investigators have paused to consider what a cache feature looks like, and particularly how they differ from other pit features (see also chap. 2, this volume).

There are, admittedly, times when the direct evidence of caching, such as specific items in pit features, leaves little doubt as to the function of a pit. But at Hidden Cave there is very little direct evidence of this sort: few of the excavated pits still retain the original cached materials. That is, the contents of the Hidden Cave pit features cannot be considered uniquely indicative of their function.

At an intuitive level the interpretation of Hidden Cave as a cache cave is satisfying. But we lack a solid, substantive basis for this interpretation.

One avenue of analysis is to compare the population of features at Hidden Cave with features from other Great Basin sites where feature functions (not necessarily site function) are clearer. How, for instance, do the Hidden Cave pit features compare with features inside cache caves elsewhere in the Great

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Basin? Are there morphological or content signatures that can be used to assign differential functions to cache features in general?

The research strategy of this chapter is to look for overall patterning against which the Hidden Cave features may be arrayed. Using cases where the function of the pit is obvious, a degree of patterning can be postulated, thereby facilitating extrapolation to the Hidden Cave pit features.

PATTERN RECOGNITION IN PIT FEATURES

The most obvious attribute of a pit feature is its shape; there must be some degree of fit between the form of a pit feature and its intended function. Pit morphology is highly variable; there are numerous "types" of pit feature shapes described in the worldwide archaeological and ethnographic literature.

One might, for instance, expect pit volume to vary somewhat, whereas pit form could remain relatively constant. This could result when there is some specific purpose, such as a storage facility, for which a general shape is required, but whose size could vary depending upon the task at hand. The overall morphology of pit features, rather than specific measurements, will be of greatest assistance in sorting out different pit shape patterns. Pit size may, of course, also prove to be functionally important, so it is also necessary to search for patterning in some measure of pit size.

An initial estimate of overall pit shape may be derived by plotting measures of the size of the pit against its shape. An estimate of pit size was derived from the volume of the pit. In this case, the volume of a pit feature was calculated by using the formula for a cone or half-cone, or in a few cases for a half-sphere or rectangular solid (depending upon the shape of the pit).

Measuring shape is more difficult. We decided to use the average width divided by the depth of the pit, as providing a measure of overall pit shape. A perfect hemisphere has a width/depth ratio of 1.00; a pit wider than it is deep has a width/depth ratio greater than 1.00; a pit deeper than it is wide has a width/depth ratio less than 1.00. In other words, large values are for pits that are shallow relative to their depth; small values are for those that are narrow relative to depth.

The Population of Hidden Cave Pit Features

Figure 105 shows the relationship between volume and width/depth ratio for the 15 features from Hidden Cave whose volume, width, and depth could be determined. Note that both variables are plotted on a log scale.

Figure 105 suggests that two groupings of pit features are present in Hidden Cave: a narrow, deep group and a wide, shallow group. For our purposes, we will define the narrow, deep pit features at Hidden Cave as those with a width/depth ratio less than 1.00; the wide, shallow pit features have a width/depth ratio greater than 1.00. The former group has a slightly larger volume than the latter group.

There also may be a linear relationship between pit volume and pit shape. One line may fit to the wide-shallow forms, and another line describes the deep narrow pits.

Distribution of these two pit shapes at Hidden Cave is discussed below. For now, the important point is that there may be more to "cache pits" than simply holes in the ground.

The Regional Population of Pit Features

Based solely on content, the functions of the Hidden Cave pit features are largely unknown (chap. 20). Almost never could primary deposits be said to refer directly to the function of a pit. Most pits seem to have been emptied; hence, based strictly on content, an empty "wide-shallow" pit and an empty "narrow-deep" pit have been assumed to have the same function: caching.

An alternative possibility is that the wide-shallow pits and the deep-narrow pits had different functions or roles in use of the site. Or, equally likely, based upon figure 105, one could suggest that the apparent grouping is spurious, simply the result of small sample size.

By themselves, the Hidden Cave pit features do not describe a consistent pattern. There may or may not be differentiation between wide-shallow pit features (width/depth ratio greater than 1.00) and narrow-deep pit

features (width/depth ratio less than 1.00). Turning to a larger population of features may allow evaluation of the validity of separating wide-shallow pits from deep-narrow ones. We do this by examining data from five additional archaeological sites, selected because they contained several pit features which were sufficiently well preserved to allow reasonably accurate measurements of shape: Lovelock Cave (Loud and Harrington, 1929; Heizer and Napton, 1970), Humboldt Cave (Heizer and Krieger, 1956), Hogup Cave (Aikens, 1970), Sudden Shelter (Jennings, Schroedl, and Holmer, 1980), and Sand Dune Cave (Lindsay et al., 1968).

LOVELOCK CAVE: Eleven pit features are reported in sufficient detail to be useful as control cases. "Typical" pits are discussed in one section of the original report (Loud and Harrington, 1929, pp. 9–17), and several others were measured from the illustrated stratigraphic profiles of various lot walls (1929, figs. 2, 5). Heizer and Napton (1970) do not discuss features found during their re-excavation of the site.

HUMBOLDT CAVE: This site, traditionally considered to be a "cache cave," contained 31 pit features interpreted as cache features by the excavators (Heizer and Krieger, 1956, pp. 91–101). Twenty-five of these are reported in sufficient detail so that volume and width/depth ratios can be computed. Although stratigraphic relationships are unclear, many of the pits contained enough of their original contents to be used as another set of control cases.

HOGUP CAVE: This eastern Great Basin site has been interpreted as both a locus of caching and a residential site (Aikens, 1970; Gunn, 1975). Most features reported for the site are surficial hearths. However, two slab-lined firepits and one pit "full of occupational debris" (Aikens, 1970, p. 26) but unburnt on its edges, provide further control cases. There is one other pit feature of unknown function.

SUDDEN SHELTER: This site in central western Utah contained 100 pit features (Jennings, Schroedl, and Holmer, 1980). Although the stratigraphic relationships are sometimes unclear, the reported data and analyses indicate that several functionally different kinds of pit features are present. Unlined firepits, slab-lined firepits, and "pits of unknown function" (i.e., not containing any evidence of fire) are all reported from the site. Unfortunately, the data are summarized as averages (with standard deviations) by stratigraphic level for each functional type of pit feature. Still, the reported data are useful. Sudden Shelter was probably used as some sort of residential site; it certainly is not a cache cave. If feature form is largely determined by function, then the Sudden Shelter unlined and slab-lined firepits should be useful as control cases. Pit features of unknown function, if they are not long-term cache features, may provide an interesting contrast to the Hidden Cave pit features.

SAND DUNE CAVE: This southeastern Utah site contained 20 slab-lined cists, 10 hearths, five bedding areas, four definite caches, and several "de facto" caches (Lindsay et al., 1968). Sand Dune Cave provides an interesting control case because the site is outside the Great Basin region and because pit feature functions are relatively clear from their contents. Hence, if there are purely mechanical relationships involved in pit morphology and function, the Sand Dune Cave cases should plot similarly to those from the Great Basin proper.

Hidden Cave features are shown plotted with all the other cases in figure 106. Supportive data are provided in table 71.

Figure 106 discloses a considerably more continuous range of variation in pit feature morphology than is apparent in the Hidden Cave features. In general, pits of greatest volume occur toward the deep, narrow end of the morphological spectrum, although the amount of variation is great.

Hidden Cave features fall toward the ends of the feature spectrum, suggesting that Hidden Cave indeed contains two different varieties of pit features. Otherwise, one might expect the distribution of the Hidden Cave features to be more scattered along the continuum.

Additional patterns emerge when the distribution of pit measurements in figure 106 is examined in detail. The Lovelock Cave pit features (points 19 to 29 on fig. 106) fall into the same portion of the graph as the deep-narrow Hidden Cave pit features; wide-shallow pit features are unreported from Lovelock Cave. This could be the result of bias on

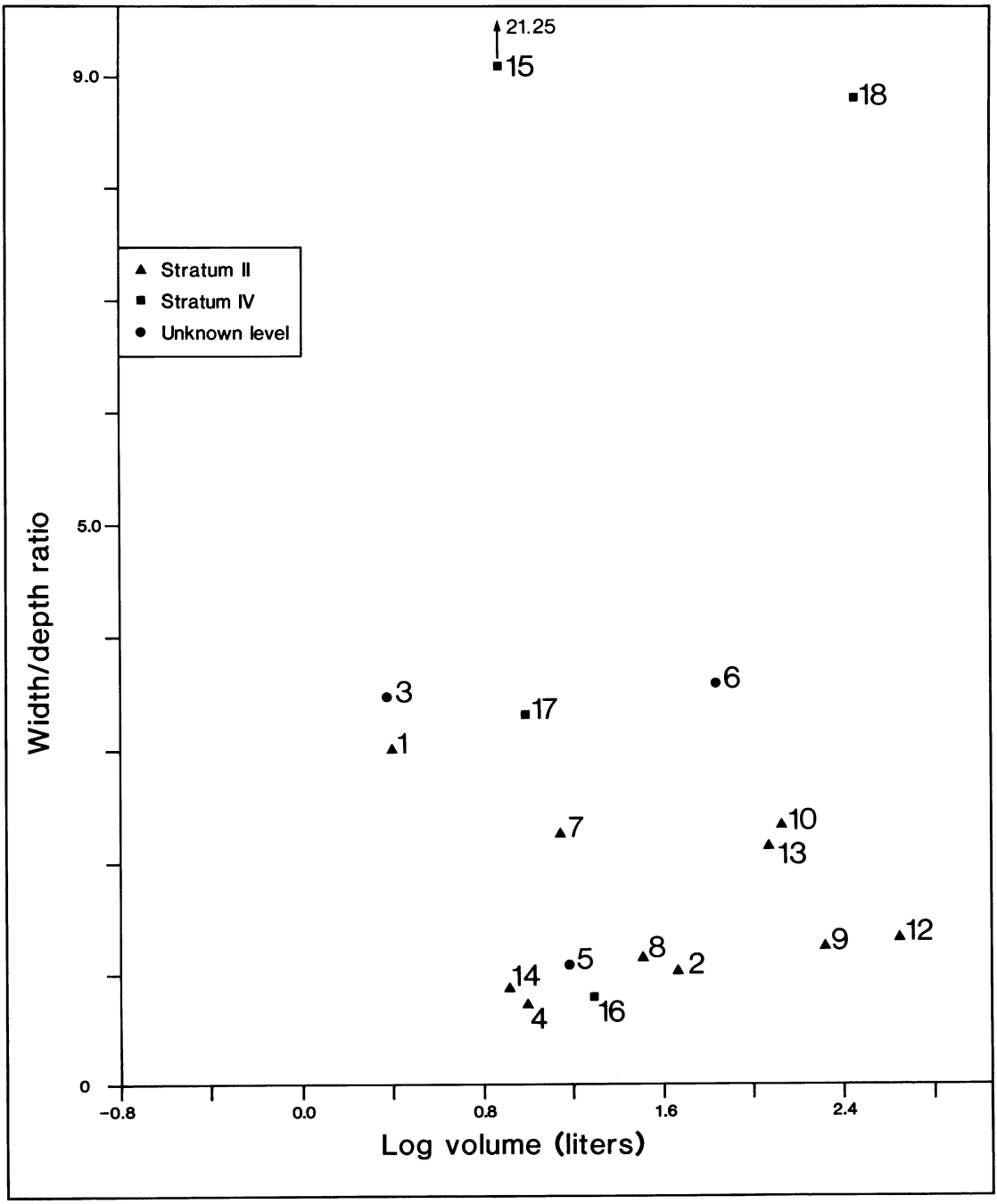

FIG. 105. Scattergram comparing volume (in liters) with width/depth ratios for the features at Hidden Cave. See table 71 for key to the data points.

the part of the excavators, or it could reflect a real difference in the feature populations between Lovelock and Hidden caves. At any rate, there does seem to be considerable sim-

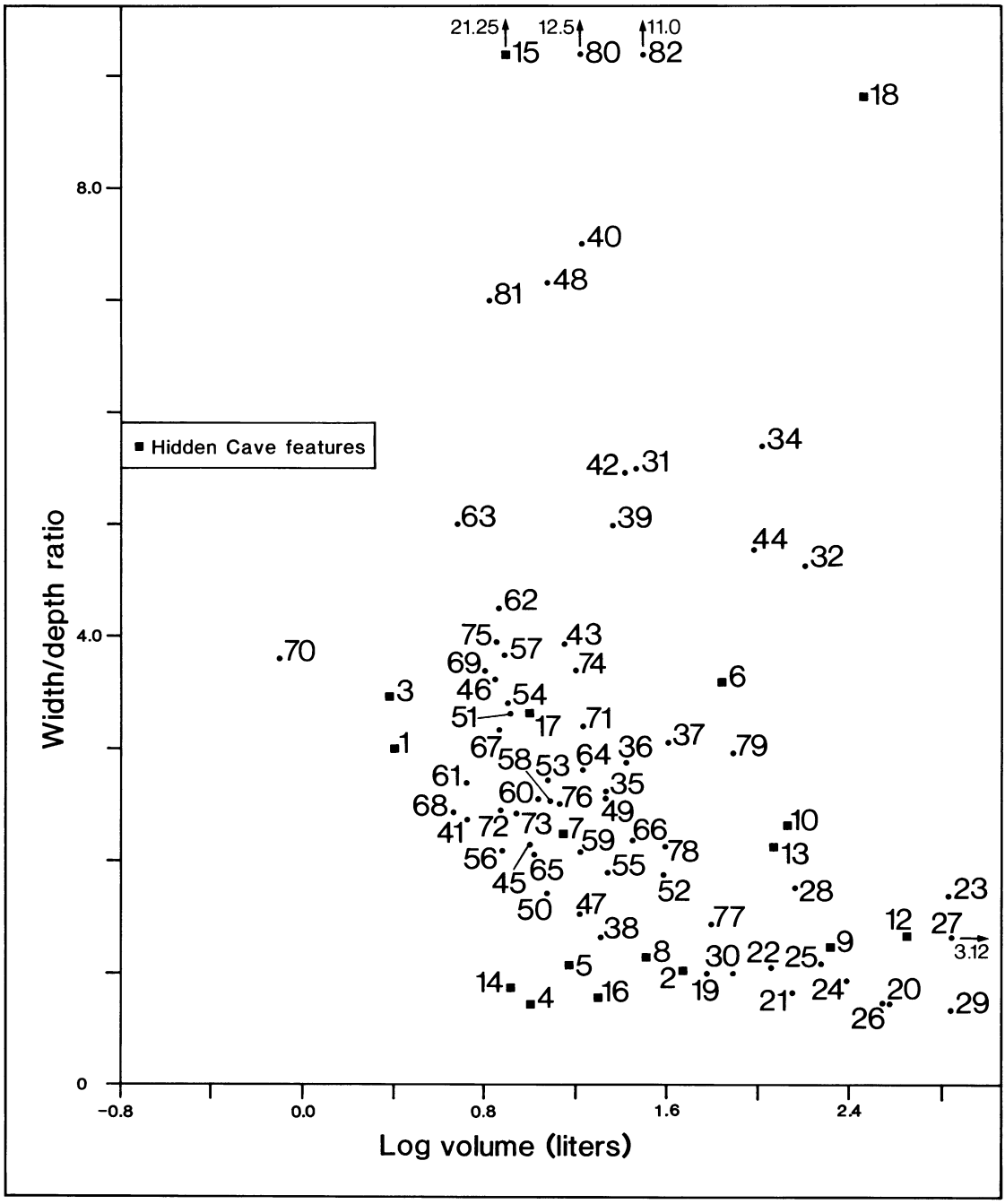

FIG. 106. Scattergram comparing volume (in liters) with width/depth ratios for pit features at six archaeological sites: Hidden Cave, Lovelock Cave, Humboldt Cave, Hogup Cave, Sudden Shelter, and Sand Dune Cave. See table 71 for key to data points.

ilarity in size and shape between the reported Lovelock Cave and Hidden Cave pit features.

Figure 106 indicates that the Humboldt Cave pit features (points 30–44) derive from

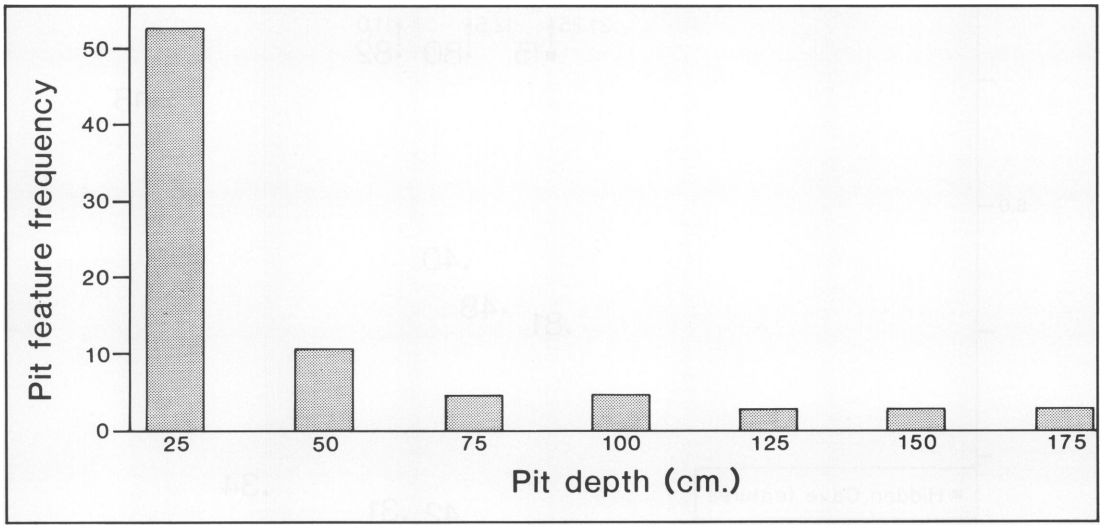

FIG. 107. Histogram plotting pit depth versus feature frequency for data on table 71.

a very different statistical population than the Lovelock and Hidden Cave features. Only two pits (points 30 and 38: Humboldt Cave Caches 2 and 15) fall within the deep-narrow distribution of the Hidden and Lovelock Cave features. At the other end of the distribution, Humboldt Cave has eight pit features which are both wider and shallower than those at Hidden Cave; these eight features also tend to have greater volumes (points 31, 32, 34, 37, 39, 40, 42, and 44). Humboldt Cave also contained four pit features that fall somewhere in the middle in terms of shape and volume (points 35, 36, 41, and 43).

When the Humboldt, Lovelock, and Hidden Cave features are pooled, there seems to be a pattern of continuous variation in pit volume and pit shape, suggesting independence between these two variables. The most cautious interpretation of the distributions discussed so far is that the pit features have a continuous range of variation, with no functional differentiation of different shapes and sizes; the Hidden Cave pit feature population could be seen as distributed into two groups simply by chance or small sample size.

To determine whether wide-shallow and deep-narrow pit features have the same functional uses, one must determine whether pits in the middle of figure 105 could be functionally different from those on the ends of the distributions.

Clearly much variability in pit shape and size is represented at the wide-shallow end of figure 106. To explore the nature of the variables involved, figures 107 and 108 plot the univariate distribution of pit depth and pit diameter.

Two things emerge from these figures. Most pit features in the sample are relatively similar with respect to depth (<50 cm.) and most pit features are narrow (from 30 to 70 cm.). Most of the variability is in the width of the pits rather than depth.

Although this emphasizes the difference between the Hidden Cave pit features and the comparative sample, it does raise the question of the degree to which pit width may be a function of pit depth or pit depth may be a function of pit width. Pit features do not seem to be distributed into wholly discrete classes; they are more normally distributed around a width and depth mean. Separating different types of pits therefore seems dubious.

Pit features from Sudden Shelter, Hogup, and Sand Dune caves tend to fall either in between the two groups of Hidden Cave features or at the very wide-shallow end of the continuum. However, the Sand Dune Cave

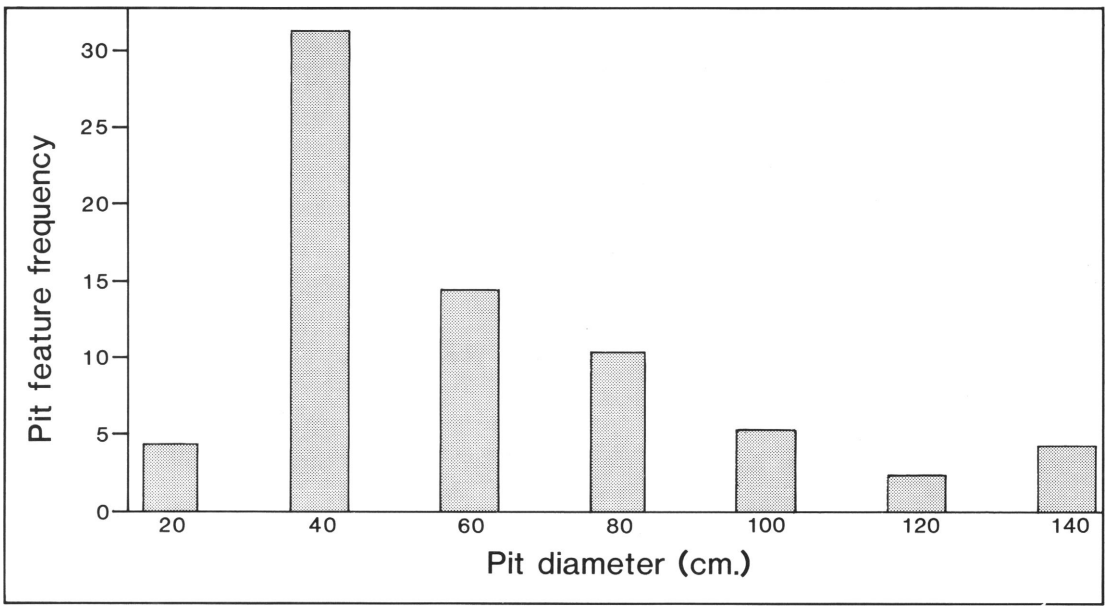

FIG. 108. Histogram plotting pit diameter versus feature frequency for data on table 71.

pit features have a bimodal distribution—some fall partly within the deep-narrow group of Hidden Cave and Lovelock Cave pit features, others are at the extremely wide-shallow end of the distribution.

It seems likely that the features at the other sample sites may represent a feature form distinct from that at Hidden Cave, and that Hidden Cave features, and hence site function, likewise differ from the other sites. Interestingly excavation reports from Hogup Cave, Sudden Shelter, and Sand Dune Cave do not identify the pit features as cache pits. The functional implications of this are explored below.

MORPHOLOGICAL AND FUNCTIONAL PATTERNING IN PIT FEATURES

Both contexts and contents can refer to pit usage; these two aspects may, in turn, be used to address the question of whether pits with diverse functions have distinctive morphologies.

Lovelock Cave may provide a case where pit functions can be directly inferred from either content, or shape and location. In addition, Lovelock Cave appears to have been less rodent-torn than Hidden Cave (see Heizer and Napton 1970, for a similar point of view). More than 45 pit features are reported by Loud and Harrington (1929), although measurements are given for only a few. These measurements all fall into the narrow-deep range of pit features shown on figure 106. Whether shallow pits were not present, or simply missed in excavation, is not known.

Forty-five pit features can further be divided between "storage pits" and "burial pits" (after Loud and Harrington, 1929, pp. 8, 14–17). Some features, such as the duck decoy cache (Pit 12, point 22 on fig. 106) are obviously cache pits. Other features, such as the infant burial in Pit 45 (point 26 on fig. 106) are obviously burial features. Whether a burial pit first had some other function is not always clear, but Loud and Harrington (1929, p. 9), thought that pit features that had been used for storage or caching were unmistakable, even when they had been emptied of their original contents: "Usually these pits had been opened and the contents removed, presumably by the owners. Some showed evidence of having been used a number of times, but in a few cases the owner had never re-

turned to recover his buried store . . . ." In either case, the information from pits features at Lovelock Cave suggest that the deep narrow pits at Hidden Cave may have been used for caching; whether of tools, foodstuffs, or corpses is not clear. Some of the Lovelock Cave burial features (points 23 to 27, fig. 106) appear to be slightly greater in volume than cache features but in general preserve the same width/depth ratio as the cache features and the narrow-deep Hidden Cave pit features.

Narrow-deep features, present in both Hidden and Lovelock caves, seem to have been used for either burial/caching or storage. Based upon the Lovelock pit features, any attempt to separate the Hidden Cave feature population into deep-narrow cache pits and deep-narrow burial pits does not seem warranted. Furthermore, none of the human bone from Hidden Cave was found in definite association with any of the pit features. It may be that rodent and/or carnivore disturbance in Hidden Cave is responsible for the dispersal of human bone from one or more of the pit features, as Loud and Harrington (1929, p. 6) noted at Lovelock Cave:

> even hair and feathers were well preserved unless attacked by insects or, in the case of human remains, by rodents or coyotes (1929, p. 6).
>
> That coyotes had dug up and devoured a number of burials we deduced from stray human bones, many bearing teeth marks, scattered through the deposit and from coyote excreta containing strings of shell beads, doubtless swallowed while feeding on a human body. The condition of a burial found a little over ten feet deep beneath the overhanging rock in Lot 15 at the southwest tip of the cave may be an example of the coyote's work, for only the skull and a few disjointed bones remained (1929, p. 17).

Judging from comments of the excavators and also the contents of pit features, the Humboldt Cave features seem to be mostly caches. But the Humboldt Cave pits are morphologically intermediate between the two groups of Hidden Cave pit features: wider relative to their depth and also smaller in volume than the Lovelock Cave features. In this respect, the features at Humboldt Cave differ from the Lovelock Cave cache or storage features, and by implication from those at Hidden Cave as well.

Contents of the Humboldt Cave pit features also differ from the Lovelock cave features, and there may have been some other form of caching or storage being undertaken in these morphologically dissimilar pit features.

Artifacts found in the pit features at Humboldt Cave with width/depth ratios of 2.00 or more and volumes of less than 100 liters seem to be examples of personal gear (Binford 1977, 1979; see also chap. 2, this volume)—tools which would have had individual owners/users. These include the "fisherman's cache" (point 43, Cache 22 in the original report), and "shaman's cache" (point 36, Cache 13 in the original report), and pits containing worked wood pieces (points 42, 44, Caches 21 and 27-A). Foodstuffs and large items, possibly corporate or household gear, seem to have been cached in deep-narrow pits, which are reported to have contained fishbone (Cache 2, point 30), often in great quantity, as well as some large artifacts. Also, deep-narrow pit features seem to be more frequently found empty than wide-shallow pit features.

This may be the result of more consistent prehistoric recovery of the pit contents. Alternatively, excavators could have failed to recognize shallow pit features, resulting in a systematic bias towards recovery of deep-narrow features. A third alternative is that the sample size used in this study is too small for generalization. The latter proposition is undoubtedly partly true, but there appear to be trends in the Humboldt and Lovelock Cave feature assemblages that are worthy of further investigation.

To this point, we have detected a consistent pattern in the distribution of probable cache or storage features at both Humboldt and Lovelock caves. There is a continuous variation in overall shape and volume; volume tends to decrease with increasing width/depth ratio. This is not a strictly linear function; it may be viewed as a cone with its apex at high volume, low width/depth ratio and sides that slope up to the left. Variability in pit volume and overall shape increases as one moves either into smaller volumes or larger width/depth ratio.

This relationship seems to reverse as width becomes 3.5 times depth (width/depth = 3.5),

so that increasing width/depth ratios result in increases in pit volume. Pit function is loosely associated with this distribution. Deep-narrow features are burial features or true cache storage features used for large amounts of foodstuffs or material and gear that may not have been "personal gear."

Intermediate wide-shallow pits—those with width/depth ratios from 1.5 to 3.5—generally lack the masses of material or foodstuffs; they tend to contain items which may all be part of personal gear kits. In general, these are fairly heterogeneous collections of items that seem intuitively to belong together. These caches of personal gear probably are intentional but are distinct from caches of bulk materials and foodstuffs.

Personal gear is frequently personal property (Binford, 1977; Nelson, in press) and the responsibility for reclamation rests with the individual. Foodstuffs and bulk materials may be corporate property and reclamation is not the responsibility of an individual but that of a group. This may explain why there are more empty deep-narrow caches than empty wide-shallow ones.

How does this shed light upon the Hidden Cave feature assemblage? First, the Hidden Cave features are similar in their morphology to most of the Lovelock Cave features, and to some of the narrow-deep Humboldt Cave features. If the above functional arguments are correct, then the Hidden Cave features were probably corporate caches of either foodstuffs or bulk materials.

However, there are some relatively wide-shallow Hidden Cave features (Cache pits 1, 3, 6, 7, 12, and 22), and we might suspect that these are evidence of some different or ancillary uses of the site.

Pushing this idea a little further, Hidden Cave appears to be more complex than a simple cache cave. To some extent, Hidden Cave shares some aspects of both Lovelock and Humboldt caves, having both personal gear caches *and* corporate caches.

This underscores a point made elsewhere in this volume: the archaeology of Hidden Cave may not be as simple to understand as it appears. Again, it is worth emphasizing that these are not proven truths and are subject to many potential vagaries and biases. The trends discerned in the Humboldt and Lovelock Cave feature assemblages are essentially patterns from which one may generate ideas about the Hidden Cave feature assemblage.

If there are different kinds of pit features used for different kinds of caching or storage, then one would also expect that other kinds of features should be distinctive in overall shape and volume. Indeed, the simple statements made above hinge upon this assertion, for they assume that cache or storage pit features form a distinct morphological class. How, for instance, one can tell a cleaned out firepit from a cache feature?

In other words, it is necessary to show that no other pits with different functions have the same morphological or volumetric attributes as cache or storage features. An examination of Sudden Shelter, Hogup Cave, and Sand Dune Shelter show that there are distinct morphological differences between cache or storage pit features and other kinds of pit features.

Hearths of Sudden Shelter are shown on figure 106 by points 48 to 62. Hearths, as expected, are clearly distinct from any storage or caching pit features from the western Great Basin sites discussed above. They are generally wide and shallow (and in Sudden Shelter have obvious burning around their edges). Looking only at the shape of hearths, as pit features, there does seem to be a strong trend for hearths to be much wider and shallower than cache or storage pit features (width is generally at least twice depth, i.e., width/depth > 2.00). The only possible exception to this is unlined firepits (points 49 to 62). These fall into the middle of the overall volume and shape distribution.

Pits of unknown function from Sudden Shelter also fall into this range, although many are smaller in volume. The uses of these pits may have been related to the firepits, perhaps as ash roasting pits, using embers from the nearby firepits (see Binford, 1983, p. 158):

> In plan view and cross-section they are identical with the firepits except that the average measurements are smaller and some are extremely shallow. . . . The fill of these pits varies between almost pure white ashy fill and dark brown, charcoal-flecked material similar to that found in the firepits. Often it was the smaller shallow pits that had the ash fill. The ash-filled pits are

often located only a few centimeters from firepits and possibly had a complementary function (Jennings, Schroedl, and Holmer, 1980, p. 39).

There are also some volumetric differences between the Lovelock, Humboldt, and Hidden Cave features and the Sudden Shelter firepits. Firepits are not only wider, relative to their depth, they all have volumes less than 100 liters.

Hogup Cave, which had only three features in it, basically mimics the Sudden Shelter feature distribution. The two firepits are similar in shape and volume to those from Sudden Shelter. The one pit feature of unknown function falls close to the distribution of the deeper-narrower Humboldt Cave features, and may be some sort of cache feature.

Sand Dune Cave provides an interesting assemblage of features, for the site is outside the Great Basin region, and most of the deposits derive from a different cultural tradition. If there are functionally conditioned parameters of pit feature shape and volume, then the Sand Dune Cave pit features with known functions should be similar to those from the Great Basin. While it is possible to generalize this relationship only in arid regions, if present it would lend support to the arguments about pit shape in Great Basin sites that we have made above.

A massive deposit of eolian sand filled the site itself, and so stratigraphic relationships and site surfaces were unclear (Lindsay et al., 1968). The materials in the site are Basketmaker and Puebloan. The site contained several different kinds of pit features: slab-lined cists; charcoal filled hearths; ash filled hearths; caches; and bedding areas (see Binford, 1983, p. 164). Slab-lined pit features are usually interpreted as food storage features (Woodbury and Zubrow, 1979, p. 52). Slab lining may have been functional rather than "stylistic," since the slabs would keep the pit from collapsing in the loose sand matrix of the site (Lindsay et al., 1968, p. 40).

Averages, by level, of the slab-lined cists fall within the same range as storage or caching pits from Lovelock Cave and Humboldt Cave. One (point 77) is close to the Lovelock Cave and Hidden Cave deep-narrow pit features. The cists in the next highest level (point 78) are approximately the same volume and overall shape as the wider Lovelock Cave features, and the cists above them (point 79) are the same shape, but much larger in volume, than most of the Humboldt Cave pit features. In general, even with a slab-lining, there does seem to be a certain range of shapes into which storage pits fall. These are probably functional parameters of pit features intended for storage: a deep-narrow pit feature is a more efficient container than a wide-shallow one if material is being "taken out of circulation" for some time.

Six large unlined hearth areas—full of ash upon excavation—were present in Sand Dune Cave (point 80). These are much wider relative to depth than the Sudden Shelter hearths, perhaps belying some different function. Two very small hearths (point 81) contained traces of charcoal and ash. These have a relatively small volume, but once again are wide relative to their depth.

In sum, the Sand Dune Cave hearth features follow the same general shape and volume trends as the Sudden Shelter and Hogup Cave features.

I argued above that some of the wide-shallow Humboldt Cave features may be caches of personal gear. The five bedding areas in Sand Dune Cave (Lindsay et al., 1968, p. 41) may be places where *ad hoc* caching was done, since personal items may often be left around bedding areas (Binford, 1983, p. 164). All five were shallow concave depressions (Lindsay et al., 1968, p. 41). Three were lined with shredded juniper bark, and two were lined with grass. One of the bedding areas had a partial border of rocks. In some settings, we can imagine that these would be mistaken for shallow cache features. One of the bedding areas even had a cache on its margin (Cache 2, discussed below). All are near or against the cave wall with their long axes parallel to it. The width/depth ratios for the bedding areas range from 7 to 15. Volumes of these depressions are fairly large due to their widths and lengths. Other than Cache Pit 2 no material was found in direct association with these bedding areas.

If Binford is correct, then there may be another form of cache feature, the shallow bedding area, where personal gear was "scuttled" (Binford, 1976)—left to become part of the site furniture. The *ad hoc* caches are dis-

tinct from more formal pit storage features, both in terms of their overall shape and size, as observable archaeologically, and in the conditions from which they result. The *ad hoc* bedding area caches that result from the residential use (for an unknown length of time) of a site are very different from the purposive deep and narrow pit features in sites like Hidden Cave, where material was not necessarily left as site furniture but was actually stored.

Sand Dune Cave contains three "caches" that appear to be *ad hoc* gear caches; one of these is associated with a bedding area. All three caches are near the cave wall, apparently left on the surface of the site and covered by later deposition. At least two caches are personal gear kits. Cache 1 consisted of three dogskin bags with personal gear in them—18 projectile points, gaming sticks, mineral lumps, bone tools, and feathers (Lindsay et al., 1968, p. 42). Cache 2 was a similar collection of gear, but not as well preserved. Cache 3 consisted of two mountain sheep horn fiber scrapers and two large bundles of basketry splints. Cache 4 consisted of two whole pots, left side by side, and then covered over with sand.

There were also several possible features that may result from "scuttling" caches of personal gear for future use on revisitation to the site:

> Small and worn-out artifacts were scattered, sometimes thickly, throughout most of the cave deposits, and warrant no further discussion than that supplied in the following artifact descriptions. However, several objects, judging by their pristine condition, careful wrapping, or complex nature, were probably not lost or discarded, but possibly cached. They are not given formal designations as caches because they were not found in close association with other artifacts. In no instance was any evidence of a pit found with these objects, but most are small enough that a very shallow hole would have sufficed to hide them, or they could have become quickly covered by sand and trash if left on the surface (Lindsay et al., 1968, p. 43).

CONCLUSIONS

Two major points can be made regarding the Hidden Cave pit features. First, we see that on a comparative basis the Hidden Cave feature assemblage falls near the deep-narrow end of a continuum of pit feature shapes. Hidden Cave shares this end of the continuum with several pit features from Lovelock Cave. Humboldt Cave, usually considered another of the western Great Basin cache caves, has generally wider and shallower pit features than Hidden Cave and Lovelock Cave. Two other Great Basin sites, Hogup Cave and Sudden Shelter, not generally considered to be "cache caves," have rather different feature assemblages—generally wider relative to depth than even the pits at Humboldt Cave. Thus, based purely upon some rather crude morphological indices, there seems to be a trend in pit shape and volume.

Secondly, morphological trends in pit features seem to have some functional causes. At least morphology can be tentatively linked to pit features of various functions.

We can recognize at least three kinds of cache features:

1. deep-narrow features with fairly high volumes: may be used for the storage of corporate equipment or bulk materials and foodstuffs, and sometimes burials;

2. somewhat wider-shallower pit features: used for the caching or storage of personal gear kits;

3. very shallow pit features (or the complete absence of a pit at all): where *ad hoc* scuttling caches (often of personal gear, perhaps as site furniture) were made. These may be associated with a bedding area, or just set in any convenient place.

Other kinds of features are morphologically distinct from caches. *Firepits* (either charcoal hearths or ash roasting features) are generally wider and shallower than all but the *ad hoc* gear caches; they are also smaller in volume. *Bedding areas* are wider and shallower than almost any other pit feature type.

Although this sample hardly exhausts the range of pit feature function, the general trends can be explored in the Hidden Cave feature assemblage.

Hidden Cave contains two types of cache features. One form is *the deep-narrow, relatively high-volume pit feature;* we think these were used to store corporate gear or bulk foodstuffs and materials. One such feature (Cache pit 21) occurs in Stratum IV. In Stratum II, these features are well-represented (Cache pits 2, 4, 8, 9, 14, and 16). Cache pit

TABLE 71
Pit Features From Selected Great Basin Sites

No.	Designation	Width (cm.)	Length (cm.)	Average Width (cm.)	Depth (cm.)	Log Volume (liters)	Width/ Depth	Contents
HIDDEN CAVE								
1	Cache pit 1	—	—	27.9	10.0	0.40	3.00	
2	Cache pit 2	—	—	58.4	51.8	1.67	1.13	
3	Cache pit 3	—	—	31.7	9.1	0.38	3.49	
4	Cache pit 4	—	—	30.5	41.1	1.00	0.74	
5	Cache pit 5	—	—	39.6	36.6	1.18	1.08	
6	Cache pit 6	—	—	45.7	12.7	1.84	3.60	
7	Cache pit 7	—	—	50.0	21.4	1.15	2.34	
8	Cache pit 8	—	—	52.0	45.7	1.51	1.14	
9	Cache pit 9	94.0	40.6	66.6	54.2	2.32	1.24	
	Cache pit 10	61.0	56.0	58.5	—	—	—	
	Cache pit 11	—	—	—	—	—	—	
10	Cache pit 12	—	—	107.0	46.2	2.13	2.32	
	Cache pit 13	cache of fire making equipment under rock						
12	Cache pit 14	—	—	61.0	46.2	2.65	1.32	pothunted
	Cache pit 15	—	—	—	—	—	—	
	Cache pit 16	—	—	94.0	—	—	—	
13	Cache pit 17	—	—	98.0	45.0	2.07	2.12	
	Cache pit 18	—	—	—	26.0	—	—	
14	Cache pit 19	—	—	30.0	35.0	0.92	0.86	
15	Cache pit 20	95.0	75.0	85.0	4.0	0.88	21.25	
16	Cache pit 21	70.0	30.0	50.0	39.0	1.30	0.78	
17	Cache pit 22	—	—	50.0	15.0	0.99	3.33	
18	Latrine feature			150 min.	17.0	2.46	8.82	
LOVELOCK CAVE								
19	Pit 4	—	—	61.0	61.0	1.77	1.00	reused twice
20	Pit 9	—	—	top 81.2 bottom 101.6	142.0	2.58	0.71	
21	Pit 10	—	—	76.2	94.0	2.15	0.81	reused twice stone-lined
22	Pit 12	—	—	76.2	74.0	2.05	1.03	duck decoy cache
23	Pit 20	—	—	76.2	45.7	2.84	1.67	child burial
24	Pit 35	—	—	96.5	102.0	2.39	0.95	adult male burial, possibly a storage pit
25	Pit 36	—	—	91.4	84.0	2.26	1.09	infant burial
26	Pit 45	121.0	50.8	85.9	121.0	2.57	0.74	infant burial
27	Pit 46	182.0	121.0	151.0	121.0	3.12	1.25	adult male burial
28	see note *a*	—	—	99.1	55.0	2.16	1.77	
29	Pit 38	—	—	121.9	183.0	2.85	0.66	burial pit?
HUMBOLDT CAVE								
30	Cache 2	—	—	66.0	66.0[b]	1.88	1.00	feather bundle, fish bones
31	Cache 5-A	91.4	76.2	83.8	15.2[b]	1.45	5.51	"False cache"
32	Cache 5-B	157.5	124.4	141.0	30.5[b]	2.20	4.62	galena, etc.
	Cache 6	—	—	76.2	—	—	—	100+ fish
33	Cache 7	228.6	76.2	note *c*	101.6	3.24	—	largest in site, over 600 items
34	Cache 9	139.7	121.9	130.8	22.8[b]	2.01	5.74	emptied
35	Cache 12	73.7	45.7	59.7	22.9	1.33	2.61	emptied(?)

TABLE 71—(*Continued*)

No.	Designation	Width (cm.)	Length (cm.)	Average Width (cm.)	Depth (cm.)	Log Volume (liters)	Width/ Depth	Contents
36	Cache 13	—	—	66.0	22.9	1.42	2.88	"shaman's cache"
37	Cache 14	101.6	53.3	77.5	25.4	1.60	3.05	emptied
38	Cache 15	55.9	38.1	47.0	35.7	1.31	1.32	emptied
39	Cache 16	86.4	66.0	76.18	15.24	1.36	5.00	emptied
40	Cache 17	91.44	66.0	78.7	10.2	1.22	7.72	emptied
41	Cache 20	40.6	33.0	36.2	15.2	0.72	2.38	3 mt. sheep sickles
42	Cache 21	83.8	76.2	80.0	15.2	1.41	5.26	fire drill
43	Cache 22	81.3	38.1	59.7	15.2	1.15	3.93	"fisherman's cache"
44	Cache 27-A	137.2	101.6	119.4	25.4	1.98	4.70	worked wood
HOGUP CAVE								
45	—	—	—	43.2	20.32	1.00	2.13	slab-lined firepit
46	—	—	—	45.7	12.7	0.84	3.60	slab-lined firepit
47	—	—	—	45.7	30.5	1.22	1.50	"full of occupational debris"
SUDDEN SHELTER[d]								
48	Surface hearths (all)			48.0 (22.0)	6.70 (4.20)	1.07 (3.98)	7.16 $n = 16$	
49	Stratum 21	—	—	46.0 (13.0)	18.0 (54.0)	1.33 (1.25)	2.56 $n = 3$	firepits
50	Stratum 18	—	—	34.0	20.0	1.07	1.70	firepit
51	Stratum 17	—	—	36.5 (7.8)	11.0 (4.2)	0.91 (0.83)	3.32 $n = 2$	firepits
52	Stratum 16	—	—	55.7 (2.7)	30.0 (7.0)	1.59 (0.96)	1.86 $n = 3$	firepits
53	Stratum 15	—	—	40.2 (8.8)	14.7 (10.0)	1.07 (0.64)	2.73 $n = 5$	firepits
54	Stratum 14	—	—	34.6 (10.7)	11.4 (4.0)	0.90 (0.71)	3.04 $n = 5$	firepits
55	Stratum 13	—	—	41.3 (7.6)	21.7 (12.4)	1.34 (1.33)	1.90 $n = 3$	firepits
56	Stratum 11	—	—	33.4 (10.1)	16.0 (18.1)	0.87 (0.27)	2.09 $n = 4$	firepits
57	Stratum 9	—	—	38.5	10.0	0.88	3.85	firepit
58	Stratum 7	—	—	38.7 (8.5)	15.3 (5.7)	1.09 (0.86)	2.53 $n = 47$	firepits
59	Stratum 6	—	—	39.7 (6.4)	19.0 (8.0)	1.22 (1.03)	2.09 $n = 4$	firepits
60	Stratum 5	—	—	36.6 (7.9)	14.3 (8.4)	1.04 (0.99)	2.56 $n = 21$	firepits
61	Stratum 4	—	—	29.7 (7.4)	11.0 (1.0)	0.72 (0.52)	2.70 $n = 3$	firepits
62	Stratum 3	—	—	38.3 (12.7)	9.0 (1.0)	0.86 (0.68)	4.26 $n = 3$	firepits
63	Stratum 21	—	—	40.0	8.0	0.68	5.00	unknown function
64	Stratum 20	—	—	45.0	16.0	1.23	2.81	unknown function
65	Stratum 18	—	—	35.0	17.0	1.01	2.06	unknown function
66	Stratum 16	—	—	49.0 (15.6)	22.5 (0.7)	1.45 (1.23)	2.18 $n = 2$	unknown function
67	Stratum 15	—	—	35.0 (14.1)	11.0 (1.4)	0.86 (0.67)	3.18 $n = 2$	unknown function
68	Stratum 14	—	—	22.1 (12.1)	9.1 (7.0)	0.66 (0.78)	2.43 $n = 7$	unknown function

TABLE 71—(*Continued*)

No.	Designation	Width (cm.)	Length (cm.)	Average Width (cm.)	Depth (cm.)	Log Volume (liters)	Width/ Depth	Contents
69	Stratum 13	—	—	34.0	9.2	0.80	3.70	unknown function
				(16.4)	(4.8)	(0.88)	$n = 5$	
70	Stratum 11	—	—	19.0	5.0	−0.10	3.80	unknown function
				(1.1)	(1.0)	(−0.74)	$n = 3$	
71	Stratum 8	—	—	48.0	15.0	1.23	3.20	unknown function
72	Stratum 7	—	—	30.8	12.7	0.87	2.43	unknown function
				(10.2)	(7.8)	(0.84)	$n = 10$	
73	Stratum 5	—	—	31.1	13.3	0.94	2.34	unknown function
				(10.2)	(7.7)	(0.95)	$n = 13$	
74	Stratum 4	—	—	43.0	14.0	1.20	3.07	unknown function
				(18.4)	(2.8)	(1.16)	$n = 2$	
75	Stratum 3	—	—	35.7	9.0	0.85	3.97	unknown function
				(8.7)	(4.0)	(0.74)		
76	Stratum 16	—	—	50.0	20.0	1.12	2.50	unknown function
SAND DUNE CAVE[c]								
77	Desha levels	—	—	70.0	48.0	1.79	1.46	slab-lined cists
							$n = 5$	
78	lower Stratum V	—		68.0	32.0	1.59	2.13	slab-lined cists
							$n = 9$	
79	middle Stratum V	—	—	95.0	33.0	1.89	2.88	slab-lined cists
							$n = 6$	
80	Stratum V	—	—	100.0	7.0	1.20	12.50	unlined hearths
							$n = 6$	
81	Stratum II	—	—	35.0	4.0	0.81	8.75	charcoal hearths
							$n = 2$	
82	Stratum V	—	—	75.0	7.0	1.48	11.0	bedding areas
							$n = 5$	

[a] No pit number; taken from Lot 12 section (Loud and Harrington, 1929, p. 7, fig. 2).

[b] Measurement not given in text, estimated from photograph.

[c] Average width not taken because of large variance; not plotted.

[d] Reported as averages; population size and standard deviations are in parentheses underneath. Features without standard deviations shown are single occurrences.

[e] Reported as ranges; average values are used here.

5, with no level of origin, is also deep and narrow. Thus eight of the 18 pit features for which volume and width/depth ratios can be determined are narrow relative to their depth.

The second major form of pit feature in Hidden Cave is wide relative to depth; these may be caches of personal gear. These features are not *ad hoc* caches, for the pits generally are lined or contain fragments of a lining. This kind of feature occurs in both Stratum IV (Cache pits 12 and 22) and also in Stratum II (Cache pits 1, 7, 10, and 17). The latrine feature in Stratum IV is also a pit feature, but because this configuration is unique, it has little comparative value at present. Cache pit 13 from Stratum II also belongs to this category because placing a gear kit (firemaking apparatus) under a large rock is nearly equivalent to placing it in a prepared pit. Features with no level of origin which are in this class are Cache pits 3 and 6.

Most of the Hidden Cave features seem to be caches of personal gear, in both of the midden strata. Few of the Hidden Cave features are extremely narrow relative to their depth. But there are some in both major strata,

and it may be that some foodstuffs or bulk materials were being cached.

This suggests that the overall use of the site, during the periods of time represented by Strata II and IV, was as a cache location used by individuals for storage of their own gear or materials. There may perhaps also have been a concurrent usage for storage of bulk goods as a kind of corporate feature. This suggests a picture of sporadic usage of the site by individuals for their own purposes. Refining this picture through studies of the horizontal distribution of items is attempted in the next chapter.

CHAPTER 22. SPATIAL ANALYSIS OF HIDDEN CAVE

ERIC INGBAR

Analysis of pit features from Hidden Cave (chap. 21) suggests that a major site function was as a gear cache, perhaps by individuals. We now examine the intrasite distribution of both features and artifacts.

Unlike the previous morphological study, the spatial analysis seeks to explore overall patterning rather than to discern specific events. Despite the exceptional stratigraphy in Hidden Cave, the degree of resolution of any specific event is probably low. During deposition of Strata II and IV the site surface was without question exposed long enough for many different visitations to have been made to the cave (see chaps. 7 and 9). Rodent disturbance also blurs the distribution of items from single events; differential excavation techniques will do the same thing. Attempting to discern specific events at Hidden Cave may yield tantalizing but potentially misleading results. Instead, we concentrate on overall intrasite spatial patterning in the site.

Hidden Cave presents an enigma: this well-preserved (if rodent churned) deposit contains more than a dozen empty pit features, but scattered nearby are hundreds of whole, serviceable artifacts. The initial task is to determine whether an association between certain shapes of pit features and certain kinds of artifacts exists. If so, did these artifacts derive from disturbed caches?

Determining whether or not the Hidden Cave artifact assemblage resulted from caching behavior will greatly influence how this site is interpreted as one node in a subsistence and settlement system.

METHODS

Rodents have ravaged the deposits of Hidden Cave for millennia, and for four decades this site was explored by an interesting variety of excavation strategies. Given this background, we believe that use of extremely fine-grained spatial analytical techniques such as nearest neighbor or dimensional analysis (Whallon, 1973, 1974) is grossly inappropriate. These techniques depend upon either point-plotted information or numerous small contiguous grids; neither condition is met at Hidden Cave.

Instead, a graphic device for pattern inspection is more appropriate. Density isopleths or trend surface analysis allows graphic inspection of general patterns on an idealized surface on which high densities appear as peaks (Camilli, 1979; Enloe, 1983; Hodder and Orton, 1976; Winter and Stiger, 1982). This simple technique can also be applied at different levels of sensitivity by changing the density levels used for the contour intervals.

Analysis has been conducted by tabulating artifacts for each square meter within the cave, using the American Museum of Natural History metric grid system as the areal unit of calculation. All artifacts recovered in the 1979–1980 excavations were included, since these items had been piece-plotted whenever possible. The artifacts recovered in 1940 are readily converted to the AMNH grid since most items were also piece-plotted. Even the grid-provenienced items came from 3-ft. squares (as discussed in chap. 6), and these were assigned to the AMNH square that encompassed the greater part of the 1940 unit. Wheeler grids which crosscut several AMNH units were excluded from the tabulations. Most artifacts recovered in 1940 were tabulated by stratum, using the strata designations listed in this report. The Wheeler items were converted to the AMNH strata according to the correlations discussed in chapter 8.

Roust and Grosscup artifacts are unfortunately excluded from this analysis because the smallest provenience unit in the 1951 excavation was the 5-ft. square.

Throughout the spatial analysis, we will find it convenient to refer to generalized areas within Hidden Cave, e.g., "the alcove," the "central block," the "entrance," and so forth. For clarity, figure 109 sets out these informal terms.

Spatial analysis began by plotting density distribution maps according to artifact type, grid location, and vertical stratigraphic provenience. Analysis proceeded by computing and plotting density isopleth overlays at

varying contour intervals. Such maps were generated for both individual artifact types and also for composite assemblages.

Using these maps, spatial patterning could then be evaluated by eye. The distribution patterns tend to be sufficiently distinct so that differences are readily discernible.

Although this method worked well, we needed to expand the technique in order to plot artifacts found in Stratum III context during the 1979–1980 field season. Most of these artifacts occurred in rodent disturbed contexts and should be of assistance in evaluating the overall degree of rodent disturbance. In most cases excavation notes and crew chief logs estimated how much of a unit was krotovina-fill or disturbed. By analyzing these field notes, it was possible to sort out items that probably derived from Stratum II or Stratum IV but were subsequently deposited in disturbed contexts. Items found in geological units immediately adjacent to Stratum IV were included in the Stratum IV tabulations (GU 33 to GU 40). Items found in the GUs immediately adjacent to Stratum II were lumped into Stratum II (comprising GU 42 to GU 50). Items found in highly disturbed contexts—that is, levels with major facies designations of "K," as in "K(CII/CIII)"—were excluded from the tabulations.

Although this solution is hardly ideal, the procedure permits us to plot the maximum number of artifacts while retaining reasonable control of vertical provenience. This technique also underscores the fact that we were seeking general distributional patterning rather than evidence of specific events.

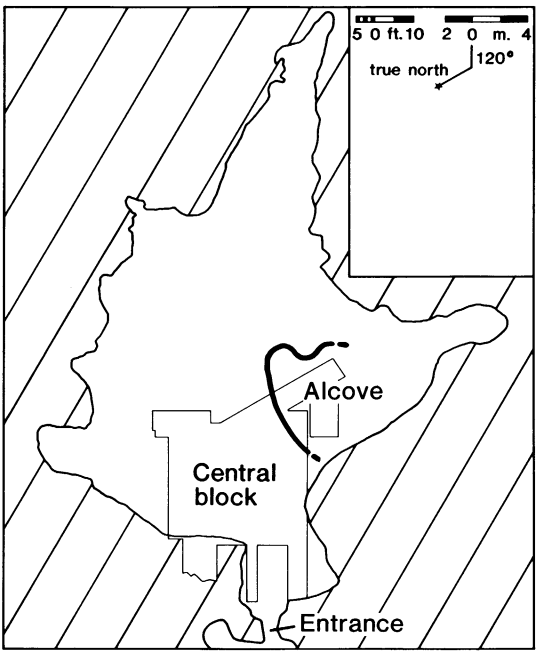

FIG. 109. Informal designations used in spatial analysis of Hidden Cave.

SPATIAL DISTRIBUTIONS WITHIN STRATUM IV

Figures 110 and 111 plot the artifact distributions within Stratum IV at Hidden Cave. Figure 110 represents the pooled distribution of all major artifact categories: projectile points, flakes, worked wood and bone, beads, and cordage.

These items are distributed with four apparent peaks during Stratum IV times. Unit Tau 5, in the alcove part of the site, contains the steepest peak; more than 40 items per sq. m. occur in one place, and a pattern of more than 20 items per sq. m. extends over at least 4 sq. m. A second peak, in Mu 13, is a sharp single spike caused by the 35 beads found together in this unit. Another concentration occurs in Pi 8, again largely confined to a single square meter. A slight peak is centered on Kappa 6.

Positioning of density peaks across Stratum IV partly results from artifact classes with inflated counts—reflecting the clumped distribution of items such as beads which usually show up in clustered fashion.

But such anomalies do not explain the overall item distribution. The alcove area has the densest concentration of materials. Moving to the northwest, the density of material breaks before reaching a diffuse scatter of materials at site center. This distributional break corresponds to a change in surface slope between the elevated alcove portion and the lower central portion of Hidden Cave. A pronounced lip divides the site at this point, resulting from a tufa layer that crops out on the cave floor. The central part of the site, north of the alcove and to the south of the AMNH

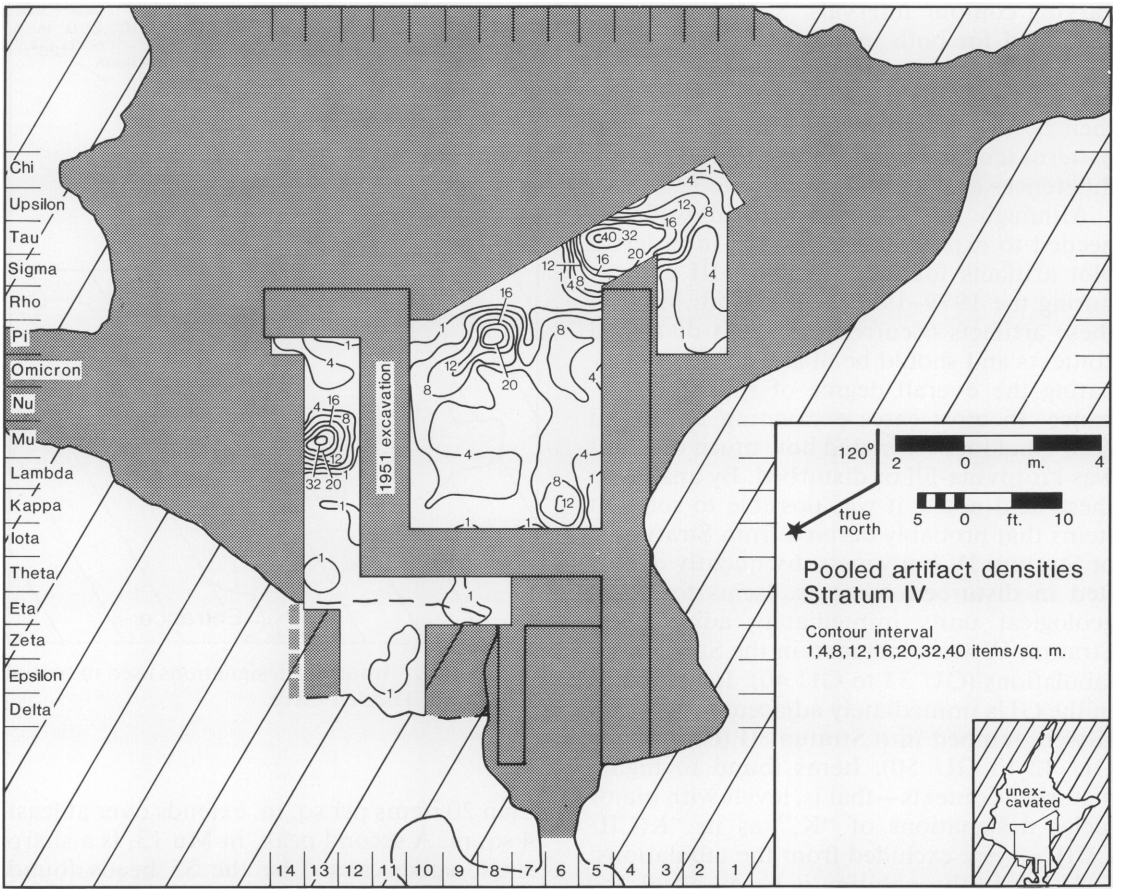

FIG. 110. Pooled artifact density distribution (items/sq. m.) for Stratum IV at Hidden Cave.

11-grid line, has a diffuse scatter of several kinds of artifacts.

The shape of this distribution may be partly artificial since the artifacts recovered in 1951 could not be plotted. The 1951-Trench P has a slightly more dense artifact distribution in Stratum IV, but this is difficult to assess. The Roust and Grosscup field notes and catalog suggest that densities in their adjacent Trench 6 and Trench K were similar to those in the central block.

Few items in Theta 13, Zeta-Epsilon 11, and Eta 9 are probably true isolates, since AMNH excavations revealed no items in the squares adjacent to these units.

Overall artifact distribution in Stratum IV can be more closely examined by looking at specific artifact classes. Figure 111A presents the distribution of whole and fragmentary projectile points which are restricted to the central part of Hidden Cave. Points were totally absent from the alcove area.

Flakes, plotted by grid on figure 111A, are likewise restricted to the central part of the site, and seem to be slightly more frequent within the western portion of the AMNH central block.

Distribution of worked wood (fig. 111B) coincides in part with the peak in projectile point density, although worked wood occurs in great concentration in the alcove area. Worked bone distribution (also plotted on fig. 111B), also coincides with the higher density area of projectile points in the northeast corner of the central block at Hidden Cave.

Shell and berry beads are concentrated in

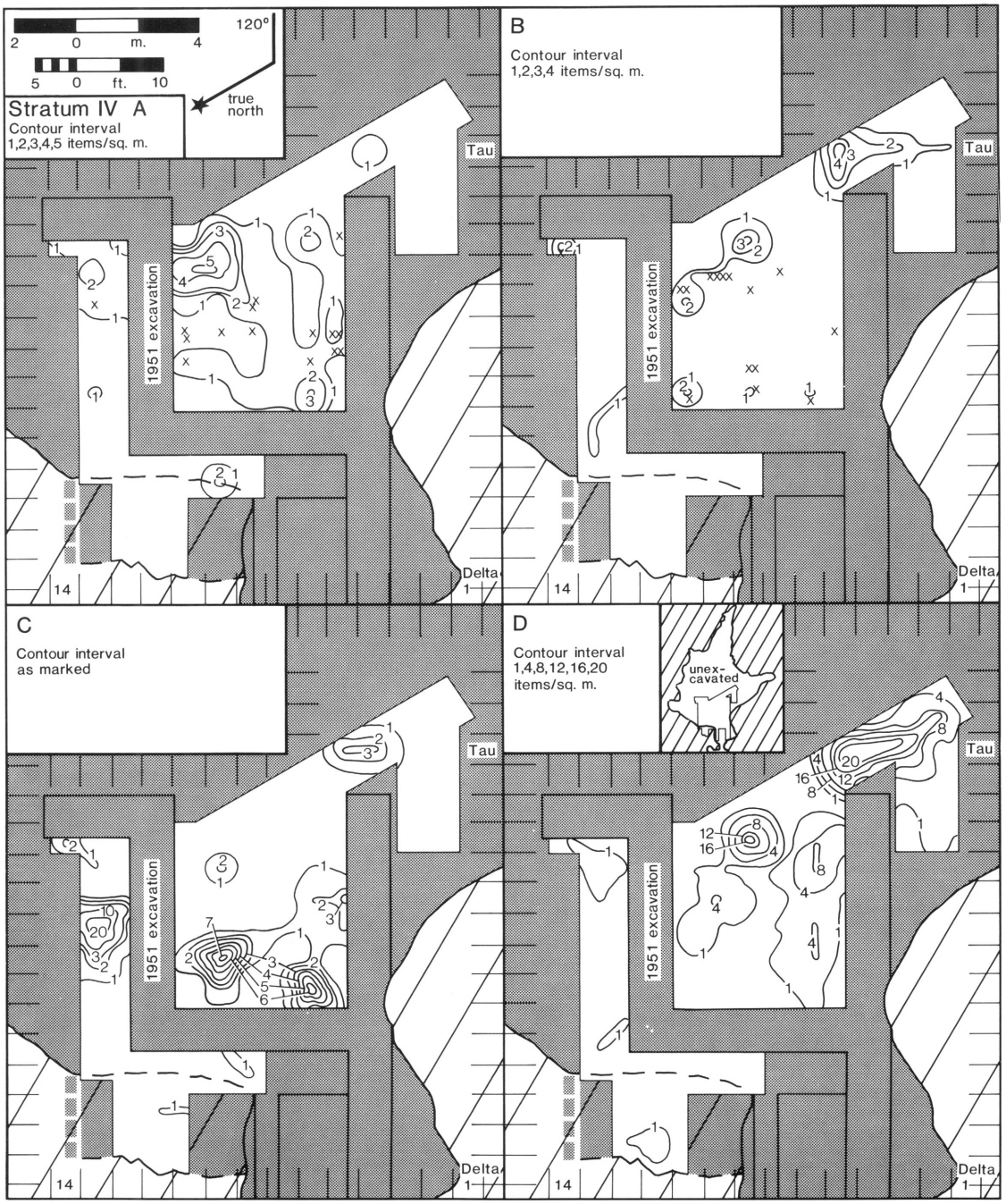

FIG. 111. Itemized artifact density distribution (items/sq. m.) for Stratum IV at Hidden Cave. A. contoured distribution of whole and fragmentary projectile points; utilized and nonutilized flakes are plotted by grid (and denoted by "X"); B. contoured distribution of worked wood; worked bone is plotted by grid (and denoted by "X"); C. contoured distribution of beads; D. contoured distribution of cordage fragments.

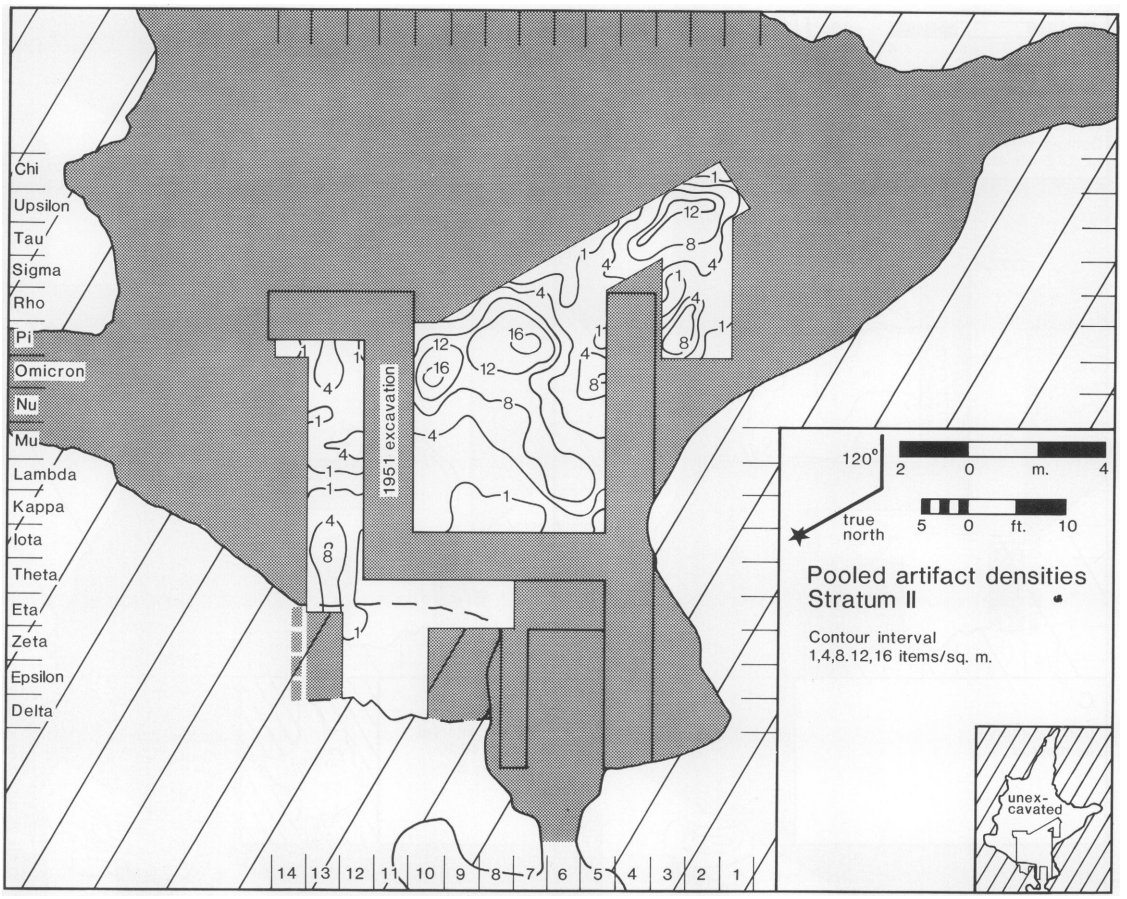

FIG. 112. Pooled artifact density distribution (items/sq. m.) for Stratum II at Hidden Cave.

three distinct areas of Hidden Cave: Mu 13, Lambda 9, and Kappa 6 (fig. 111C). A few beads were also found scattered in the eastern portion of the alcove. This distribution is distinctive in that beads do not follow the overall distributional patterning for projectile points, worked wood, or bone. The western part of the scatter seen in the pooled Stratum IV distribution (fig. 110) across the central block is largely due to beads.

Cordage fragments occur with sufficient frequency to be plotted on the density contour maps (fig. 111C). Cordage is especially subject to rodent movement, and this distribution provides a measure of relative rodent fragmentation of perishables. But since cordage dispersal is also partially conditioned by where it was initially deposited within Hidden Cave, interpretation of this distribution is difficult.

Note that cordage is generally concentrated away from the cave entrance—in the alcove and southeastern corner of the central block. The distribution may be somewhat misleading since it is possible that central block cordage was so badly rodent gnawed or trampled as to have vanished entirely. The peak densities in the alcove on figure 110 result from large amounts of cordage in this area.

The Stratum IV distributions thus show two marked trends. Projectile points, worked wood, and worked bone are concentrated in the east-central portion of the site. Beads, and to some extent cordage, are concentrated on

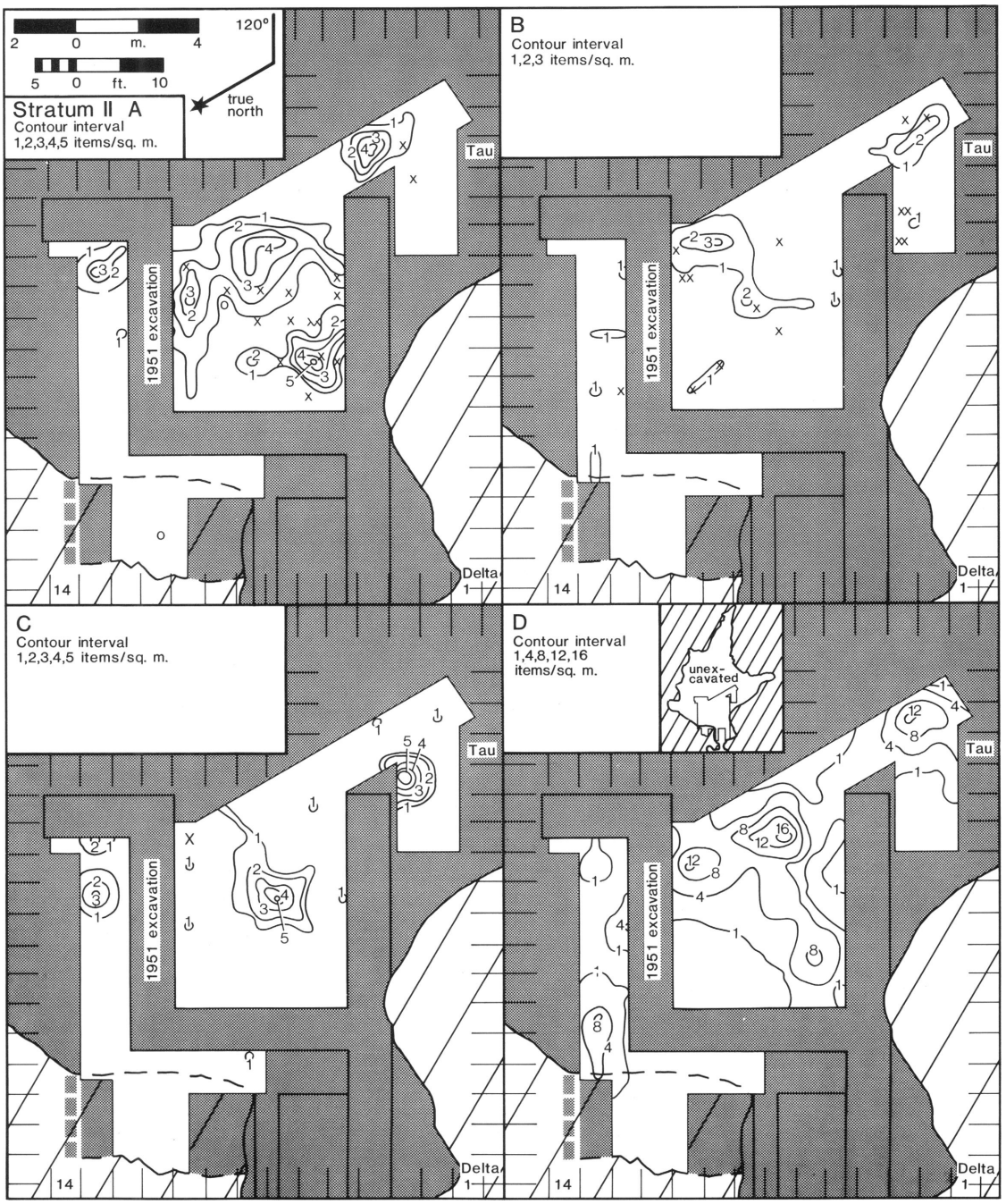

FIG. 113. Itemized artifact density distribution (items/sq. m.) for Stratum II at Hidden Cave. A. contoured distribution of whole and fragmentary projectile points; bifaces (denoted by "O"), utilized, and nonutilized flakes (denoted by "X") are plotted by grid; B. contoured distribution of worked wood; worked bone is plotted by grid (and denoted by "X"); C. contoured distribution of beads ("X" marks the location of a string of seed beads recovered in 1940); D. contoured distribution of cordage fragments.

the peripheries of the central floor of the cave. Utilized and nonutilized flakes fall in between these two areas.

Even given the disturbance of Stratum IV deposits by rodents, it seems improbable that their activity would cause such a separation of items.

SPATIAL DISTRIBUTIONS WITHIN STRATUM II

Overall spatial distribution of Stratum II material culture is markedly different from that in Stratum IV. Figure 112 shows fewer sharp peaks in item density, and there seems to be less restriction in item occurrence. Since all excavated units used in this analysis were dug through both strata, this must reflect some real difference in the distributions within the two strata.

There are two general concentrations of Stratum II artifacts, in the alcove and the southeast part of the central block. As in Stratum IV, a distinct break in distribution occurs at the northern margin of the alcove, where the slope breaks.

The Stratum II distribution, when examined in more detail, seems to be more differentiated than that in Stratum IV. Whole and fragmentary projectile points (fig. 113A) are distributed in four zones, separated from each other by a 1 or 2 m. sterile buffer. The contiguous distribution of two or more projectile points per sq. m. in the eastern part of the central block has a light scatter pattern (as in Stratum IV), but this scatter does not overlap any of the adjacent concentrations (except perhaps in the extreme north, across the Roust and Grosscup Trench P).

Most flakes (also plotted on fig. 113A) occur in the southwestern edge of the central block and diagonally to the northwest, diminishing in frequency to the northwest edge of the excavations on the central block.

Worked wood pieces in Stratum II are present in two parts of Hidden Cave, coincident with the projectile point concentrations (fig. 113B). Worked bone is rare, but is generally separated from projectile points and worked wood (see fig. 113B).

Beads are diffused throughout the site, except for a concentration in Sigma 2 and a string of seed beads in Rho 9 (fig. 113C). Note the apparent lack of upward mixing of beads in Mu 13 from Stratum IV.

Cordage fragments, by far the most frequent artifact in Stratum II (fig. 113D), are concentrated in three places: to the north of the Roust and Grosscup Trench P, in the center of the alcove, and in the southeastern part of the central block.

The Stratum II distributions contrast sharply with those in Stratum IV. First, items which were spatially separate in Stratum IV are clustered together in Stratum II. Note also that Stratum II distributional peaks occur toward the south side of the site and on the alcove—somewhat closer to the entrance than in Stratum IV. The absolute artifact densities of Stratum II are generally higher near the alcove than on Stratum IV (a difference that could perhaps be due to the difficulty of recognizing Stratum IV in this portion of the cave).

Finally, the extreme western margin of Stratum II contained almost no items, probably due to the extremely low roof present during Stratum II times; the roof was relatively higher when Stratum IV was the cave surface.

DISCUSSION

Gross artifact distributional patterns point up several interesting aspects about prehistoric usage of Hidden Cave. Spatial variability is seen as sharp distributional peaks and valleys in figures 110–113.

For one thing, it is clear that the extensive and obvious rodent disturbance has not totally homogenized the deposit. Stratum IV projectile points, for example, are clumped together in only a few places inside Hidden Cave. Had rodents been moving these objects around, they should be more dispersed. Given the level of resolution employed here, the degree of disturbance is considered to be minimal. It remains almost impossible, of course, to know whether a specific artifact associated with a feature retains its original position. But the relative gains in pattern recognition are offset by loss of information about the specific associations that make up the patterns. We think that while extensive rodent disturbance no doubt occurred, the varying artifact intensities throughout the site suggest that

movement of items may have been rather slight.

The distributional maps also suggest the kinds of artifacts that might have been intentionally placed in the site in large amounts. Projectile points in Stratum IV, for example, are definitely clustered by specific area, and these clusters are separated from one another by large empty zones. This patterning suggests intentional caching of projectile points, worked wood, and perhaps worked bone.

But other artifact categories that seem to exhibit the same distributional pattern may not actually have been cached. Beads found inside Hidden Cave could come from a few strings which were subsequently broken and scattered; we know this is the case for some beads, since two beads retained the original string material. Items such as beads, pendants, and other "ornaments" (Thomas, 1983a, p. 72; Winters, 1969) may have entered the cave as caches of personal items, as accidental losses, or in association with skeletal material found in the cave. The behavioral role of such artifacts differs greatly from that of the items that were discarded independently and in quantity: the latter are individual specific, while the former are specific to an activity.

We must also allow for the possibility that other kinds of items were present in the site but were removed prehistorically. These "invisible items" may have been foodstuffs—as is suggested by the deep-narrow cache pits—or possibly other kinds of artifacts. There also could have been greater numbers of the items than were found during the excavations. After all, a cache is simply a temporary container. Hidden Cave, in a sense, is a very complex container because it holds other smaller containers—the pit features.

Looking only at distributional patterns, Hidden Cave certainly qualifies as a cache cave. But this is a complex site and cannot simply be viewed as an adequate container for storing things. Rather, as a container Hidden Cave has properties which can be examined in a way similar to that in which various properties of pit features were analyzed in the last chapter.

A foremost factor influencing the human use of Hidden Cave is the amount of available light inside the chamber. We know from historical and geological studies that the opening was not, at least during Stratum II and Stratum IV times, significantly larger than it was when Hidden Cave was rediscovered in the 1920s. Since this is true, the amount of light that reached the alcove area and the northern part of the central block has always been minimal. Without some kind of artificial light, one is basically in complete darkness everywhere but within 5 or 6 m. of the entrance. To use the inside of the cave, even just to dig cache pits, would have required some kind of light.

Another important factor is the nature of the cave itself. The fine silts quickly turn to powder and in the restricted inside atmosphere form dense clouds of dust when trampled or otherwise disturbed.

Light and dust limit the potential use of Hidden Cave, but there are also some beneficial properties of the site. The inside temperature is fairly stable, much more equable than the outside temperature. The cave also provides extremely effective shelter.

Viewed simply as a "storage container," Hidden Cave provides an extremely well-controlled environment. But whatever activities took place inside, the difficulties of little light and ample dust must have been overcome.

The dust problem seems to have been solved prehistorically by laying down tule, sometimes in coarsely woven mats. The high organic content of Strata II and IV are caused by this matting. If Hidden Cave was simply a cache cave and (possibly) a burial location, then why line the floor of the site with matting?

Long-term use of this site would also have required some kind of artificial light. The absence of intensively burned hearths makes it unlikely that Hidden Cave served as a residential site.

Our most plausible inference is that Hidden Cave functioned as more than a mere cache container. The site could, for instance, have served sporadically as a short-term camp, or as a specialized activity area associated with an open-air residential site. Most activities would have had to be done outside, and we lack an archaeological record for the outside of the cave. But there are certainly numerous open sites near Hidden Cave (Car-

son-Stillwater Archaeological Survey site records; Pendleton, McLane, and Thomas, 1982) which could have been behaviorally associated with Hidden Cave.

While these suggestions remain speculation, the distribution of features reinforces this line of thought. Note that in figure 101 features tend to occur in a cone-shaped area formed by exterior light coming from the entrance of the cave. Few features occur near the site entrance. In addition, features are also rare where the combination of light and easily dug sediment is greatest, close to the entrance in the central part of the site.

Perhaps it is significant that this is where we found the greatest concentration of organic matting. Since matting does not seem to have any direct association with features, it is possible that the matting reflects a site use other than caching.

The combined pollen, coprolite, and macrobotanical evidence (chap. 9, this volume) lead to the possibility that Hidden Cave may have been used as a protected processing area for locally available plant food, such as *Typha* or *Scirpus*. This would explain both the organic matting and the high densities of economic plant pollen found in the midden strata. If processed plants were stored directly in the cave, then this would account for the deep-narrow storage pits which (as discussed in the previous chapter) we think were associated with bulk caches of foodstuffs.

The wide-shallow pit features in Hidden Cave seem to result from caching of gear. Ideally, artifacts of this sort (such as projectile points) would be spatially associated with wide-shallow pit features. Unfortunately, the high density of cache pits in Hidden Cave, and the problems with rodent disturbance and variable excavation strategies, require interpretive caution on this point.

There is no consistent associative patterning between artifact types, kinds of features, or specific areas within Hidden Cave. Artifact densities do appear to increase near features, but this patterning might only reflect the caching of artifacts in particular features. We must keep in mind that the distribution of many items found in Hidden Cave, especially the high concentration of "weaponry," may have little to do with the processing/storage aspect of the function of the cave.

The complexity of Hidden Cave warns against the facile interpretation that this site served merely as a "cache cave." The truth is that Lovelock Cave, Humboldt Cave, and the other western Great Basin cache caves are probably just as functionally complex as Hidden Cave. To understand the patterning in any of these sites, one must consider the general role of caching within a settlement system.

Thomas distinguishes between the *resource cache* and the *artifact cache* (chap. 2, see also 1983a, p. 81). Resource caches are a solution to temporal incongruity in an exploitative strategy (Binford, 1980, p. 12). As Thomas points out, solving the temporal incongruity problem can lead to a problem of spatial incongruity—the stored resources cannot be economically recovered from another part of a group's territory (1983a, p. 81).

Two further factors must be considered: how long a resource is stored, and the degree of settlement repositioning that occurs relative to those stored resources. Bulk processed resources may be put into long-term storage when a group has no immediate intention of returning to collect them; such activities would require a secure cache location. But resources could also be placed in seasonal storage to be used later in the same year, perhaps using an equally secure storage location.

By contrast, artifact caches are used to save transport costs of tools rather than resources. These may be items that are used only seasonally, or extra gear that is "scuttled" (Binford, 1977). In either case, degree of residential or logistical mobility determines the utility of this kind of cache.

The degree of residential or logistical mobility determines the role of both resource and artifact caches. It is not enough to say that collectors make caches and foragers do not. The distinction has to be made in terms of caching as an overall strategy in a settlement-subsistence system. How routinely are caches, both of artifacts and of resources, made and used?

This information is generally unavailable from the archaeological record. But a rough indicator might be the frequency of caches within an area as a whole. Caching is very

common in the Carson and Humboldt sinks—apparently a strategy routinely associated with resource exploitation in this area. Kelly (1980b) has argued that the resources available here are relatively unpredictable and unproductive per unit of labor investment. He concludes that use of the sink areas in general would have been sporadic: as a back-up strategy to some more productive strategy somewhere else. This implies that although the area was used residentially, groups were repositioning to the sink areas only when necessary, and this may have been infrequent.

If Kelly is correct, this implies that groups did not reposition to make use of the stored resources; the stored resources may have simply gained some time utility while further local resources were being processed. Artifact caches represent the gear which was not taken away when the group departed. The two kinds of caches in Hidden Cave—resources and artifacts—might therefore result from two different events: the arrival of a group, and the departure of a group.

We cannot know the number of arrival and departure cycles represented in Hidden Cave. Gatecliff series points are relatively rare in the surface archaeological record of the Carson Sink, suggesting that the whole region was not used very intensively during Devils Gate times (Kelly, personal commun.).[1]

The point is that Hidden Cave was a sporadically used node in a settlement system, a "place" (*sensu* Binford, 1982) from which the exploitation of the area was organized. This site was part of a complex land-use system, and its archaeology is likewise complex. This is why Hidden Cave cannot be considered merely a "cache cave."

[1] This may, instead, represent a different strategy of artifact and material conservation during Devils Gate times.

CHAPTER 23. OBSIDIAN SOURCE USE AT HIDDEN CAVE

RICHARD E. HUGHES[1]

Although obsidian source and artifact characterization studies have been conducted in California for more than a decade, comparable investigations in the Great Basin have been few. In fact, so little work in the Great Basin had been accomplished by 1980 that obsidian sourcing studies received no mention at all in the "Directions for Future Research" section in O'Connell and Madsen (1982). To help remedy this situation, this chapter not only identifies the sources of volcanic glass used to manufacture artifacts found at Hidden Cave, but explores some of the potential of obsidian source analysis for elucidating aspects of sociocultural complexity in the western Great Basin.

SAMPLE SELECTION

A total of 176 obsidian artifacts were analyzed from Hidden Cave. This total includes all typable obsidian projectile points (n = 153; see table 78 at the end of this chapter) and a small sample of biface fragments, projectile point fragments and utilized flakes from various strata (n = 23; table 79).

X-RAY FLUORESCENCE ANALYTICAL CONDITIONS

Analyses were completed at the Department of Geology and Geophysics, University of California, Berkeley, on a Spectrace 440 (United Scientific Corporation) energy dispersive X-ray fluorescence machine using hardware described in Hughes (1983a, 1983b, pp. 26–29).

All 176 specimens were subjected to analysis in the 5–25 keV region. After overlapping Kα, Kβ, and L lines were subtracted and background intensity suppressed, parts per million (ppm) concentrations for Pb, Th, Rb, Sr, Y, Zr, and Nb[2] were determined using a least squares polynomial fit routine (see Hughes, 1983b, pp. 25–26). Two different X-ray tubes were employed. Hidden Cave artifacts analyzed prior to February 1983, were excited using an Ag (silver) X-ray tube at 30.0 kV, 0.20 mA pulsed, with a 0.05 mm. Ag primary beam filter in an air path at 200 seconds livetime. Specimens analyzed after March 1983, were analyzed using a Rh (rhodium) X-ray tube at 30.0 kV, 0.40 mA pulsed, with a 0.04 mm. Rh primary beam filter in an air path at 200 seconds livetime. Artifacts analyzed using different X-ray tubes are indicated in tables 78 and 79 by a raised asterisk following the catalogue number for those specimens analyzed using Ag tube excitation. Unless otherwise noted, all other specimens were excited by the Rh X-ray source. Trace element concentration comparisons between recommended values reported for U.S. Geological Survey rock standards and the values determined using Ag X-ray excitation appear elsewhere (Hughes, 1983a, table 76; 1983b, tables 2-1 and 2-2), whereas comparisons with trace element values derived using the Rh X-ray tube appear in table 72.

All obsidian source standards (and artifacts) could not be distinguished solely on the basis of Rb, Sr, Y, Zr, and Nb trace element concentrations. For example, these concentration values failed to separate obsidian of the Majuba Mountain geochemical type from the Casa Diablo type (cf. Hughes, 1984; Jack, 1976, p. 203; table 73, this chap.) and the Pine Grove Hills geochemical type from that found at the Bodie Hills source (cf. Jack, 1976, p. 191). Use of Ba and Ce ppm values provided a remarkably good separation for Pine Grove Hills and Bodie Hills glasses (see fig. 114), so when Rb, Sr, Y, and Zr trace element overlap was encountered, specimens were analyzed for these additional elements. An Am^{241} 100 mCi radioisotope was employed as an excitation source to generate Ba, La, and Ce ppm concentration values. This radioisotope source is very efficient in the 20–60 keV region, and thus was ideal for exciting

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[2] Emission lines used in this analysis were: Pb (Lβ), Th (Lα), Rb (Kα), Sr (Kα), Y (Kα), Zr (Kα), and Nb (Kα).

TABLE 72

X-ray Fluorescence Determinations (in ppm) Using Rh Primary Excitation for Trace Element Concentrations in Two United States Geological Survey Standard Rocks Compared to Recommended Values[a]

U.S. Geological Survey Standard	Pb	Th	Rb	Sr	Y	Zr	Nb
BCR-1 (Flanagan, 1976)	17.6	6.0	46.6	330.0	37.1	190.0	13.5
BCR-1 (This study)	15.8 ±1.3	0.0 ±0.0	50.2 ±1.4	342.8 ±8.4	37.1 ±1.7	183.1 ±4.4	16.0 ±2.4
W-1 (Flanagan, 1976)	7.8	2.4	21.0	190.0	25.0	105.0	9.5
W-1 (This study)	13.4 ±1.1	0.0 ±0.0	23.5 ±1.9	184.4 ±1.5	21.1 ±3.1	110.9 ±2.9	15.3 ±1.1

[a] BCR-1 values reported here averaged from six analyses; W-1 values averaged from four analyses.

the Ba Kα, La Kα, and Ce Kα emission lines. However, Am^{241} excitation efficiency drops dramatically below this region (< *ca.* 16.0 keV; see Woldseth, 1973, pp. 2.43–2.45), and because of this suboptimal performance in the mid-Z region the radioisotope source was not employed to analyze the entire 5–60 keV energy spectrum. These analytical constraints required that Ba, La, and Ce analyses be conducted in a separate run (in the configuration illustrated in Hughes, 1983b, fig. 2-2b) at 200 seconds livetime. Results of analysis of U.S. Geological Survey rock standards using Am^{241} excitation appear in Hughes 1983b, tables 2-1 and 2-2.

TABLE 73

Ranges for Trace and Rare Earth Element Concentrations (in ppm) for Obsidian Source Standards from Casa Diablo, Majuba Mountain, and Garfield Hills[a]

Element	Casa Diablo ($n = 4$)	Majuba Mountain ($n = 4$)	Garfield Hills ($n = 4$)
Pb	27–48	12–25	29–33
Th	9–18	31–33	10–20
Rb	145–154	161–180	143–195
Sr	90–136	126–136	53–64
Y	11–18	15–24	11–20
Zr	180–208	159–181	82–101
Nb	10–20	14–18	15–20
Ba	1020–1311	1060–1222	203–240
La	44–46	36–43	18–29
Ce	70–84	69–86	24–42

[a] Casa Diablo values from Jack (1976, p. 203).

The overlap between Majuba Mountain and Casa Diablo required a third analysis. As can be seen from inspection of trace element concentration values (table 73 and Jack, 1976, p. 203), these two sources cannot be clearly distinguished on the basis of Rb, Sr, Y, Zr, and Nb or Ba, La, and Ce ppm values. Separation was achieved, however, using iron/manganese peak count ratios (see fig. 115; cf., Jack, 1976, p. 212; Hughes, 1983a, fig. 208). Source standards from Majuba Mountain and Casa Diablo were analyzed for iron (Fe Kα line) and manganese (Mn Kα line) using the Rh X-ray tube operated at 15.0 kV, 0.40 mA pulsed with an Al primary beam filter in a vacuum path at 200 seconds livetime.

A WORD ABOUT ASSIGNING ARTIFACTS TO OBSIDIAN SOURCES

Before detailing the results of X-ray fluorescence analysis, it is important to consider briefly some of the affective variables involved in artifact-to-source studies. Although it is commonly assumed that obsidian artifacts can be assigned to parent geological obsidian sources on the basis of congruence in elemental profiles (in this case, trace element concentration values), a correspondence in trace element concentrations does not necessarily indicate that the artifact in question was made from that particular source material (see Ward, 1977; Hughes, 1982). The artifact might have been made from an undocumented obsidian source material whose trace elements overlap with those of

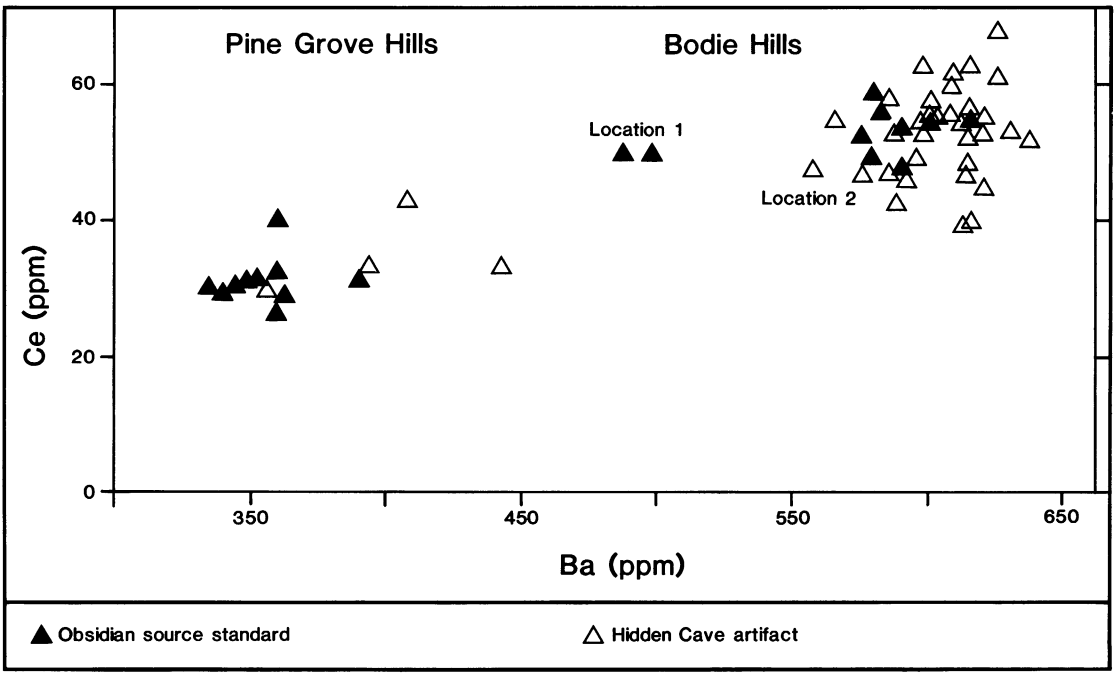

FIG. 114. Scattergram of Ce vs. Ba concentrations for obsidian source standards (Pine Grove Hills and Bodie Hills) and Hidden Cave artifacts. Bodie Hills Location 1 specimens collected by R. N. Jack (Jack and Carmichael, 1969, pp. 28, 31), Location 2 specimens collected by R. J. Jackson from Singer and Ericson's (1977, fig. 1) outcrop T_2.

a known source. Therefore, it does not follow that the assigned source is necessarily the correct one, only that it is more likely to be correct than any of the others in the sampling universe.

There are circumstances in which correspondences between artifacts and obsidian source trace element profiles might be misleading and actually result in an incorrect assignment. I have discussed elsewhere how Humboldt Lakebed (Ch15) obsidian artifacts of the Majuba Mountain geochemical type could have been misassigned to the Casa Diablo source because at the time Jack conducted his research, the Majuba Mountain source had not been recorded (Hughes, 1984). The implication is, of course, that obsidian artifact-to-source assignments are more likely to be incorrect in regions where little is known about the geochemistry of local sources of artifact quality volcanic glass. However, the greatest potential source of error in artifact-to-source assignment results from technical problems associated with actual elemental analysis and resulting data manipulation. For a discussion of these problems, see Hughes (1983b, pp. 67–78; 1984).

RESULTS: PROJECTILE POINTS

Eight distinct geochemical types of obsidian were recognized in the Hidden Cave artifact assemblage. Six of these sources are located about 100–200 km. south of the site, whereas the remaining two are situated more than 150 km. to the northwest (see fig. 116). Trace element concentration values (in ppm) have been published for most of these sources (Jack and Carmichael, 1969; Jack, 1976), so Hidden Cave artifact concentration values can be compared directly with these. Quantitative values for two new Nevada sources (Majuba Mountain and Garfield Hills) appear here for the first time (see table 73). A summary of source-specific attribution for projectile

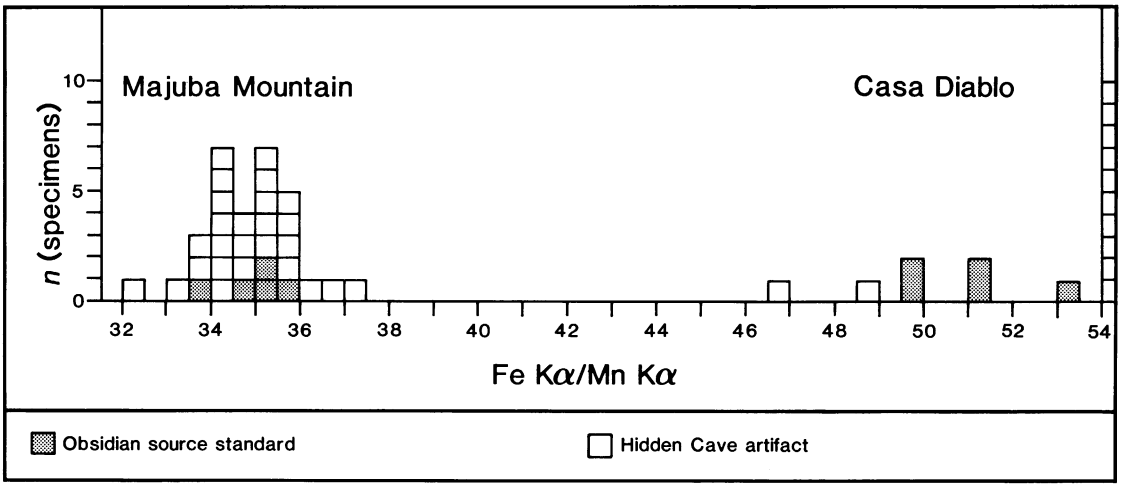

FIG. 115. Histogram of Fe/Mn ratios for Majuba Mountain and Casa Diablo source standards and Hidden Cave artifacts.

points appears in table 74. Source attributions for each specimen appear in table 78 at the end of this chapter.

MT. HICKS (n = 60)

Thirty-nine percent of the sample of typable projectile points were fashioned from volcanic glass of the Mt. Hicks geochemical type. Mt. Hicks obsidian was used to manufacture 37 percent of all Gatecliff Split Stem points, 50 percent of the Gatecliff Contracting Stem points, and 39 percent of the Humboldt Basal-notched points recovered from the site.

BODIE HILLS (n = 29)

Obsidian of the Bodie Hills geochemical type accounted for 19 percent of the sample of typable obsidian points from the site. Sixteen percent of the Gatecliff Split Stem points, 11 percent of all Gatecliff Contracting Stem points, and 44 percent of the Humboldt Basal-notched points at Hidden Cave were fashioned from Bodie Hills glass.

QUEEN (n = 13)

Queen obsidian accounted for about 9 percent of the site total of projectile point obsidian and 7 percent of Gatecliff Split Stem, 11 percent of Gatecliff Contracting Stem, and 11 percent of the Humboldt Basal-notched totals.

PINE GROVE HILLS (n = 4)

This source of obsidian accounted for 3 percent of the sample of typable obsidian points. Single occurrences of Pine Grove Hills obsidian were represented in Gatecliff Split Stem, Gatecliff Contracting Stem, residual concave base, and Rosegate series totals.

CASA DIABLO (n = 1)

Only one typable projectile point of Casa Diablo obsidian was represented at Hidden Cave, and this Gatecliff Contracting Stem specimen (20.3/9781) was recovered from backdirt outside the cave.

GARFIELD HILLS (n = 8)

Source standards used to identify this geochemical type were obtained in an alluvial fan originating from the northwestern lobe of the Garfield Hills.[3] Obsidian nodules also oc-

[3] Garfield Hills obsidian source standards were collected in T8N, R31E, SE ¼ of Section 13; T8N, R32E, NE ¼ of Section 24, and the SW ¼ of Section 18 as depicted on the U.S.G.S. Kinkaid, Nevada 7.5 minute quadrangle (1979). I thank Joe Moore and James P. Green, Nevada Department of Transportation, for providing source specimens and provenience information.

TABLE 74
Obsidian Sources Represented in the Hidden Cave (Ch16) Projectile Point Assemblage

Obsidian Source (Geochemical Type)	Projectile Point Type: Gatecliff Series: Split Stem	Gatecliff Series: Contracting Stem	Elko Series: Eared	Elko Series: Corner-notched	Humboldt Series: Basal-notched	Humboldt Series: Series	Residual: Concave Base	Residual: Rosegate Series	Total
Mt. Hicks	25	19	1	1	7	2	5	—	60
Bodie Hills	11	4	1	—	8	1	2	2	29
Pine Grove Hills	1	1	—	—	—	—	1	1	4
Queen	5	4	1	1	2	—	—	—	13
Casa Diablo	—	1	—	—	—	—	—	—	1
Garfield Hills	5	2	1	—	—	—	—	—	8
Majuba Mountain	17	5	—	—	1	1	1	1	26
Homecamp A or C	1	1	—	1	—	—	—	—	3
Unknown	3	1	—	—	—	2	2	1	9
Total	68	38	4	3	18	6	11	5	153

cur to the west of the Garfield Hills in the flats east of Hawthorne (cf. Sappington, 1981, "Hawthorne"), but inspection of the geological context suggests that it is likely that these nodules have been redeposited from primary occurrence(s) in the Garfield Hills. Five percent of the site total of typable obsidian points corresponded to the trace element profile of Garfield Hills obsidian; 7 percent of the Gatecliff Split Stem points and 5 percent of Gatecliff Contracting Stem points were fashioned from obsidian of this geochemical type.

Majuba Mountain ($n = 26$)

While the main occurrence of obsidian of the Majuba Mountain geochemical type occurs about 130 km. northwest of Hidden Cave, small obsidian pebbles of this same geochemical type also occur in alluvial fan deposits to the east and southeast of Majuba Mountain. However, many of these pebble occurrences are too small to have served as raw material sources for Gatecliff series points. Source standards were collected from weathered nodule and cobble exposures near Poker Brown Wash,[4] where prehistoric tool manufacturing residues also were observed. Seventeen percent of the typable obsidian projectile points recovered from Hidden Cave were fashioned from Majuba Mountain source material; 25 percent of the Gatecliff Split Stem points, 13 percent of the Gatecliff Contracting Stem points and six percent of Humboldt Basal-notched points were manufactured from Majuba Mountain glass.

Homecamp "A" and Homecamp "C" ($n = 3$)

Obsidian of the Homecamp geochemical type occurs across much of Washoe County

TABLE 75
Strata II and IV Distributions of Gatecliff Series and Humboldt Basal-notched Points at Hidden Cave

	Gatecliff Split Stem		Gatecliff Contracting Stem		Humboldt Basal-notched	
	II	IV	II	IV	II	IV
Obsidian Source						
Mt. Hicks	3	6	3	2	5	—
Bodie Hills	4	2	—	—	4	—
Pine Grove Hills	—	—	—	—	—	—
Queen	2	1	1	1	2	—
Casa Diablo	—	—	—	—	—	—
Garfield Hills	1	—	1	1	—	—
Majuba Mountain	5	3	3	—	1	—
Homecamp A or C	—	—	1	—	—	—
Unknown	—	—	—	—	—	—

[4] Obsidian source standards were collected near the southern end of the Majuba Mountains near Poker Brown Wash in T31N, R31E, SW ¼ of the NE ¼ and SE ¼ of the NW ¼ of Section 27 as depicted on the U.S.G.S. Poker Brown, Nevada 7.5 minute quadrangle (1971).

in northwestern Nevada. It has been identified at Bordwell Spring, Summit Spring Canyon, Grass Valley Spring, Duck Flat, and Fox Mountain (Hughes, 1983b, pp. 42, 345–347, map 5), but because there have been no systematic, intensive inventories of obsidian source occurrences in this part of Nevada, the areal distribution of this geochemical type remains unclear. Only 2 percent of the typable points from Hidden Cave matched the trace element profile of the Homecamp geochemical type. Although two percent of the Gatecliff Split Stem points and three percent of Gatecliff Contracting Stem points were fashioned from this glass, in each case only single occurrences are represented.

Unknown Sources ($n = 9$)

Six percent of the projectile point assemblage could not be attributed with confidence to any of the obsidian sources presently in the available source inventory. Four percent of the Gatecliff Split Stem points and 3 percent of Gatecliff Contracting Stem points were from "unknown" sources.

Discussion of Projectile Point Sources

Three projectile point types—Gatecliff Split Stem ($n = 68$), Gatecliff Contracting Stem ($n = 38$) and Humboldt Basal-notched ($n = 18$)—accounted for over 80 percent of the typable obsidian points at Hidden Cave; the Gatecliff series alone accounted for 69 percent of the site total (chap. 14, this volume).

Twenty-seven of 68 Gatecliff Split Stem points (40% of the type total) and 15 of 38 Gatecliff Contracting Stem points (40% of the site total) could not be correlated to specific stratigraphic context. These specimens were either from the surface, from backdirt outside the cave, or were otherwise not correlated with particular strata (see chap. 8). Although the sample size was significantly smaller, Humboldt Basal-notched points were more frequently recovered in stratigraphic context than were Gatecliff series points; only three of 18 specimens (17% of the Humboldt Basal-notched total) could not be assigned stratigraphic provenience.

In an attempt to discern finer distinctions in source-specific use, all specimens of uncertain stratigraphic association were eliminated from consideration. Eliminating minor types and emphasizing the three most frequent types recovered from Strata II and IV resulted in the distribution that appears in table 75. Data from this table were recombined by source direction to investigate potential differences in source use between Gatecliff series subtypes (table 76). Although a smaller percentage of Gatecliff Split Stem points were manufactured from southern obsidian source material than were Gatecliff Contracting Stem (72% vs. 84%, respectively), these differences most likely reflect variability in sample size. Computation of a chi-square test on the absolute frequencies in table 76 indicates no significant deviation from that expected by chance.

TABLE 76
Frequencies of Gatecliff Split Stem and Gatecliff Contracting Stem Points by Source Direction from Hidden Cave

Direction from Hidden Cave	Gatecliff Series	
	Split Stem	Contracting Stem
South	47	31
North	18	6

$\chi^2 = 1.88$, df = 1, $p = 0.167$
(Yates' Correction for Continuity applied.)

To investigate the possibility that subtle changes in source direction had occurred through time and that they might have been masked by focusing solely on source-specific type frequencies, stratigraphic occurrences of these two subtypes also were combined and sorted by obsidian source direction (see table 77). Once again, despite the fact that these data indicate a percentage frequency increase from Stratum IV (19%) to Stratum II (38%) in the use of northern obsidian source ma-

TABLE 77
Occurrences of Gatecliff Series Points in Strata II and IV at Hidden Cave by Source Direction

Direction from Hidden Cave	Gatecliff Series	
	Stratum II	Stratum IV
South	15	13
North	9	3

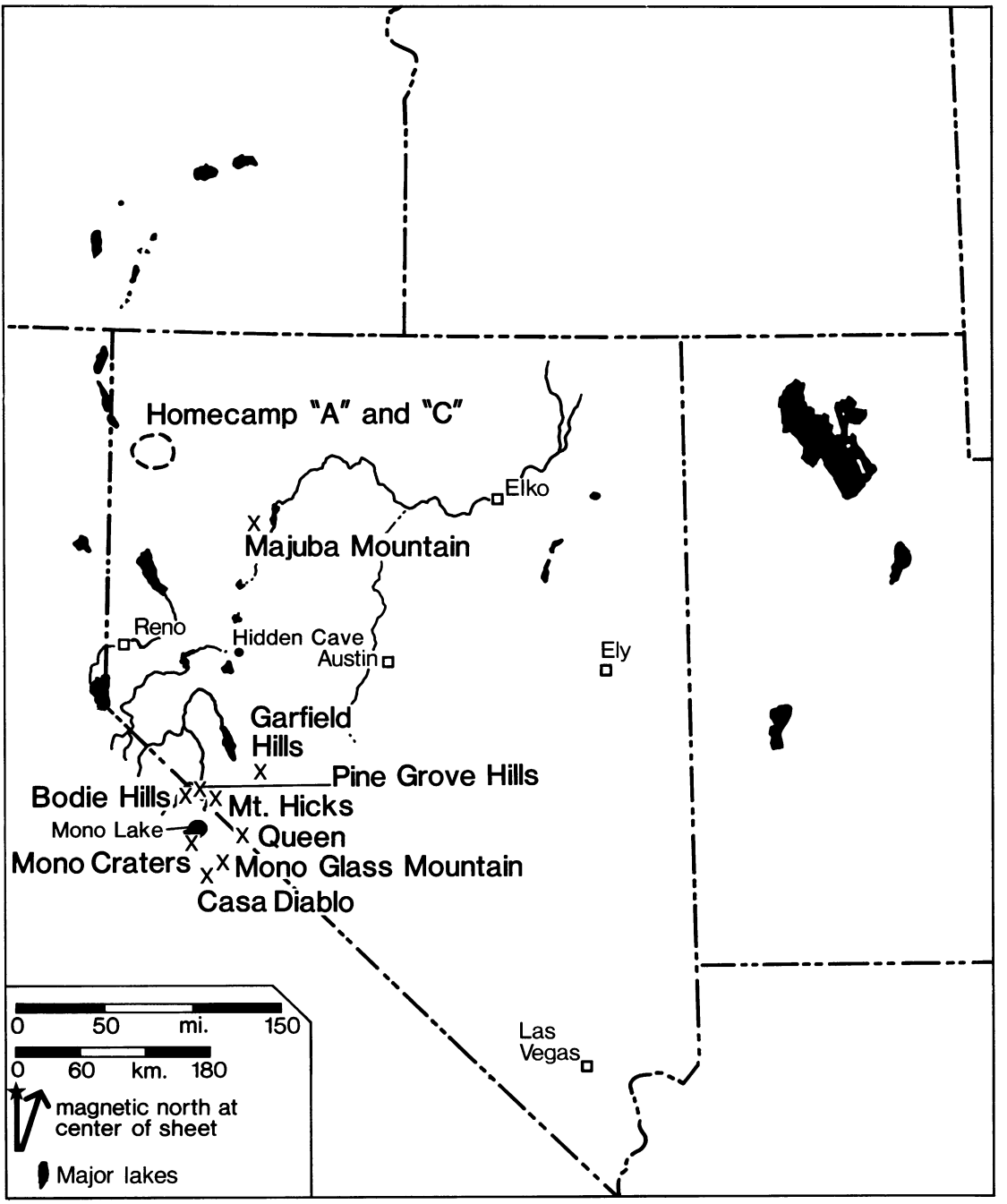

FIG. 116. Locations of major obsidian sources discussed in the text.

terials, computation of a Fisher's Exact Test (Thomas, 1976, pp. 291–298) on the absolute frequencies in table 77 suggests that this distribution could easily have arisen by chance ($p = 0.181 > p\,\alpha = 0.025$).

The source directional affinities of Humboldt Basal-notched points were quite unambiguous; 14 of 15 specimens recovered in stratigraphic context were fashioned from Mono Basin obsidian source materials. Of

these 15 Humboldt Basal-notched points, three were recovered in Stratum I, 12 occurred in Stratum II, and none were recovered in Stratum IV; only one was fashioned from northern obsidian source material.

RESULTS: MISCELLANEOUS OBSIDIAN ARTIFACTS

Twenty-three additional obsidian artifacts were analyzed from Hidden Cave (table 79). Most of these were untypable projectile point fragments or obsidian bifaces, though three obsidian flakes were analyzed. Because so little artifact manufacture apparently was undertaken at the site, it was not possible to sample various classes of objects to investigate potential differences in source-specific acquisition patterns (cf. Hughes and Bettinger, 1984). Mt. Hicks obsidian accounts for the vast majority of miscellaneous artifacts analyzed. This finding was to be expected since most of the artifacts in this category are projectile point fragments, and high frequencies of Mt. Hicks obsidian also characterize the typable point assemblage (table 78).

INTERPRETATIONS

Source-specific frequencies of obsidian projectile points in the Hidden Cave assemblage provide some clues to the exchange route through which these artifacts may have moved. To begin with, it can be observed that Mt. Hicks and Bodie Hills obsidians dominate the Hidden Cave point assemblage (table 78), despite the fact that these sources are not the closest to the site (see fig. 116). The Pine Grove Hills source is about 43 km. closer to Hidden Cave than is Bodie Hills, yet only four projectile points were fashioned from Pine Grove Hills glass, suggesting that absolute distance to source is not the best predictor of the observed source-specific frequencies at Hidden Cave. Further, if the exchange or procurement route from Hidden Cave to Mt. Hicks and Bodie Hills had been direct (i.e., the shortest straight-line distance), one would expect much higher frequencies of Pine Grove Hills obsidian in the assemblage because this route would have passed within a few kilometers of the source.

Thus it appears that the "direct route"—perhaps along East Walker River to the west of the Wassuk Range—was not the principal channel through which obsidian came to the site.

Although involving a slightly greater distance, a more likely alternative route may have existed south of Hidden Cave, passing to the east of the Wassuk Range along Walker Lake, connecting with the Mono Basin through the pass at the south end of the Anchorite Hills. Once in the Mono Basin, the Mt. Hicks, Bodie Hills, and Queen obsidian sources would have been readily accessible. This hypothesized southern exchange route also could account for the observed frequencies of obsidian of the Garfield Hills geochemical type, since this route would have passed near this nodule occurrence. Excellent documentation exists to support the existence of this route during the ethnographic period (Steward, 1933, p. 329, map 1).

In short, the source-specific obsidian projectile point frequencies at Hidden Cave would be consistent with what one would expect if this southern exchange route had been operating between *ca.* 1500–2000 B.C. in a fashion analogous to that recorded by Steward.

Shell bead and ornament data provide some further support for a southern exchange route. Most of the shell artifacts recovered from Hidden Cave are central Californian types (chap. 17, this volume; see Bennyhoff and Hughes, ms.), likely obtained through trans-Sierran exchange. During the ethnographic period, central Californian commodities, including shell beads, reached the Mono Lake area to the east of the Sierra Nevada via a well-traveled route through the Yosemite region (Steward, 1933, p. 257; Davis, 1965, pp. 21–22), and it is not unreasonable to suppose that a trans-Sierran route through this region existed at the apex of shell bead and ornament exchange between California and the Great Basin *ca.* 3000–1000 B.C. (cf. Bennyhoff and Hughes, ms.). Although alternative trans-Sierran shell artifact transmission routes cannot be ruled out (see Davis, 1961, map 1), the most parsimonious account for the co-occurrence of Mono Basin obsidians and Californian shell beads at the site is that they both were conveyed through the same exchange route, though not necessarily in the same exchange transactions.

In view of the relative abundance of other high-quality Mono Basin glasses in the Hid-

den Cave projectile point assemblage, the paucity of Casa Diablo obsidian is noteworthy. Very little is currently known about the eastward distribution of Casa Diablo obsidian—only one artifact fashioned from this geochemical type was recovered from Gatecliff Shelter (Hughes, 1983a), and no specimens have yet been identified in projectile point and debitage samples collected by Robert Kelly during extensive archaeological surveys elsewhere in the Carson Sink (Hughes, unpubl. data). In the Mono Basin, Casa Diablo obsidian projectile point frequencies in pre-A.D. 700 assemblages at Mno-446 were lower than would have been anticipated based solely on proximity to source (Hughes and Bettinger, 1984, table X.6), suggesting that access to the Casa Diablo source may have been influenced by sociopolitical factors and territorial shifts independent of absolute distance to source.

It may turn out that Casa Diablo obsidian, aside from its distribution in the Mono Basin, was not widely exchanged to the east of this area, being confined essentially to trans-Sierran exchange transactions similar to those documented by Jack (1976, pp. 205–206) and Jackson (1974). To date, however, too few site collections from east of the Mono Basin have been analyzed, so the more general regional significance of Casa Diablo obsidian frequencies at Hidden Cave remains unclear.

Up to this point, discussion has focused on possible routes linking the inhabitants of the Carson Sink with peoples to the south. Inspection of the data in table 74 makes it clear, however, that exchange relationships also were maintained to the north. Obsidian of the Majuba Mountain geochemical type accounts for 21 percent of the Gatecliff series projectile points at the site, and occasional specimens fashioned from glass sources further northwest in Nevada also are represented.

This information is of considerable interest, not only because it documents exchange and social contact in a different geographic direction, but because of the implications it carries for settlement-subsistence range and interaction. Employing the Toedökadö exploitative strategy discussed in chapter 2 for comparison, projectile point source frequencies indicate that interactions may have been more frequent with social groups to the north in the Humboldt Sink area between 1500–1800 B.C. than appears to have been the case during ethnographic times (see chap. 2). However, at the present time it would be difficult to bring much material evidence to bear on the issue because the key site (aside from Ch15) in the Humboldt Sink—Lovelock Cave—was most intensively occupied later in time than Hidden Cave. Consequently, a source-specific comparison of projectile point frequencies between these two sites would be misleading.

To the northwest, radiocarbon dates on features from Kramer Cave (Hattori, 1982) indicate that this site was occupied during the same temporal interval as Hidden Cave. Hidden Cave and Kramer Cave contained many of the same projectile point and Californian shell bead types, suggesting the possibility that these typological affinities could have resulted from participation in common interaction networks. If this had been the case, it would be anticipated that these two sites might also contain obsidian projectile points manufactured from many of the same volcanic glass source materials.

Although my analysis of the Kramer Cave material is not yet complete, it does not appear that Mono Basin obsidian source materials were exchanged in significant frequencies into the Winnemucca Lakes area, at least during this temporal interval (*ca.* 1500–1800 B.C.). Analyses completed to date reveal that only one projectile point (196/1752; Hattori, 1982, table 17, fig. 38j, p. 144) in the Kramer Cave assemblage was fashioned from southern Mono Basin obsidian.

Kramer Cave and Hidden Cave may have participated in the same shell bead and ornament exchange network; however, source analysis does not provide support for the position that obsidian projectile points were regularly exchanged between peoples utilizing these two sites. The Kramer Cave projectile point assemblage is not dominated by Mono Basin obsidians, even though shell bead and projectile point types are shared with Hidden Cave. This may signal that Kramer Cave shell beads came to the site through a different (northern ?) exchange route (e.g., Davis, 1961, map 1, trails 17, 18, 27, and 30) or that if they derived from the south,

shell beads and Mono Basin obsidians, once in the Carson Sink, were subject to different redistributive practices.

Finally, how do we account for the high frequencies of Mono Basin volcanic glasses at Hidden Cave and at other sites in the Carson Sink? Recall that these sources are not those located closest to the site, and that other, closer source materials could have been employed to manufacture projectile points. Holding the physical properties of these volcanic glasses constant, the key to this question, therefore, probably relates not so much to absolute distance to source as it does to effective distance. Ericson (1981, pp. 95, 145–147) has discussed the "space-utility" function of exchange, noting that exchange networks actually provide more energy efficient means of commodity transfer than do direct access systems. Although these exchange systems may be more efficient, they may also result in the increased value of the commodity due to increased handling costs. In the present case, if Mono Basin obsidian points were conveyed to Hidden Cave through an exchange network, costs resulting from multiple transactions may have enhanced the value of these objects. If so, these points may have been cached for later redistribution beyond Hidden Cave in nonutilitarian contexts.

A complementary account could be advanced by first considering obsidian procurement strategies in the context of the overall settlement-subsistence system hypothesized during this time period for Hidden Cave. Viewed in this light, the high frequencies of Mono Basin obsidians at the site may have resulted from less formal exchanges conducted during actual visits by families or fishing parties to the Walker River and Walker Lake area. The close proximity of Walker Lake villages to the abundant glass sources in the Mono Basin could then help account for these high frequencies. But even if peoples in the Carson Sink had comparatively unrestricted, low-cost access to Mono Basin glasses, once back in the Carson Sink these objects might have taken on a higher value, making them desirable exchange media.

Regardless of the specific exchange or procurement mechanisms involved, obsidian source data clearly support a systematic and directional contact between Carson Sink populations and social units further to the south in the Mono Basin. Contacts also were maintained to the north, presumably with folk in the Humboldt Sink. Insofar as it can be inferred on the basis of frequencies of Majuba Mountain obsidian, northern exchange transactions appear to have been less frequent than those to the south. Distance alone cannot account for the lower frequency of northern obsidian, since Majuba Mountain is only about 20 km. farther from Hidden Cave than Mt. Hicks (fig. 116). If the southern exchange route conveyed high status items (shell beads and ornaments) as well as obsidian, lower frequencies of northern obsidians would be expected because both commodities would have been obtained through the same southern network.

If this is correct, it might be possible to investigate nonutilitarian obsidian use on a source-specific basis in western Great Basin sites by determining which source materials consistently co-occur with known exchange items, such as Californian shell beads and ornaments. For example, if typable Mono Basin obsidian projectile points are consistently associated with temporally coeval Californian shell beads, one might infer a common exchange network for status items. However, discontinuities in these distributions (or pairings) might signal the operation of different procurement systems potentially monitoring differences in value. This proposal, of course, would have to be evaluated on a case by case basis, taking into account the availability of suitable alternative lithic sources (local obsidians, chert, and chalcedony).

Thus, a case for transmission of obsidian points and shell beads through the same exchange network could be made at sites like Hidden Cave where X-ray fluorescence analysis shows that closer alternative obsidian source materials to the southwest were virtually ignored and that frequencies of northern source material were lower than would have been expected solely on the basis of distance. In any event, source-specific distributional studies provide one promising avenue of attack on the problem of discerning variability in prehistoric exchange and interaction networks.

TABLE 78

Trace and Rare Earth Element Concentrations (in ppm), Fe/Mn Ratios, and Obsidian Source Attributions for Each Projectile Point Analyzed from Hidden Cave

Cat. No.	Stratum	Trace Element Concentrations										Ratio Fe/Mn	Obsidian Source	Point Type	Fig. No.
		Pb	Th	Rb	Sr	Y	Zr	Nb	Ba	La	Ce				
1-1B-883	Surface	37.4 ±2.1	23.7 ±3.8	155.4 ±3.2	23.9 ±2.0	12.8 ±2.5	95.1 ±2.6	19.5 ±2.0	—	—	—	—	Mt. Hicks	GSS	50a
1-1B-878	Surface	42.8 ±2.1	23.7 ±3.8	160.3 ±3.2	23.6 ±1.9	15.4 ±2.5	97.0 ±2.6	23.5 ±2.0	—	—	—	—	Mt. Hicks	GSS	50b
1-1B-131	Surface	41.4 ±2.0	24.8 ±3.7	160.1 ±3.1	23.9 ±1.9	13.6 ±2.4	93.6 ±2.5	20.7 ±2.0	—	—	—	—	Mt. Hicks	GSS	50f
1-1B-130	Surface	41.9 ±2.0	25.3 ±3.7	156.4 ±3.1	20.9 ±1.9	8.0 ±2.4	95.9 ±2.6	21.6 ±2.0	—	—	—	—	Mt. Hicks	GSS	50c
1-1B-59	Surface	41.8 ±2.5	23.0 ±4.6	167.5 ±3.9	94.4 ±3.2	0.0 ±0.0	93.1 ±3.2	16.7 ±2.4	630.0 ±13.8	37.6 ±4.9	53.5 ±5.5	—	Bodie Hills	GSS	50c
1-1B-880	Surface	31.1 ±1.7	18.6 ±3.3	178.0 ±3.0	64.6 ±2.1	14.3 ±2.2	101.6 ±2.4	19.4 ±1.8	231.8 ±7.7	20.7 ±3.7	38.3 ±4.2	—	Garfield Hills	GSS	55e
1-1B-958	Surface	26.2 ±2.1	19.4 ±4.1	160.3 ±3.5	120.2 ±3.2	18.8 ±2.8	166.6 ±3.5	17.6 ±2.2	—	—	—	35.76	Majuba Mountain	GSS	50i
1-1B-128?	Surface	31.9 ±2.2	12.7 ±4.2	153.5 ±3.6	117.6 ±3.2	17.7 ±2.9	153.1 ±3.5	13.7 ±2.2	—	—	—	34.36	Majuba Mountain	GSS	50j
1-1B-884	Surface	27.4 ±1.6	21.9 ±3.2	154.4 ±2.7	118.3 ±2.5	27.2 ±2.5	173.1 ±2.7	16.9 ±1.7	—	—	—	34.08	Majuba Mountain	GSS	50l
1-1B-145	Surface	28.7 ±1.7	10.3 ±3.1	77.8 ±2.2	265.2 ±3.4	16.5 ±2.1	130.4 ±2.7	13.4 ±1.8	1409.7 ±17.4	23.3 ±4.0	41.0 ±4.5	—	Unknown	GSS	50g
1-1B-249	Surface	35.2 ±2.0	17.9 ±3.9	157.4 ±3.3	75.1 ±2.6	21.2 ±2.7	108.5 ±2.9	18.5 ±2.1	1018.0 ±17.8	34.4 ±5.0	60.1 ±5.7	—	Unknown A	GSS	50d
1-1B-874	Surface	34.1 ±1.9	15.8 ±3.6	167.2 ±3.2	18.4 ±1.9	21.3 ±2.5	131.8 ±2.8	27.4 ±2.1	—	—	—	—	Queen	GCS	55a
1-1B-873	Surface	32.8 ±2.1	15.4 ±4.1	173.6 ±3.5	19.8 ±2.1	22.4 ±2.8	132.9 ±3.1	28.0 ±2.3	—	—	—	—	Queen	GCS	55d
1-1B-885	Surface	38.5 ±2.3	22.5 ±4.2	164.6 ±3.5	16.6 ±2.1	13.2 ±2.7	93.8 ±2.8	20.3 ±2.2	—	—	—	—	Mt. Hicks	HBN	61a
1-1B-886	Surface	35.7 ±2.5	17.6 ±4.6	136.6 ±3.7	22.2 ±2.3	0.0 ±0.0	81.9 ±3.1	17.6 ±2.4	—	—	—	—	Mt. Hicks	HBN ?	n.i.
1-1B-871	Surface	40.6 ±2.3	28.3 ±4.2	176.2 ±3.6	98.0 ±2.9	6.4 ±2.7	104.5 ±3.0	18.0 ±2.2	607.8 ±15.1	38.2 ±5.4	59.7 ±6.0	—	Bodie Hills	HS	63a

TABLE 78—(*Continued*)

Cat. No.	Stratum	Trace Element Concentrations										Ratio Fe/Mn	Obsidian Source	Point Type	Fig. No.
		Pb	Th	Rb	Sr	Y	Zr	Nb	Ba	La	Ce				
1-1B-129	Surface	33.0 ±1.8	24.6 ±3.5	181.0 ±3.1	20.1 ±1.8	23.7 ±2.4	141.3 ±2.7	31.5 ±2.0	—	—	—	—	Queen	EE	59a
1-1B-872	Surface	29.5 ±1.9	18.5 ±3.8	166.2 ±3.1	75.6 ±2.5	23.0 ±2.5	115.5 ±2.8	17.2 ±2.0	1076.5 ±19.3	33.8 ±5.4	56.6 ±6.3	—	Unknown A	RS	60a
2/32481*	I	37.8 ±4.9	29.9 ±5.0	169.4 ±3.6	23.7 ±2.5	14.1 ±3.1	81.9 ±3.7	18.7 ±2.7	—	—	—	—	Mt. Hicks	GSS	50o
2/32584*	I	27.8 ±4.7	18.1 ±4.8	168.2 ±3.5	25.3 ±2.5	11.9 ±3.0	91.8 ±3.7	18.5 ±2.7	—	—	—	—	Mt. Hicks	GSS	50m
20.4/398	I	38.7 ±2.1	30.0 ±3.9	165.3 ±3.2	23.6 ±2.0	13.0 ±2.5	98.0 ±2.6	22.0 ±2.1	—	—	—	—	Mt. Hicks	GCS	55g
20.4/908*	I	25.2 ±4.3	24.9 ±4.5	176.7 ±3.5	92.7 ±2.9	12.0 ±2.8	92.9 ±3.7	11.0 ±2.5	612.2 ±12.8	28.3 ±4.6	38.5 ±5.0	—	Bodie Hills	HBN	61c
20.4/985*	I	40.4 ±4.5	28.6 ±4.6	177.9 ±3.6	101.9 ±3.1	13.5 ±2.9	97.5 ±3.8	12.4 ±2.6	608.0 ±11.9	29.0 ±4.3	54.5 ±4.7	—	Bodie Hills	HBN	61d
20.4/813*	I	29.6 ±4.6	19.0 ±4.9	185.5 ±3.8	100.2 ±3.2	10.2 ±3.1	101.1 ±4.0	14.0 ±2.7	590.9 ±11.7	31.7 ±4.2	47.2 ±4.6	—	Bodie Hills	HBN	61b
20.4/965	I	40.6 ±1.7	28.8 ±3.4	185.6 ±2.9	96.2 ±2.3	14.8 ±2.1	116.8 ±2.4	16.0 ±1.7	616.5 ±11.5	35.4 ±4.0	57.4 ±4.6	—	Bodie Hills	RCB	64d
20.4/807*	I	27.5 ±4.5	15.2 ±4.6	141.8 ±3.5	73.8 ±3.0	17.3 ±3.0	83.1 ±3.8	12.2 ±2.7	746.4 ±16.7	37.8 ±5.6	59.8 ±6.3	20.11	Unknown	RCB	64c
1-1B-114	I	31.1 ±2.3	13.2 ±4.3	151.4 ±3.6	83.1 ±3.0	16.9 ±3.0	87.5 ±3.0	21.6 ±2.4	442.1 ±14.6	19.2 ±5.3	33.2 ±6.3	—	Pine Grove Hills ?	RS	60b
1-1B-890	I	27.9 ±2.1	17.5 ±4.1	153.0 ±3.5	116.3 ±3.2	19.5 ±2.8	160.0 ±3.5	18.0 ±2.2	—	—	—	35.28	Majuba Mountain	RS	60c
20.4/1245	I, II	45.7 ±2.2	26.0 ±4.2	175.7 ±3.5	99.4 ±2.9	9.3 ±2.6	106.9 ±2.9	18.1 ±2.1	576.3 ±14.7	36.2 ±5.5	46.9 ±6.1	—	Bodie Hills	GCS	55i
20.4/1291	I, II	29.2 ±1.8	20.6 ±3.6	164.0 ±3.1	87.6 ±2.5	25.2 ±2.5	126.7 ±2.7	17.8 ±1.9	1078.7 ±16.1	38.8 ±4.4	73.3 ±5.0	12.32	Unknown	GCS	66j
2/32463*	II	33.0 ±5.3	18.9 ±5.3	165.1 ±3.8	27.9 ±2.8	16.7 ±3.3	84.7 ±4.0	18.2 ±2.9	—	—	—	—	Mt. Hicks	GSS	51m
1-1B-378	II	43.4 ±2.2	18.9 ±4.1	166.9 ±3.4	25.4 ±2.1	12.7 ±2.6	97.0 ±2.7	23.1 ±2.2	—	—	—	—	Mt. Hicks	GSS	51b
1-1B-365	II	44.3 ±2.1	23.7 ±3.9	168.8 ±3.3	27.9 ±2.1	14.3 ±2.5	96.7 ±2.7	18.9 ±2.1	—	—	—	—	Mt. Hicks	GSS	51c

TABLE 78—(*Continued*)

Cat. No.	Stratum	Trace Element Concentrations										Ratio Fe/Mn	Obsidian Source	Point Type	Fig. No.
		Pb	Th	Rb	Sr	Y	Zr	Nb	Ba	La	Ce				
20.4/572*	II	40.0 ±4.5	29.0 ±4.8	184.1 ±3.8	97.5 ±3.2	7.4 ±3.0	90.0 ±3.9	13.5 ±2.7	595.9 ±11.9	27.5 ±4.2	48.8 ±4.8	—	Bodie Hills	GSS	51j
2/32749*	II	34.5 ±4.7	27.3 ±4.9	184.2 ±3.7	103.8 ±3.1	12.6 ±3.0	104.5 ±3.8	13.2 ±2.6	637.5 ±15.5	32.6 ±5.5	52.0 ±6.2	—	Bodie Hills	GSS	51p
1-1B-456	II	35.2 ±2.0	22.8 ±3.7	173.3 ±3.2	20.2 ±1.9	21.3 ±2.6	131.5 ±2.9	31.8 ±2.1	—	—	—	—	Queen	GSS	51g
1-1B-586	II	32.2 ±2.1	13.0 ±3.9	168.5 ±3.4	20.6 ±2.0	19.4 ±2.7	128.6 ±3.0	28.9 ±2.2	—	—	—	—	Queen	GSS	51a
1-1B-620	II	29.5 ±1.9	17.1 ±3.7	167.3 ±3.2	60.2 ±2.4	15.0 ±2.5	96.1 ±2.6	18.5 ±2.0	219.8 ±7.5	18.3 ±3.6	37.5 ±4.3	—	Garfield Hills	GSS	51f
20.4/653*	II	24.3 ±4.5	12.8 ±4.7	156.6 ±3.6	117.9 ±3.4	22.0 ±3.1	168.1 ±4.4	8.6 ±2.6	1045.9 ±16.7	33.8 ±4.8	76.6 ±5.5	34.89	Majuba Mountain	GSS	51o
2/32660*	II	25.0 ±4.4	16.0 ±4.6	174.5 ±3.4	131.1 ±3.2	17.8 ±2.9	180.1 ±4.1	8.6 ±2.5	1079.6 ±15.5	42.5 ±4.6	70.1 ±5.1	35.24	Majuba Mountain	GSS	51k
2/32750*	II	35.8 ±4.5	20.9 ±4.6	171.5 ±3.2	134.4 ±3.2	20.4 ±3.0	180.7 ±4.1	9.9 ±2.5	1108.8 ±15.8	33.2 ±4.5	75.1 ±5.0	35.79	Majuba Mountain	GSS	51h
1-1B-399†	II	29.6 ±2.1	15.4 ±4.0	159.9 ±3.5	119.4 ±3.1	16.0 ±2.8	163.7 ±3.4	15.4 ±2.1	—	—	—	34.79	Majuba Mountain	GSS	51i
1-1B-706	II	30.6 ±1.9	15.8 ±3.8	159.8 ±3.2	129.6 ±2.9	18.0 ±2.6	161.4 ±3.1	17.2 ±2.0	—	—	—	35.24	Majuba Mountain	GSS	51l
2/32433*	II	35.4 ±4.9	28.3 ±5.0	186.9 ±3.8	111.8 ±3.3	13.6 ±3.1	100.0 ±4.0	12.4 ±2.7	597.3 ±11.3	38.3 ±4.0	53.7 ±4.6	—	Bodie Hills	GSS ?	66a
2/32759*	II	33.8 ±4.9	26.8 ±5.0	192.6 ±3.8	103.2 ±3.2	16.2 ±3.1	96.5 ±3.9	10.2 ±2.6	583.8 ±11.9	23.0 ±4.3	58.5 ±4.8	—	Bodie Hills	GSS ?	66b
20.4/549*	II	38.4 ±5.2	19.5 ±5.2	159.6 ±3.9	26.0 ±2.7	13.7 ±3.3	79.4 ±4.1	18.4 ±3.0	—	—	—	—	Mt. Hicks	GCS	55n
2/32485*	II	49.3 ±5.6	20.4 ±5.6	178.7 ±4.0	27.0 ±2.8	15.6 ±3.5	87.7 ±4.1	17.7 ±3.0	—	—	—	—	Mt. Hicks	GCS	55q
20.4/1005*	II	32.5 ±4.7	25.4 ±4.8	174.0 ±3.8	17.6 ±2.4	20.4 ±3.2	130.6 ±4.2	26.4 ±2.9	—	—	—	—	Queen	GCS	55m
2/32747*	II	20.5 ±4.4	10.8 ±4.5	189.0 ±3.5	67.0 ±2.7	17.2 ±2.9	89.3 ±3.5	15.3 ±2.5	221.3 ±7.8	211.1 ±3.7	31.9 ±4.2	—	Garfield Hills	GCS	55r
20.4/434*	II	30.8 ±4.6	18.1 ±4.7	163.3 ±3.7	125.7 ±3.5	21.9 ±3.1	170.0 ±4.5	9.0 ±2.7	1067.9 ±16.7	39.0 ±4.7	66.5 ±5.4	36.70	Majuba Mountain	GCS	55x

TABLE 78—(*Continued*)

Cat. No.	Stratum	Trace Element Concentrations										Ratio Fe/Mn	Obsidian Source	Point Type	Fig. No.
		Pb	Th	Rb	Sr	Y	Zr	Nb	Ba	La	Ce				
1-1B-466	II	27.3 ±1.9	12.5 ±3.7	154.6 ±3.2	120.5 ±2.9	16.2 ±2.5	158.0 ±3.1	16.2 ±2.0	—	—	—	33.96	Majuba Mountain	GCS	55l
1-1B-534	II	33.6 ±1.9	14.0 ±3.8	168.2 ±3.2	132.3 ±3.0	22.1 ±2.6	174.4 ±3.2	17.3 ±2.0	—	—	—	33.98	Majuba Mountain	GCS	55aa
1-1B-366	II	43.4 ±2.0	25.7 ±3.5	175.1 ±3.0	2.4 ±1.6	62.0 ±2.7	358.5 ±3.8	21.0 ±1.9	—	—	—	64.26	Homecamp A	GCS	55o
1-1B-273	II	39.9 ±2.0	27.2 ±3.6	168.9 ±3.0	24.1 ±2.3	12.0 ±2.3	96.0 ±2.4	22.4 ±1.9	—	—	—	—	Mt. Hicks	GCS	55p
2/32751*	II	40.6 ±5.0	23.2 ±5.0	170.9 ±3.7	25.3 ±2.6	15.9 ±3.2	85.0 ±3.8	17.4 ±2.8	—	—	—	—	Mt. Hicks	HBN	61j
2/32408*	II	37.6 ±5.5	23.8 ±5.5	169.6 ±4.0	28.4 ±2.8	15.2 ±3.4	86.3 ±4.1	19.1 ±3.0	—	—	—	—	Mt. Hicks	HBN	61l
1-1B-290	II	43.2 ±2.2	19.4 ±4.0	147.2 ±3.3	22.1 ±2.0	12.6 ±2.6	91.9 ±2.7	20.6 ±2.1	—	—	—	—	Mt. HIcks	HBN	61p
1-1B-286	II	40.5 ±2.1	15.9 ±3.8	157.3 ±3.2	24.1 ±2.0	15.1 ±2.5	94.2 ±2.6	19.4 ±2.1	—	—	—	—	Mt. Hicks	HBN	61g
1-1B-341	II	37.4 ±1.6	29.0 ±3.1	157.9 ±2.6	22.0 ±1.6	16.3 ±2.0	96.4 ±2.1	22.1 ±1.7	—	—	—	—	Mt. Hicks	HBN	61n
2/32611*	II	36.6 ±5.5	27.4 ±5.7	184.0 ±4.2	101.9 ±3.6	15.2 ±3.5	110.3 ±4.5	16.5 ±3.0	557.1 ±14.2	30.4 ±5.3	48.2 ±5.9	—	Bodie Hills	HBN	61f
2/32734*	II	41.7 ±5.2	34.0 ±5.4	187.1 ±4.0	100.5 ±3.4	12.2 ±3.3	96.0 ±4.1	12.7 ±2.8	614.3 ±12.7	33.5 ±4.5	63.1 ±5.1	—	Bodie Hills	HBN	61e
1-1B-216	II	38.7 ±2.2	23.6 ±4.1	173.5 ±3.5	94.3 ±2.8	10.6 ±2.6	102.1 ±2.9	16.7 ±2.1	614.6 ±12.2	36.3 ±4.5	46.6 ±5.0	—	Bodie Hills	HBN	61h
1-1B-313	II	42.1 ±2.1	29.2 ±3.9	183.1 ±3.4	101.3 ±2.7	8.7 ±2.5	102.6 ±2.7	16.8 ±2.0	590.1 ±12.0	33.4 ±4.4	52.9 ±5.0	—	Bodie Hills	HBN	61i
20.4/1201	II	32.6 ±2.1	15.4 ±4.1	163.2 ±3.5	21.4 ±2.1	20.6 ±2.8	127.9 ±3.1	27.4 ±2.8	—	—	—	—	Queen	HBN	61k
1-1B-615	II	31.7 ±2.1	18.1 ±4.1	174.5 ±3.6	18.4 ±2.1	22.2 ±2.8	132.2 ±3.1	29.0 ±2.3	—	—	—	—	Queen	HBN	61o
20.4/827	II	27.5 ±1.8	14.6 ±3.5	158.8 ±3.0	121.5 ±2.8	20.4 ±2.4	165.9 ±3.0	15.1 ±1.9	—	—	—	35.50	Majuba Mountain	HBN	61m
2/32570*	II	33.0 ±5.4	23.6 ±5.4	170.0 ±4.0	20.3 ±2.8	13.7 ±3.4	82.8 ±4.1	20.7 ±3.0	—	—	—	—	Mt. Hicks	HS	63b

TABLE 78—(*Continued*)

Cat. No.	Stratum	Trace Element Concentrations Pb	Th	Rb	Sr	Y	Zr	Nb	Ba	La	Ce	Ratio Fe/Mn	Obsidian Source	Point Type	Fig. No.
1-1B-399†	II	38.5 ±2.1	15.8 ±3.9	151.6 ±3.2	22.8 ±2.0	13.5 ±2.5	91.3 ±2.6	19.6 ±2.1	—	—	—	—	Mt. Hicks	RCB	64e
1-1B-646	II	29.1 ±2.2	10.1 ±4.3	155.7 ±3.6	122.7 ±3.3	21.2 ±2.9	166.2 ±3.6	15.3 ±2.3	—	—	—	33.79	Majuba Mountain	RCB	64f
1-1B-278	II	43.8 ±2.6	18.1 ±4.8	154.8 ±3.9	20.8 ±2.4	12.2 ±3.1	93.9 ±3.2	18.8 ±2.5	—	—	—	—	Mt. Hicks	ECN	58c
2/32557*	II	25.3 ±5.4	26.9 ±5.7	187.2 ±4.2	100.5 ±3.5	12.1 ±3.4	96.2 ±4.3	13.2 ±2.9	619.0 ±14.4	40.8 ±5.4	52.8 ±5.8	—	Bodie Hills	RS	60e
20.4/1302	II, III	41.4 ±3.0	24.1 ±5.6	151.4 ±4.3	18.2 ±2.8	16.5 ±3.5	90.9 ±3.6	20.3 ±2.8	—	—	—	—	Mt. Hicks	GSS ?	66c
20.4/1641	III	36.3 ±2.1	19.9 ±3.9	153.3 ±3.2	23.6 ±2.0	10.6 ±2.5	90.4 ±2.6	18.5 ±2.1	—	—	—	—	Mt. Hicks	GSS	52d
20.4/828*	III	24.2 ±4.8	24.0 ±5.1	185.3 ±3.9	99.1 ±3.3	13.1 ±3.2	94.9 ±4.1	14.6 ±2.8	599.5 ±14.0	29.8 ±5.1	58.1 ±5.7	—	Bodie Hills	GSS	52h
20.4/555*	III	33.8 ±4.4	33.8 ±4.6	186.8 ±3.6	100.7 ±3.0	10.1 ±2.9	101.2 ±3.8	14.1 ±2.5	593.6 ±11.1	30.3 ±4.0	63.0 ±4.6	—	Bodie Hills	GSS	52c
20.4/1651	III	42.2 ±2.1	29.0 ±3.9	183.7 ±3.3	100.9 ±2.7	12.8 ±2.5	104.3 ±2.7	18.4 ±2.0	597.1 ±12.3	33.8 ±4.6	52.8 ±5.1	—	Bodie Hills	GSS	52e
20.4/1312	III	35.5 ±1.8	23.8 ±3.4	180.6 ±3.0	20.8 ±1.7	26.5 ±2.3	139.9 ±2.6	30.9 ±1.9	—	—	—	—	Queen	GSS	52a
20.4/1194	III	28.5 ±1.7	22.3 ±3.5	170.0 ±3.0	127.2 ±2.7	22.2 ±2.4	172.3 ±2.9	16.2 ±1.8	—	—	—	34.56	Majuba Mountain	GSS	52g
20.4/1648	III	37.8 ±1.9	21.0 ±3.6	159.9 ±2.9	24.4 ±1.8	15.2 ±2.3	96.5 ±2.4	20.9 ±1.9	—	—	—	—	Mt. Hicks	GCS	56c
1-1B-865	III	39.9 ±2.1	16.3 ±3.8	156.5 ±3.1	23.9 ±2.0	9.7 ±2.5	94.2 ±2.6	20.9 ±2.0	—	—	—	—	Mt. Hicks	GCS	56b
20.4/557*	III	36.2 ±5.0	31.9 ±5.3	186.0 ±4.1	103.9 ±3.5	10.1 ±3.3	97.7 ±4.3	9.3 ±2.9	619.5 ±14.6	34.5 ±5.2	45.2 ±5.8	—	Bodie Hills	GCS	56d
20.4/1199	III	30.7 ±1.9	15.1 ±3.8	163.9 ±3.2	126.6 ±2.9	24.3 ±2.6	168.0 ±3.2	16.2 ±2.0	—	—	—	34.03	Majuba Mountain	GCS	66d
20.4/864*	III, IV	23.0 ±4.5	18.0 ±4.6	177.6 ±3.7	67.6 ±2.9	17.0 ±3.1	86.5 ±3.8	12.4 ±2.6	260.6 ±9.0	27.0 ±4.2	42.1 ±4.1	—	Garfield Hills	GSS	52i
20.4/863*	III, IV	29.0 ±4.3	19.4 ±4.3	160.2 ±3.3	20.9 ±2.2	11.2 ±2.8	81.3 ±3.4	15.6 ±2.5	—	—	—	—	Mt. Hicks	GCS	56e

TABLE 78—(*Continued*)

Cat. No.	Stratum	Trace Element Concentrations										Ratio Fe/Mn	Obsidian Source	Point Type	Fig. No.
		Pb	Th	Rb	Sr	Y	Zr	Nb	Ba	La	Ce				
20.4/685*	III, IV	29.9 ±4.7	24.0 ±4.9	153.1 ±3.7	21.1 ±2.5	11.0 ±3.1	73.7 ±3.8	14.6 ±2.8	—	—	—	—	Mt. Hicks	GCS	56f
20.4/1678	III, IV	36.7 ±2.0	22.5 ±3.7	156.5 ±3.1	22.2 ±1.9	14.3 ±2.4	99.0 ±2.5	19.5 ±2.0	—	—	—	—	Mt. Hicks	GCS	56g
20.4/939*	III, IV	25.5 ±5.0	17.7 ±5.1	156.2 ±4.0	122.2 ±3.8	18.5 ±3.4	160.1 ±4.9	9.5 ±2.9	1011.0 ±17.9	37.0 ±5.3	62.2 ±6.1	35.00	Majuba Mountain	HS	63d
20.4/680*	IV	29.8 ±4.5	20.3 ±4.7	157.5 ±3.6	20.5 ±2.4	14.2 ±3.0	75.9 ±3.7	16.7 ±2.7	—	—	—	—	Mt. Hicks	GSS	53f
20.4/833	IV	36.2 ±2.0	18.5 ±3.6	152.0 ±3.0	23.0 ±1.9	10.5 ±2.4	87.2 ±2.5	18.2 ±1.9	—	—	—	—	Mt. Hicks	GSS	53a
20.4/1552	IV	40.7 ±2.2	18.3 ±4.0	148.8 ±3.3	21.4 ±2.1	9.8 ±2.6	90.6 ±2.7	21.5 ±2.2	—	—	—	—	Mt. Hicks	GSS	53i
20.4/1564	IV	41.2 ±2.0	22.1 ±3.6	164.9 ±3.0	23.8 ±1.9	14.9 ±2.4	96.8 ±2.5	21.7 ±1.9	—	—	—	—	Mt. Hicks	GSS	53h
1-1B-326	IV	41.1 ±2.0	24.0 ±3.8	162.4 ±3.1	23.7 ±2.0	13.4 ±2.5	100.2 ±2.6	20.4 ±2.0	—	—	—	—	Mt. Hicks	GSS	53j
20.4/852*	IV	31.2 ±4.5	24.1 ±4.7	180.9 ±3.7	108.3 ±3.2	16.1 ±3.0	95.1 ±3.9	14.3 ±2.6	608.1 ±11.7	37.4 ±4.2	61.9 ±4.7	—	Bodie Hills	GSS	53b
2/32442*	IV	28.1 ±4.5	22.5 ±4.6	179.5 ±3.5	108.7 ±3.0	11.6 ±2.9	98.2 ±3.7	11.2 ±2.5	614.9 ±13.0	41.8 ±4.6	47.6 ±5.1	—	Bodie Hills	GSS	53q
20.4/936*	IV	28.5 ±4.6	21.2 ±4.7	167.3 ±3.7	17.6 ±2.4	26.4 ±3.2	122.9 ±4.1	27.5 ±2.8	—	—	—	—	Queen	GSS	53c
2/32655*	IV	26.9 ±4.8	15.5 ±4.9	185.4 ±3.7	64.3 ±2.9	16.4 ±3.1	93.1 ±3.8	10.6 ±2.7	236.0 ±7.9	21.0 ±3.7	35.7 ±4.4	—	Garfield Hills	GSS	53g
20.4/681*	IV	24.1 ±4.3	14.8 ±4.4	158.7 ±3.4	123.4 ±3.2	16.3 ±2.9	166.2 ±4.2	11.9 ±2.5	1066.1 ±17.4	30.0 ±5.0	73.9 ±5.6	32.03	Majuba Mountain	GSS	53p
1-1B-307	IV	23.7 ±2.3	10.8 ±4.5	143.8 ±3.7	113.3 ±3.4	16.5 ±3.1	148.0 ±3.7	14.4 ±2.4	—	—	—	36.03	Majuba Mountain	GSS	53d
20.4/1233	IV	30.9 ±1.9	12.5 ±3.7	168.8 ±3.1	127.1 ±2.9	26.2 ±2.5	173.9 ±3.1	14.1 ±2.0	—	—	—	35.59	Majuba Mountain	GSS	53o
20.4/1672	IV	42.1 ±2.2	20.2 ±4.0	146.4 ±3.3	20.4 ±2.1	11.2 ±2.6	88.3 ±2.7	17.1 ±2.2	—	—	—	—	Mt. Hicks	GSS ?	66e
2/32758*	IV	34.4 ±4.6	18.9 ±4.6	167.5 ±3.4	25.4 ±2.4	12.7 ±2.9	81.7 ±3.5	13.6 ±2.5	—	—	—	—	Mt. Hicks	GCS	56i

TABLE 78—(*Continued*)

Cat. No.	Stratum	Trace Element Concentrations										Ratio Fe/Mn	Obsidian Source	Point Type	Fig. No.
		Pb	Th	Rb	Sr	Y	Zr	Nb	Ba	La	Ce				
20.4/1689	IV	40.2 ±2.1	28.0 ±3.8	154.3 ±3.2	21.5 ±2.0	15.1 ±2.5	100.6 ±2.6	19.8 ±2.0	—	—	—	—	Mt. Hicks	GCS	56i
20.4/928*	IV	25.9 ±5.0	16.1 ±5.1	176.5 ±4.0	22.0 ±2.7	24.8 ±3.4	126.0 ±4.4	23.8 ±3.1	—	—	—	—	Queen	GCS	56j
20.4/861*	IV	38.2 ±4.9	23.1 ±5.0	153.6 ±3.7	30.4 ±2.7	18.5 ±3.2	77.4 ±3.9	13.2 ±2.8	—	—	—	—	Mt. Hicks	RCB	64k
20.4/688*	IV	30.7 ±4.9	20.8 ±4.9	146.0 ±3.6	22.8 ±2.5	13.4 ±3.1	77.1 ±3.8	14.3 ±2.8	—	—	—	—	Mt. Hicks	RCB	64j
2/32403*	IV, V	28.7 ±4.7	10.3 ±4.8	168.9 ±3.6	134.4 ±3.4	23.6 ±3.1	178.3 ±4.3	9.9 ±2.6	1038.8 ±15.6	36.7 ±4.5	72.8 ±5.2	33.82	Majuba Mountain	GSS	53r
20.4/1501	IV, V	40.7 ±1.9	32.8 ±3.6	165.6 ±3.0	24.1 ±1.8	16.0 ±2.3	97.4 ±2.4	23.0 ±1.9	—	—	—	—	Mt. Hicks	GCS	56m
20.4/1708	V	44.4 ±1.9	31.2 ±3.6	166.6 ±3.0	23.5 ±1.9	19.4 ±2.4	99.7 ±2.5	24.0 ±1.9	—	—	—	—	Mt. Hicks	GSS	53t
20.4/955*	V	28.3 ±4.2	30.1 ±4.4	183.9 ±3.5	102.3 ±3.0	10.7 ±2.8	100.4 ±3.7	11.8 ±2.5	602.0 ±12.0	24.5 ±4.3	54.5 ±4.8	—	Bodie Hills	GSS	53u
2/32607*	V	39.0 ±5.1	28.7 ±5.2	189.3 ±3.8	21.3 ±2.6	28.1 ±3.3	131.2 ±4.2	31.4 ±2.9	—	—	—	—	Queen	ECN	58e
20.4/1238	IX	30.8 ±1.9	18.1 ±3.7	180.9 ±3.3	59.1 ±2.4	14.6 ±2.5	99.3 ±2.7	16.5 ±2.0	225.2 ±7.6	15.8 ±3.6	35.9 ±4.1	—	Garfield Hills	EE	59c
2/32696*	IX, X	32.8 ±4.6	18.3 ±4.6	170.8 ±3.4	107.1 ±3.0	24.6 ±3.0	124.1 ±3.8	8.2 ±2.5	1125.7 ±15.8	30.6 ±4.3	58.1 ±4.8	13.85	Unknown	HS	63e
2/32698*	IX, X	33.5 ±4.6	18.6 ±4.6	156.6 ±3.3	25.5 ±2.4	13.7 ±2.9	80.9 ±3.5	17.3 ±2.6	—	—	—	—	Mt. Hicks	RCB	64m
2/32695*	IX, X	24.5 ±5.7	16.9 ±5.8	140.9 ±4.1	56.3 ±3.4	24.6 ±3.8	121.5 ±4.8	11.5 ±3.2	672.0 ±13.2	26.7 ±4.4	42.4 ±4.9	28.99	Unknown	RCB	64l
20.3/9929*	N.C.	30.3 ±4.6	20.4 ±4.7	155.5 ±3.6	23.6 ±2.4	13.9 ±3.0	76.2 ±3.7	14.8 ±2.7	—	—	—	—	Mt. Hicks	GSS	54z
20.3/9784*	N.C.	39.6 ±4.6	26.1 ±4.7	152.9 ±3.5	25.2 ±2.4	18.0 ±3.0	81.4 ±3.7	13.5 ±2.6	—	—	—	—	Mt. Hicks	GSS	54k
20.4/756*	N.C.	38.5 ±4.4	18.6 ±4.5	147.5 ±3.4	30.4 ±2.4	17.5 ±2.9	73.5 ±3.6	18.6 ±2.6	—	—	—	—	Mt. Hicks	GSS	54i
20.4/960*	N.C.	31.2 ±4.6	19.3 ±4.7	159.2 ±3.6	27.1 ±2.4	18.6 ±3.1	71.6 ±3.7	16.3 ±2.7	—	—	—	—	Mt. Hicks	GSS	54x

TABLE 78—(*Continued*)

Cat. No.	Stratum	Trace Element Concentrations										Ratio Fe/Mn	Obsidian Source	Point Type	Fig. No.
		Pb	Th	Rb	Sr	Y	Zr	Nb	Ba	La	Ce				
2/32509*	N.C.	30.9 ±5.0	17.2 ±5.1	180.7 ±3.7	26.8 ±2.6	14.7 ±3.2	90.5 ±3.8	16.5 ±2.8	—	—	—	—	Mt. Hicks	GSS	54y
20.4/1618	N.C.	38.9 ±2.1	19.3 ±3.8	154.4 ±3.2	24.5 ±2.0	13.7 ±2.5	93.7 ±2.6	19.0 ±2.0	—	—	—	—	Mt. Hicks	GSS	54g
20.3/9923	N.C.	42.5 ±1.9	20.9 ±3.5	166.3 ±3.0	20.5 ±1.8	13.4 ±2.3	94.4 ±2.4	18.5 ±1.9	—	—	—	—	Mt. Hicks	GSS	54e
2/32639*	N.C.	33.0 ±4.6	29.4 ±4.7	179.0 ±3.5	21.4 ±2.4	23.3 ±3.1	134.1 ±3.9	29.6 ±2.7	—	—	—	—	Queen	GSS	54d
20.4/396*	N.C.	34.6 ±4.2	19.5 ±4.4	155.3 ±3.4	93.1 ±3.0	10.2 ±2.8	75.6 ±3.5	8.4 ±2.5	354.9 ±9.1	19.3 ±3.5	30.6 ±4.0	—	Pine Grove Hills	GSS	54f
20.4/583*	N.C.	26.6 ±4.4	19.4 ±4.7	177.3 ±3.7	63.2 ±2.9	15.5 ±3.1	83.7 ±3.8	15.9 ±2.7	—	—	—	—	Garfield Hills ?	GSS	54q
2/32638*	N.C.	26.5 ±5.3	15.0 ±5.3	172.8 ±3.9	127.4 ±3.7	20.1 ±3.5	180.4 ±4.8	13.0 ±2.9	1060.9 ±17.5	38.8 ±5.1	70.4 ±5.7	37.32	Majuba Mountain	GSS	54i
20.4/1706	N.C.	30.4 ±2.0	11.3 ±3.9	174.8 ±3.4	133.6 ±3.1	22.2 ±2.7	177.5 ±3.3	15.7 ±2.1	—	—	—	34.36	Majuba Mountain	GSS	54v
20.4/1619	N.C.	28.9 ±1.8	21.5 ±3.5	162.3 ±3.0	122.1 ±2.7	21.6 ±2.4	172.8 ±3.0	18.3 ±1.9	—	—	—	34.40	Majuba Mountain	GSS	54n
20.4/386	N.C.	43.9 ±2.3	20.3 ±4.2	167.0 ±3.5	3.2 ±1.9	59.0 ±3.2	335.1 ±4.3	19.1 ±2.3	—	—	—	61.76	NW Nevada	GSS	54r
20.3/9920*	N.C.	32.1 ±4.6	25.7 ±4.7	150.6 ±3.6	101.5 ±3.3	22.1 ±3.2	131.1 ±4.2	11.1 ±2.7	1125.5 ±17.4	26.2 ±4.7	52.4 ±5.4	14.04	Unknown	GSS	54w
20.4/1327	N.C.	31.8 ±1.9	15.8 ±3.8	144.6 ±3.2	116.8 ±2.9	16.8 ±2.6	142.9 ±3.1	12.1 ±2.0	—	—	—	33.29	Majuba Mountain	GSS ?	66f
20.3/9922*	N.C.	32.4 ±5.5	22.6 ±5.6	158.5 ±4.2	25.2 ±2.9	11.9 ±3.6	77.0 ±4.4	20.0 ±3.2	—	—	—	—	Mt. Hicks	GCS	57b
20.3/9926*	N.C.	39.7 ±4.8	20.3 ±4.8	155.7 ±3.6	22.4 ±2.5	14.2 ±3.1	78.9 ±3.8	15.9 ±2.7	—	—	—	—	Mt. Hicks	GCS	57g
20.4/687*	N.C.	38.4 ±4.7	18.8 ±4.9	161.4 ±3.7	24.5 ±2.5	13.0 ±3.1	83.3 ±3.8	17.6 ±2.8	—	—	—	—	Mt. Hicks	GCS	57c
20.4/704*	N.C.	34.3 ±4.2	20.3 ±4.2	161.6 ±3.2	24.7 ±2.2	11.1 ±2.7	78.6 ±3.3	19.3 ±2.4	—	—	—	—	Mt. Hicks	GCS	57q
20.4/768*	N.C.	31.8 ±4.3	20.1 ±4.4	155.5 ±3.3	24.0 ±2.3	16.4 ±2.8	76.4 ±3.5	14.8 ±2.5	—	—	—	—	Mt. Hicks	GCS	57o

TABLE 78—(*Continued*)

Cat. No.	Stratum	Trace Element Concentrations										Ratio Fe/Mn	Obsidian Source	Point Type	Fig. No.
		Pb	Th	Rb	Sr	Y	Zr	Nb	Ba	La	Ce				
20.4/397*	N.C.	34.1 ±4.5	24.8 ±4.6	153.0 ±3.5	24.0 ±2.4	16.8 ±3.0	81.7 ±3.7	18.7 ±2.6	—	—	—	—	Mt. Hicks	GCS	66g
20.4/686*	N.C.	37.0 ±5.1	27.5 ±5.2	159.0 ±3.9	22.1 ±2.7	18.7 ±3.3	76.1 ±4.1	16.4 ±3.0	—	—	—	—	Mt. Hicks	GCS	57d
20.4/382*	N.C.	33.4 ±5.0	30.9 ±5.3	187.0 ±4.1	99.3 ±3.4	9.9 ±3.3	102.3 ±4.2	12.9 ±2.9	619.3 ±15.2	38.8 ±5.6	54.3 ±6.2	—	Bodie Hills	GCS	57k
20.4/1523	N.C.	39.7 ±2.1	25.6 ±3.9	183.5 ±3.3	125.9 ±2.9	12.2 ±2.5	109.4 ±2.7	17.8 ±2.0	599.3 ±12.0	33.2 ±4.3	55.2 ±4.8	—	Bodie Hills	GCS	57s
20.4/1431	N.C.	30.4 ±2.0	0.0 ±0.0	139.4 ±3.1	79.2 ±2.6	14.8 ±2.6	79.2 ±2.6	21.1 ±2.1	407.5 ±10.1	21.6 ±3.9	43.2 ±4.4	—	Pine Grove Hills ?	GCS	57m
20.3/9925*	N.C.	26.0 ±4.4	14.6 ±4.6	173.2 ±3.7	65.8 ±2.8	18.6 ±3.1	83.1 ±3.8	11.2 ±2.7	219.3 ±8.0	18.9 ±3.9	47.3 ±3.8	—	Garfield Hills ?	GCS	57n
20.4/328*	N.C.	34.6 ±4.9	16.9 ±5.0	159.2 ±3.8	121.3 ±3.6	20.1 ±3.3	169.1 ±4.7	8.9 ±2.8	997.7 ±18.2	32.5 ±5.5	67.8 ±6.2	35.25	Majuba Mountain	GCS	57t
20.3/9781*	N.C.	32.3 ±4.5	17.5 ±4.7	148.8 ±3.5	91.5 ±3.1	18.0 ±3.1	180.4 ±4.5	14.5 ±2.7	—	—	—	48.94	Casa Diablo	GCS ?	n.i.
20.3/9775*	N.C.	26.2 ±4.7	30.5 ±5.0	187.0 ±3.9	96.6 ±3.3	12.1 ±3.1	101.5 ±4.1	13.8 ±2.7	586.4 ±12.0	22.5 ±4.3	44.5 ±4.9	—	Bodie Hills	HBN	61q
20.3/9919*	N.C.	33.3 ±5.1	19.2 ±5.2	154.5 ±3.9	21.9 ±2.7	14.4 ±3.3	82.5 ±4.0	19.2 ±2.9	—	—	—	—	Mt. Hicks	HS	63g
20.4/584	N.C.	29.5 ±2.2	0.0 ±0.0	59.9 ±2.8	218.9 ±4.3	13.4 ±2.8	88.9 ±3.4	0.0 ±0.0	—	—	—	—	Unknown	HS	63h

TABLE 78—(*Continued*)

Cat. No.	Stratum	Trace Element Concentrations										Ratio Fe/Mn	Obsidian Source	Point Type	Fig. No.
		Pb	Th	Rb	Sr	Y	Zr	Nb	Ba	La	Ce				
20.4/979*	N.C.	34.2 ±5.1	17.6 ±5.2	152.5 ±3.9	21.5 ±2.7	12.3 ±3.3	75.5 ±4.1	16.1 ±2.9	—	—	—	—	Mt. Hicks	RCB	64q
1-1B-510	N.C.	39.4 ±2.3	24.8 ±4.2	163.7 ±3.6	91.6 ±2.9	9.2 ±2.7	89.2 ±2.9	17.0 ±2.2	565.8 ±11.0	40.8 ±4.1	55.3 ±4.5	—	Bodie Hills	RCB	64n
20.4/378*	N.C.	26.3 ±5.3	4.8 ±5.2	142.3 ±4.0	74.7 ±3.5	14.0 ±3.5	58.5 ±4.2	19.5 ±3.1	393.1 ±13.8	16.5 ±5.6	32.9 ±6.3	—	Pine Grove Hills	RCB	64p
20.3/9777*	N.C.	26.0 ±4.3	23.6 ±4.4	157.8 ±3.3	21.1 ±2.3	10.8 ±2.8	75.7 ±3.5	15.9 ±2.5	—	—	—	—	Mt. Hicks	EE	59d
20.4/329*	N.C.	24.8 ±4.4	22.0 ±4.6	173.1 ±3.6	95.4 ±3.1	10.7 ±2.9	95.6 ±3.7	12.6 ±2.5	624.8 ±12.4	26.4 ±4.4	60.7 ±4.9	—	Bodie Hills	EE	59f
20.3/9924	N.C.	39.5 ±2.1	19.5 ±3.6	169.8 ±3.1	3.1 ±1.7	61.1 ±2.8	354.1 ±3.9	19.2 ±2.0	—	—	—	56.93	Homecamp A or C	ECN	58f
20.3/9930*	N.C.	41.7 ±6.2	37.6 ±6.4	183.4 ±4.9	99.7 ±4.1	11.5 ±4.0	96.2 ±5.1	15.2 ±3.5	624.1 ±18.4	34.5 ±6.9	68.7 ±7.9	—	Bodie Hills	RS	60h

* = Ag (silver) x-ray tube

† These points were assigned the same catalog number.

N.C. = not correlated

n.i. = not illustrated

± = counting error uncertainty

Point type abbreviations:

GSS = Gatecliff Split Stem

GCS = Gatecliff Contracting Stem

HBN = Humboldt Basal-notched

HS = Humboldt Series

RCB = Residual Concave Base

EE = Elko Eared

ECN = Elko Corner-notched

RS = Rosegate Series

TABLE 79

Trace and Rare Earth Element Concentrations (in ppm), Fe/Mn Ratios and Obsidian Source Attributions for Miscellaneous Artifacts from Hidden Cave

Cat. No.	Stratum	Trace Element Concentrations										Ratio Fe/Mn	Obsidian Source	Description	Fig. No.
		Pb	Th	Rb	Sr	Y	Zr	Nb	Ba	La	Ce				
1-1B-892	Surface	38.5 ±2.7	24.9 ±5.0	145.0 ±4.0	20.1 ±2.6	15.3 ±3.2	89.5 ±3.3	22.0 ±2.6	—	—	—	—	Mt. Hicks	Point fragment	n.i.
1-1B-891	Surface	37.8 ±2.4	21.7 ±4.4	151.8 ±3.6	22.4 ±2.2	15.3 ±2.8	95.1 ±2.9	20.4 ±2.3	—	—	—	—	Mt. Hicks	Point fragment	n.i.
1-1B-879	Surface	40.0 ±2.3	23.2 ±4.3	172.4 ±3.6	95.7 ±2.9	9.9 ±2.7	97.5 ±3.0	17.8 ±2.2	612.0 ±14.5	31.9 ±5.3	54.5 ±6.0	—	Bodie Hills	Point fragment	n.i.
1-1B-242	Surface	40.5 ±2.1	31.0 ±3.9	186.2 ±3.3	104.6 ±2.7	10.8 ±2.5	114.3 ±2.7	18.6 ±2.0	614.0 ±14.9	31.0 ±5.3	53.3 ±6.0	—	Bodie Hills	Point fragment	n.i.
1-1B-889	Surface	38.8 ±2.0	33.8 ±3.8	170.9 ±3.2	90.4 ±2.6	12.7 ±2.4	111.1 ±2.7	20.0 ±1.9	587.3 ±14.2	30.6 ±5.2	43.1 ±5.8	—	Bodie Hills	Point fragment	n.i.
1-1B-887	Surface	40.5 ±2.3	21.4 ±4.2	162.4 ±3.5	96.7 ±2.9	19.1 ±2.8	185.3 ±3.5	19.6 ±2.2	—	—	—	46.60	Casa Diablo	Point fragment	n.i.
1-1B-881	Surface	40.9 ±2.3	32.3 ±4.2	192.3 ±3.6	16.9 ±1.9	20.0 ±2.7	95.1 ±2.7	24.1 ±2.1	—	—	—	—	Mt. Hicks	Biface fragment	n.i.
1-1B-882	Surface	34.6 ±2.3	12.6 ±4.2	153.3 ±3.5	21.6 ±2.1	8.6 ±2.7	97.2 ±2.8	19.8 ±2.2	—	—	—	—	Mt. Hicks	Biface fragment	n.i.
1-1B-671	II	33.5 ±2.5	14.9 ±4.6	140.2 ±3.8	24.8 ±2.4	11.2 ±3.0	88.3 ±3.1	16.6 ±2.4	—	—	—	—	Mt. Hicks	Point fragment	n.i.
1-1B-324	II	38.8 ±1.8	28.9 ±3.4	162.6 ±2.8	24.9 ±1.8	16.0 ±2.2	100.1 ±2.3	22.5 ±1.8	—	—	—	—	Mt. Hicks	Point fragment	n.i.
1-1B-387	II	35.7 ±2.6	20.3 ±4.7	137.0 ±3.8	16.1 ±2.3	7.1 ±3.0	82.9 ±3.1	19.6 ±2.4	—	—	—	—	Mt. Hicks	Point fragment	n.i.
1-1B-403	II	40.5 ±2.1	31.8 ±3.8	157.7 ±3.2	25.5 ±2.0	13.8 ±2.5	96.0 ±2.6	25.1 ±2.0	—	—	—	—	Mt. Hicks	Biface	68b
1-1B-315	II	41.7 ±2.1	23.8 ±3.8	161.6 ±3.1	20.6 ±1.9	13.4 ±2.4	97.3 ±2.5	23.9 ±2.0	—	—	—	—	Mt. Hicks	Biface fragment	n.i.
2/32641*	II	36.5 ±5.5	23.3 ±5.6	166.7 ±4.0	27.0 ±2.9	14.7 ±3.5	79.5 ±4.2	17.2 ±3.0	—	—	—	—	Mt. Hicks	Drill	69c

TABLE 79—(*Continued*)

Cat. No.	Stratum	Trace Element Concentrations										Ratio Fe/Mn	Obsidian Source	Description	Fig. No.
		Pb	Th	Rb	Sr	Y	Zr	Nb	Ba	La	Ce				
1-1B-585	II	41.9 ±1.9	27.7 ±3.5	165.2 ±2.9	25.0 ±1.8	14.7 ±2.3	98.6 ±2.4	23.9 ±1.9	—	—	—	—	Mt. Hicks	Flake	n.i.
1-1B-960	N.C.	32.8 ±3.3	26.0 ±6.3	154.8 ±5.0	14.1 ±3.2	24.2 ±4.1	119.7 ±4.4	29.9 ±3.4	—	—	—	—	Mt Hicks ?	Point fragment	n.i.
20.4/980*	N.C.	29.3 ±4.5	21.2 ±4.7	163.1 ±3.6	27.4 ±2.4	13.1 ±3.0	79.8 ±3.7	17.5 ±2.7	—	—	—	—	Mt. Hicks	Biface	68g
20.4/327*	N.C.	28.6 ±4.8	27.7 ±5.1	171.8 ±3.9	96.9 ±3.4	12.2 ±3.2	101.3 ±4.2	16.1 ±2.8	—	—	—	—	Bodie Hills	Biface	68f
20.3/9778*	N.C.	29.5 ±4.8	19.3 ±5.0	161.8 ±3.8	94.0 ±3.3	15.7 ±3.2	83.9 ±4.0	8.1 ±2.8	—	—	—	—	Bodie Hills ?	Biface	68e
1-1B-?	N.C.	46.8 ±2.3	18.5 ±4.0	165.7 ±3.3	3.7 ±1.9	66.2 ±3.1	376.7 ±4.3	21.9 ±2.2	—	—	—	50.16	Homecamp C	Biface	68h
20.4/627*	N.C.	22.6 ±4.8	22.2 ±5.1	180.0 ±4.0	99.3 ±3.4	13.0 ±3.2	93.7 ±4.1	10.0 ±2.8	—	—	—	—	Bodie Hills	Biface fragment	n.i.
1-1B-850	N.C.	40.7 ±2.1	28.2 ±4.0	155.8 ±3.2	21.7 ±2.0	19.2 ±2.6	94.9 ±2.6	21.1 ±2.1	—	—	—	—	Mt. Hicks	Flake	n.i.
1-1B-513	N.C.	28.7 ±1.8	19.0 ±3.6	180.5 ±3.2	65.6 ±2.3	19.6 ±2.5	102.9 ±2.6	19.3 ±2.0	231.2 ±8.5	11.1 ±4.1	32.7 ±4.8	—	Garfield Hills	Flake	n.i.

* = Ag (silver) x-ray tube. N.C. = not correlated n.i. = not illustrated ± = counting error uncertainty

CHAPTER 24. OBSIDIAN HYDRATION ANALYSIS

ROBERT JAMES JACKSON[1]

Obsidian hydration has become an established method for determining the relative age of archaeological specimens. The physical process of obsidian hydration is still poorly understood, and methods of deriving accurate absolute dates have not been fully developed. Increased understanding of this process may result in more refined applications of this method of analysis. Despite the problems yet to be overcome, obsidian hydration can be of great value in discerning patterns of prehistoric human lifeways.

A BRIEF HISTORY

The history of obsidian hydration analysis has been reviewed by Ericson, Mackenzie, and Berger (1976). To recap briefly, in 1948 Irving Friedman and Robert L. Smith demonstrated that volcanic glasses become hydrated with atmospheric water from the glass surface over time. This hydration process is not only continuous, but the rate at which water enters the stone is relatively predictable. In 1959, Donavan Clark studied Central California archaeological obsidian specimens with the goal of developing a regional hydration rate. Clark hoped that this research would provide California archaeologists with a chronometric dating tool.

Several major difficulties were encountered during early hydration studies, particularly the discovery that obsidian from different geographic/geologic sources hydrates at differing rates, and that each rate may be affected by numerous, complex variables. Several years passed before archaeologists accepted the challenge to understand the process of obsidian hydration on a source-specific basis.

Serious study of obsidian hydration as a chronometric tool is barely 15 years old. While many problems must still be overcome, significant advances have been made. In recent years trace element analyses have resulted in the chemical characterization of obsidian sources, allowing the ascription of archaeological obsidian specimens to point of origin (geologic source). Researchers are also beginning to identify the specific chemical constituents within obsidian which retard or encourage obsidian hydration, but a great deal more work is needed before archaeologists can obtain absolute dates for the manufacture of obsidian tools with confidence from all obsidian sources (see chap. 23, this volume).

THE HYDRATION PROCESS

All natural and artificial glasses are thermodynamically unstable and undergo progressive alteration through the gradual incorporation of moisture from the environment (soil and atmosphere). Rhyolitic obsidian, the most abundant form of natural glass, contains about 0.1 to 0.9 percent water by weight, as derived from the parent magma. After cooling, molecular water is incorporated into the obsidian from its surface, advancing into the obsidian as a gradient of concentration which is sharply demarcated by a diffusion front. The water content of the hydrated layer increases tenfold, reaching approximately 3.5 percent by weight. This increased water content changes both the density and the volume of the hydrated layer. An increase in density raises the index of refraction, while an increase in volume produces mechanical strain at the interface between the layer of absorbed water and the nonhydrated interior of the obsidian, resulting in an optical effect called birefringence (the power of double refraction). It is the strain-produced birefringence and the higher index of refraction that microscopically differentiate the hydrated zone from the unaltered obsidian.

Several poorly understood variables affect the rate of obsidian hydration: atmospheric temperature, chemical composition of obsidian, soil chemicals, and solar radiation. Obsidian accumulates water at a very slow rate, and atmospheric moisture in even the driest of the earth's environments is thought to be sufficient to maintain a constant process of

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obsidian hydration. Temperature appears to be a significant variable in hydration rates, yet regional ambient air temperatures have not been incorporated into hydration rate formulations. Several oxides have been identified as playing important roles in retarding or encouraging hydration, and current study incorporating these variables into physical model obsidian hydration-rate formulations is very promising. Further refinement in our understanding of affective variables, as well as rigorous testing, is required before obsidian hydration can be considered a valid absolute dating method. Obsidian hydration data can, however, be used effectively by archaeologists for relative dating and for addressing specific questions that relate to the integrity of prehistoric site deposits and other intrasite relationships, including artifact reuse, resharpening, and the discernment of tool assemblages. For more complete and technical discussions of obsidian hydration, see Clark (1964), Ericson (1977), Michels and Bebrich (1971), Taylor (1976), and Michels and Tsong (1980).

ANALYTICAL TECHNIQUES

Fifty-three obsidian artifacts from Hidden Cave—mostly projectile points—were submitted for obsidian hydration analysis. Prepared slides are curated at the University of California, Davis, Obsidian Hydration Laboratory under specimen accession numbers UCD-629 through 681.

An appropriate section of each artifact was selected for study, based primarily on visible physical qualities and potential for maximum data retrieval. Two parallel cuts were made into the edge of the specimen, using a 0.4 mm.-thick, diamond-impregnated lapidary saw blade, powered by a motor turning at approximately 3600 rpm. These cuts isolated a 1 mm. thick wedge, which was removed from the artifact. The freshly cut and exposed faces of the wedge were ground in a slurry of 600 grade, optical quality corundum powder. This grinding removed shallow nicking and pitting from the uncut, exposed faces of the artifact. The obsidian wedge was then mounted to a microscope specimen slide with Lakeside cement and ground further, to a thickness of between 30–50 microns.

The final product was an extremely thin cross-section of the outer faces of the artifact, through which light can pass. The slide was mounted on a petrographic microscope, fitted with cross-polarizing filters and a gypsum or quartz I–IV order filter. The filter maximized the visual contrast between the hydrated zone and the unaltered obsidian. The edges of the specimen were then examined under a constant magnification of 1250×. When a clearly defined and representative hydration band was located and centered to minimize any parallax effect, the filar micrometer eyepiece was used to measure the thickness of the band. At least eight separate readings (four along each edge) were recorded. The mean and standard deviation from each edge were then compared by a two-tailed *t*-test. The result estimates the probability that the two sets of readings represent the same or different hydration bands. Significantly different readings on the same specimen could reveal important aspects of the artifact's history: artifact reuse, long-term curation, and breakage at either time of manufacture or much later. Data obtained from examination of the Hidden Cave specimens are summarized on table 80.

The diverse data on Hidden Cave obsidians are synthesized in later chapters. We think it important to note, however, that three artifacts—two Gatecliff Split Stem points (20.4/555 and 20.4/955) and the single Rosegate series point (20.3/9930)—yielded two distinct hydration bands, suggesting manufacture from older flakes. These artifacts yielded not only "old" bands, more than roughly three microns thick, but also "younger" bands, thinner than three microns. This may reflect an unmodified, remnant surface on at least one face of each artifact, from which the larger band reading was derived. It is, of course, not known whether manufacture of these points occurred at Hidden Cave or at different locations, but if enough specimens exhibiting two or more hydration thicknesses were present in the collection, one might argue for scavenging or recycling of older materials.

TABLE 80

Summary of Obsidian Hydration Data for Hidden Cave Artifacts[a]
(Level of magnification is 1250× throughout)

Specimen Number	O.H.L. Number[b]	Artifact Type	Primary Surface[c] $\bar{X}$	Primary Surface[c] S	Secondary Surface[d] $\bar{X}$	Secondary Surface[d] S	Tertiary Surface[e] $\bar{X}$	Tertiary Surface[e] S	p[f]	Mean Band Thickness[g] $\bar{X}$	Mean Band Thickness[g] S
20.3/9784	646	Gatecliff Split Stem	3.84 ± 0.2		4.05 ± 0.2		—		>0.1	**3.94 ± 0.2**	
20.3/9920	678	Gatecliff Split Stem	2.04 ± 0.2		2.11 ± 0.2		—		>0.1	**2.07 ± 0.2**	
20.3/9929	644	Gatecliff Split Stem	4.22 ± 0.2		4.14 ± 0.2		—		>0.1	**4.18 ± 0.2**	
20.4/555	670	Gatecliff Split Stem	2.76 ± 0.2		2.66 ± 0.2		3.77 ± 0.2		<0.01	**2.71 ± 0.2**	
										3.77 ± 0.2	
20.4/572	679	Gatecliff Split Stem	3.35 ± 0.2		3.49 ± 0.2		—		>0.1	3.42 ± 0.2	
20.4/583	630	Gatecliff Split Stem	3.47 ± 0.2		3.36 ± 0.2		—		>0.1	3.41 ± 0.2	
20.4/653	635	Gatecliff Split Stem	2.65 ± 0.2		2.48 ± 0.2		—		>0.1	2.56 ± 0.2	
20.4/680	643	Gatecliff Split Stem	4.01 ± 0.2		3.99 ± 0.2		—		>0.1	4. 0 ± 0.2	
20.4/681	636	Gatecliff Split Stem	2.91 ± 0.2		2.91 ± 0.2		—		>0.1	2.91 ± 0.2	
20.4/756	647	Gatecliff Split Stem	2.9 ± 0.2		2.92 ± 0.2		—		>0.1	2.91 ± 0.2	
20.4/828	676	Gatecliff Split Stem	3.62 ± 0.2		3.49 ± 0.2		—		>0.1	3.55 ± 0.2	
20.4/852	671	Gatecliff Split Stem	4.15 ± 0.2		4.16 ± 0.2		—		>0.1	4.16 ± 0.2	
20.4/864	631	Gatecliff Split Stem	2.16 ± 0.2		2.05 ± 0.2		—		>0.1	2.1 ± 0.2	
20.4/936	645	Gatecliff Split Stem	3.51 ± 0.2		3.62 ± 0.2		—		>0.1	3.56 ± 0.2	
20.4/955	673	Gatecliff Split Stem	1.95 ± 0.2		1.92 ± 0.2		2.88 ± 0.2		<0.01	1.93 ± 0.2	
										2.88 ± 0.2	
20.4/960	642	Gatecliff Split Stem	2.8 ± 0.2		2.48 ± 0.2		—		>0.1	2.64 ± 0.2	
20.3/9922	651	Gatecliff Contracting Stem	3.16 ± 0.2		2.89 ± 0.2		—		>0.1	3.02 ± 0.2	
20.3/9925	629	Gatecliff Contracting Stem	3.5 ± 0.2		3.61 ± 0.2		—		>0.1	3.55 ± 0.2	
20.3/9926	654	Gatecliff Contracting Stem	4.22 ± 0.2		4.12 ± 0.2		—		>0.1	4.17 ± 0.2	
20.4/328	634	Gatecliff Contracting Stem	2.65 ± 0.2		2.41 ± 0.2		—		>0.1	2.53 ± 0.2	
20.4/382	674	Gatecliff Contracting Stem	2.19 ± 0.2		2.08 ± 0.3		—		>0.1	2.13 ± 0.2	
20.4/434	632	Gatecliff Contracting Stem	3.01 ± 0.2		2.97 ± 0.2		—		>0.1	2.99 ± 0.2	
20.4/549	657	Gatecliff Contracting Stem	5.19 ± 0.2		4.99 ± 0.2		—		>0.1	5.09 ± 0.2	
20.4/557	672	Gatecliff Contracting Stem	2.03 ± 0.2		2.1 ± 0.2		—		>0.1	2.06 ± 0.2	
20.4/685	648	Gatecliff Contracting Stem	4.14 ± 0.2		4.19 ± 0.2		—		>0.1	4.16 ± 0.2	
20.4/686	655	Gatecliff Contracting Stem	4.5 ± 0.2		4.39 ± 0.2		—		>0.1	4.44 ± 0.2	
20.4/687	650	Gatecliff Contracting Stem	1.94 ± 0.2		1.96 ± 0.2		—		>0.1	1.95 ± 0.2	
20.4/704	649	Gatecliff Contracting Stem	2.63 ± 0.2		2.71 ± 0.2		—		>0.1	2.67 ± 0.2	
20.4/863	653	Gatecliff Contracting Stem	4.03 ± 0.2		3.81 ± 0.2		—		>0.1	3.92 ± 0.2	
20.4/928	638	Gatecliff Contracting Stem	3.18 ± 0.2		3.38 ± 0.2		—		>0.1	3.28 ± 0.2	
20.4/1005	656	Gatecliff Contracting Stem	3.39 ± 0.2		3.33 ± 0.2		—		>0.1	3.36 ± 0.2	
20.3/9777	640	Elko Eared	3.32 ± 0.2		3.12 ± 0.2		—		>0.1	3.22 ± 0.2	
20.4/329	677	Elko Eared	3.91 ± 0.2		4.03 ± 0.2		—		>0.1	3.97 ± 0.2	
20.3/9930	680	Rosegate Series	3.17 ± 0.2		1.68 ± 0.2		—		<0.001	3.17 ± 0.2	
										1.68 ± 0.2	

TABLE 80—(*Continued*)

Specimen Number	O.H.L. Number[b]	Artifact Type	Primary Surface[c] $\bar{X}$	Primary Surface[c] S	Secondary Surface[d] $\bar{X}$	Secondary Surface[d] S	Tertiary Surface[e] $\bar{X}$	Tertiary Surface[e] S	p[f]	Mean Band Thickness[g] $\bar{X}$	Mean Band Thickness[g] S
20.3/9775	667	Humboldt Basal-notched	2.65 ± 0.2		2.5 ± 0.2		—		>0.1	2.57 ± 0.2	
20.4/813	669	Humboldt Basal-notched	2.09 ± 0.2		1.9 ± 0.2		—		>0.1	2.0 ± 0.2	
20.4/908	666	Humboldt Basal-notched	2.73 ± 0.2		2.47 ± 0.2		—		>0.1	2.6 ± 0.2	
20.4/985	668	Humboldt Basal-notched	2.03 ± 0.2		2.11 ± 0.2		—		>0.1	2.07 ± 0.2	
20.3/9919	661	Humboldt Series	2.65 ± 0.2		2.66 ± 0.2		—		>0.1	2.65 ± 0.2	
20.4/939	637	Humboldt Series	2.07 ± 0.2		1.96 ± 0.2		—		>0.1	2.05 ± 0.2	
20.4/378	663	residual concave base point	5.39 ± 0.2		5.37 ± 0.2		—		>0.1	5.38 ± 0.2	
20.4/688	658	residual concave base point	4.02 ± 0.2		4.04 ± 0.2		—		>0.1	4.03 ± 0.2	
20.4/807	664	residual concave base point	3.47 ± 0.2		3.48 ± 0.2		—		>0.1	3.5 ± 0.2	
20.4/861	659	residual concave base point[h]			—		—				
20.4/979	660	residual concave base point	4.8 ± 0.2		4.88 ± 0.2		—		>0.1	4.84 0.2	
20.3/9781	633	untypable point	4.09 ± 0.2		4.27 ± 0.2		—		>0.1	4.18 ± 0.2	
20.4/396	675	untypable point[i]	2.1 ± 0.2		2.08 ± 0.2		—		>0.1	2.09 ± 0.2	
20.4/397	639	untypable point	1.07 ± 0.2		1.37 ± 0.2		—		>0.1	1.22 ± 0.2	
20.4/527	662	untypable point	3.59 ± 0.2		3.53 ± 0.2		—		>0.1	3.56 ± 0.2	
20.4/768	641	untypable point	2.66 ± 0.2		2.75 ± 0.2		—		>0.1	2.7 ± 0.2	
20.3/9778	665	pressure flaked biface	2.3 ± 0.2		2.27 ± 0.2		—		>0.1	2.28 ± 0.2	
20.4/327	681	pressure flaked biface	3.55 ± 0.2		3.55 ± 0.2		—		>0.1	3.55 ± 0.2	
20.4/980	652	pressure flaked biface	no visible hydration—cut twice								

[a] Complete records on file at Obsidian Hydration Laboratory, University of California, Davis.

[b] Obsidian Hydration Laboratory Number.

[c] This represents the first surface of the thin section to be measured. If only one surface of the artifact contained a hydration band, then that surface was designated as the Primary Surface. Four observations were made on this surface for each artifact.

[d] This surface is the second to be observed and measured for hydration bands, usually located opposite the Primary Surface. Four observations were made on this surface for each artifact.

[e] This set of hydration band readings refers to either a third surface exposed to atmospheric water of hydration, or additional readings taken on the IS or SS. Four observations were made on this surface whenever recorded.

[f] A two-sample, two-tailed, difference of means *t*-test used to determine the probability that differences between readings on various surfaces are chance occurrences.

[g] Results of the *t*-test are used to determine the number of hydration bands present on each specimen. If only one is present, all measurements are added and the mean micron value and standard deviation calculated. If more than one band is present, individual mean and standard deviations are computed for each surface.

[h] No visible hydration, cut twice.

[i] Gatecliff Split Stem?

CHAPTER 25. INTEGRATIVE SYNTHESIS: PALEOENVIRONMENTAL CHRONOLOGY

DAVID HURST THOMAS

Throughout this volume, various investigators have examined the geomorphological, paleobotanical, and paleontological record at Hidden Cave. Salient conclusions, implications, and points of disagreement from these disparate avenues of research are summarized here.

ENVIRONMENTAL CHANGES IN THE CARSON DESERT DURING THE HISTORIC PERIOD

Kelly and Hattori explore the degree of historic period ecological variability in the Carson Desert (chap. 3), concluding that significant changes in both hydrology and vegetation have occurred over the past 150 years.

The ecology of the Carson Desert is closely related to minor changes in water supply and flow. Subtle climatic changes also influence both stream courses and lake levels, each heavily dependent on the highly variable Sierra snowpack. Shifting drainage patterns were probably as commonplace in the prehistoric past as in the present, and numerous abandoned river channels are evident throughout the Hidden Cave area. Vegetation surrounding these shallow bodies of water apparently responded to even minor lake-level fluctuations, influencing densities of both marsh plants and water birds.

Euro-American immigrants and settlers also modified the local watershed by diverting the Carson River for irrigation, by extensive logging of the Sierra slopes, by intensive milling in the Comstock, and by introducing exotic plants and animals. Much water from the Carson and Humboldt rivers is now intercepted upstream, radically reducing flow into the Carson Desert. Distribution of surface water and level of the water table have also been modified by redirection of the Truckee River into the Lahontan Valley/Carson Desert area.

Historic records document significant vegetational change since initial Euro-American settlement in the Carson Desert: a decrease in wetland habitat acreage, an increase in arboreal vegetation across the valley floor, reduced densities of native grasses and annuals, and a correlative increase in desert shrubs and exotics. It is against this background that the paleoenvironmental record of Hidden Cave must be viewed.

THE SEDIMENTS OF HIDDEN CAVE

Hidden Cave contains a moderately well-preserved stratigraphic column spanning at least the past 21,000 years (Davis, chap. 7). Although considerable vertical mixture has occurred in late Holocene times, combined radiocarbon and tephrochronological evidence allow Davis to make estimates of the ages of various deposits. Davis summarizes these findings in terms of two chronostratigraphic hypotheses; we employ his "Hypothesis 2" throughout the rest of this volume (see tables 13 and 14).

With few exceptions, Davis follows the work of Morrison (1964) in interpreting the Hidden Cave sediments. Whereas Morrison viewed the layer of silt and fine sand of the Turupah and Fallon formations as eolian, Davis suggests that these strata are alluvial in origin. Davis agrees that the poorly sorted gravel of the Indian Lakes Formation is probably derived from colluvial processes as originally suggested by Morrison (1964).

Recent excavations refined the Hidden Cave tephrochronology. A lower tephra unit (the Tsoyawata Bed of the Mazama Member) had been previously recognized at Hidden Cave (Davis, 1978). The 1979–1980 excavations revealed another white tephra bed slightly above the Tsoyawata Bed. Petrographic analysis shows that this tephra belongs to the Mazama Bed proper. A third ash (the Turupah Flat Bed of the Salt Wells Member) also occurs inside Hidden Cave. Unfor-

tunately, this ash zone is too contaminated to permit further petrographic analysis, and insufficient geological work was done outside Hidden Cave to determine if better exposures exist locally. Davis provisionally correlates this upper tephra to an age of 1500 B.P.

Although some new stratigraphic units were defined (chap. 7)—because of the additional lateral exposures made during the 1979–1980 excavations—the remainder of Morrison's original interpretations are unmodified.

Davis proposes a composite model to account for the depositional episodes in Hidden Cave. Early Holocene deposition came about primarily through hillside slopewash, rodent activity, and a combination of creep and slopewash along the back slope of the cave that redeposited lacustrine gravels into a rubble pile. During the Middle Holocene—between about 7500 and 5400 B.P.—hillside slopewash continued to build an entrance rubble cone, but silt from the entrance filled the lower portion of the cave. Rodent deposition of bone continued, but creep and slopewash from the rear of the site had ceased by the Middle Holocene. At this point, Hidden Cave had probably become a "dry" environment, except when briefly flooded from the entrance. Finally, during the Late Holocene, animals—mostly humans, rodents, and bats—became the major depositional agent, except for Strata I and III, which were formed by rather brief episodes of Middle Holocene-like depositional processes.

Davis's second chronological hypothesis correlates well with the better-known depositional record at Gatecliff Shelter, 150 km. to the east (Davis, 1983). Although Hidden Cave and Gatecliff Shelter exist in very different microenvironments, these two sites are similar in a number of important ways (Davis, chap. 7, this volume): each site is below a debris-covered slope that accounts for much of the alluvial deposition; in-filling at both sites probably results from episodes of torrential summer rainfall; temperature-sensitive strata at each site correlate closely

Specifically, Mazama ashfall accumulated near the base of both stratigraphic columns, followed by accumulation of several thin alluvial beds. A few massive alluvial strata built up at Gatecliff Shelter from 5500 until 5100 B.P., when deposition effectively ceased. Deposition also ceased at Hidden Cave, *ca.* 5400 B.P.

Then deposition began again. At Gatecliff, alluvium accumulated from 4250 until 3200 B.P., after which the depositional record was dominated by slope sediments. Although renewed alluvial deposition briefly commenced at Hidden Cave about 3800 B.P. (as Stratum III), significant sedimentation generally held off until about 1500 B.P.

The correlative strata in these two sites thus provide a useful framework for comparing archaeological and geomorphic records of two seemingly disjunct regions.

THE PALEOBOTANY OF HIDDEN CAVE

Wigand and Mehringer (chap. 9) report the results of paleobotanical investigations at Hidden Cave. Pollen was extracted from 54 stratigraphic samples collected from a location stratigraphically comparable to Morrison's (1964) section; pollen was also analyzed from 26 human coprolites. Wigand and Mehringer also examined 10 pollen samples from two clearly traceable stratigraphic units to determine the relationships between pollen abundance, and the volume, weight, size distribution, and lateral position of sediments collected from Hidden Cave. Grain size analyses were performed on 21 samples to characterize the nature of Hidden Cave sediments, and for comparison with pollen influx estimates.

Although a complete analysis of plant macrofossils from Hidden Cave was not possible, Wigand and Mehringer identified some of the seeds, fruits, and inflorescences encountered in the 1979 excavations.

The fossil pollen record from cave fill shows no obvious change in local terrestrial vegetation over the past 6000–7000 years. The only apparent differences in natural vegetation reflected by fossil pollen occur at the top of Stratum XI, with the sharp decline in *Pinus* and *Artemisia* pollen known to characterize the late Pleistocene to Holocene vegetational shift recorded by fossil pollen through much of the Great Basin (Mehringer, 1977). This shift predates human occupation of Hidden Cave and corresponds to shrinking of the Pleistocene lakes and replacement of wood-

land or steppe by sagebrush or shadscale desert, probably dominant on the slopes near Hidden Cave since 7000–6000 B.P.

THE PALEONTOLOGY OF HIDDEN CAVE

Hidden Cave provides the first stratified late Pleistocene and Holocene sequence of birds, mammals, fish, amphibians, and reptiles available from the basin of Pleistocene Lake Lahontan.

Extinct Pleistocene faunal remains are rare at Hidden Cave. In 1940, Wheeler recovered two fossilized bones, one lodged in a crack in the ceiling of the cave. Both bones were identified by E. L. Furlong as horse, perhaps *Equus occidentalis.* Because of the obvious stratigraphic displacement, Wheeler attributed little significance to the horse bones. Grayson did not study the 1940 materials in detail, and these horse bones have not been located.

Morrison (1964) listed the fossil birds and mammals recovered from Unit N-6 during the 1951 Hidden Cave excavations, the earliest being attributed to the late Pleistocene. Although Grayson studied all the material available to him from these excavations, the N-6 specimens reported by Morrison are not represented in those collections.

During the 1979–1980 excavations, we recovered an isolated, heavily mineralized left upper molar of *Equus* sp. This tooth was found in the backdirt of previous excavations. A few additional horse bones were also found: two distal sesamoids, and a complete second phalanx.

A fragmentary left navicular of *Camelops* cf. *hesternus* (Yesterday's Camel) occurred in Stratum III, clearly out of primary stratigraphic context (since this camel was almost certainly extinct by at least 10,000 B.P.). Hidden Cave becomes the fifth published record of Yesterday's Camel from Nevada (Grayson, 1982).

The Hidden Cave fauna also contains bones and teeth of the noble marten (*Martes nobilis*), generally thought to have become extinct at the end of the Pleistocene. The stratigraphic position of these bones, however, suggests that either *M. nobilis* survived much longer than has been thought, or the single *M. nobilis* specimen here has been displaced upward from Pleistocene strata (Grayson, chap. 10; see also Grayson, in press b).

Regardless of the stratigraphic context of *M. nobilis* at Hidden Cave, it is clearly not indicative of a boreal fauna. Neither Pleistocene nor Holocene strata from Hidden Cave contain boreal vertebrate species, and the pollen spectrum is consistent with this interpretation (Wigand and Mehringer, chap. 9, this volume). The Hidden Cave data suggest that *Martes nobilis* was adapted to a broad variety of settings, and should not be used as an indicator of boreal conditions.

The Hidden Cave bird and mammal fauna is less informative about changing late Pleistocene and Holocene environments than one might expect. Although the mammalian taxa involved suggest a more mesic local environment during part of the late Holocene, the relative changing frequencies of those species through time tells little about long-term environmental changes.

Today, the modern small mammal fauna in the Hidden Cave area is clearly adapted to the contemporary xeric setting: Marmots are absent, the only wood rat is *Neotoma lepida,* the most common ground squirrel is *Ammospermophilus leucurus,* and Merriam's kangaroo rat (*Dipodomys merriami*) is at least as abundant as the more mesic chisel-toothed kangaroo rat (*D. microps*).

The Hidden Cave fauna does not fit into this modern picture. Marmots (*Marmota flaviventris*) are present in number through the stratigraphic sequence, as are bushy-tailed wood rats (*Neotoma* cf. *cinerea* and *Neotoma cinerea*). Although ground squirrels are not common, those present are primarily Townsend's ground squirrels (*Spermophilus townsendii*), rather than the more xeric white-tailed antelope squirrel, *Ammospermophilus leucurus.*

The mammalian fauna of Hidden Cave thus contains both xeric and mesic species. The sheer numbers of *Marmota flaviventris* and *Neotoma cinerea* strongly implies that these animals lived on Eetza Mountain throughout the history of Hidden Cave. Even during Stratum I times and above the Mono ash (post-1500 B.P.), the small mammal fauna of this area was quite different from that living there today.

In other words, a process of desertification occurred in the Hidden Cave area sometime in the last 15 centuries. The timing of this important shift is unclear, primarily due to the lack of adequate geological controls over the past 1500 years at Hidden Cave. The shift to purely xeric species on Eetza Mountain may be related to the decrease in terrestrial pollen influx noted by Wigand and Mehringer (chap. 9, this volume) in the uppermost sample in the Stratum I pollen profile—perhaps the result of reduced vegetation cover on the slopes surrounding Hidden Cave. Grayson (chap. 10) suggests that retreat of Carson Lake may have caused the extirpation of species of mesic mammals at Hidden Cave at some unspecified time during this 1500 year interval.

The herpetofauna of Hidden Cave contained nearly 1000 identifiable elements of anurans, lizards, and snakes recovered from unmixed strata (Mead, chap. 11). Whereas most of the recovered taxa are common in the area today, the presence of either *Lampropeltis zonata* (California Mountain Kingsnake) or *L. pyromelana* (Sonora Mountain Kingsnake) is of some interest, since neither species lives in the central basin region today. *Lampropeltis zonata* lives only in the mountainous regions of California and Oregon. *Lampropeltis pyromelana* occurs mainly on the south and eastern margins of the Great Basin, and there is a relict population in the Snake Range, eastern Nevada. Hidden Cave may thus provide an extralimital record for one or both species, but further study is required to confirm identification of *Lampropeltis* species involved.

Fish bones (Smith, chap. 12) demonstrate that the deep lakes disappeared from the Hidden Cave area sometime during the deposition of Stratum V. Prior to that time, fishes found in Stratum XIII (table 46) include lake species, *Chasmistes cujus* and *Gila bicolor pectinifer,* as well as species that inhabit both lakes and streams.

But Stratum V, deposited approximately 6900 to 5400 years ago, marks a transition in the fish fauna at Hidden Cave, when lake fishes such as *Chasmistes cujus* probably became unavailable within the local catchment due to the recession of lake waters from the vicinity.

Fish data further suggest that during the time of deposition of Stratum IV, roughly 3800 years ago, the nearest lake habitat had receded to a distance of at least 5 to 10 km. from the cave, perhaps to Carson Lake, to the southwest. Fish, primarily *Gila bicolor obesus,* were obtained from sloughs tributary to the Carson River, probably about 3 km. to the west and north. The dominance of *Gila bicolor obesus* and the surprising absence of normally abundant benthic forms such as mountain suckers (*Catostomus platyrhynchus*) and dace (*Rhinichthys osculus*), suggests that available local aquatic habitat (from which fish were obtained) was sloughlike.

SUMMARY: THE NATURAL HISTORY OF HIDDEN CAVE

Hidden Cave was created about 21,000 B.P. by wave action from Lake Lahontan. The basal Stratum XVI deposit was described by Morrison (1964) as uncemented lake gravel, but Davis found this stratum to be different in lithology from other sediments in the cave. The absolute age of this stratum is not known, and Davis correlates Stratum XVI at Hidden Cave to the Yarmouthian.

Grayson and Mead disagree (chap. 10 and 11, this volume). Because reptile and mammal bones from Stratum XIV differ in no way from those of higher levels, these investigators conclude that either the correlation is incorrect, or the Stratum XIV fauna has been derived from late Pleistocene levels.

Hidden Cave was inundated until about 16,000 B.P., when it was briefly exposed and Stratum XII rubble accumulated inside. Lake levels rose once again by 15,000 B.P., covering the cave until about 7500 B.P. Debris accumulated in both the entrance and the rear of Hidden Cave during this interval.

A distinctive change in the surrounding vegetation is reflected in the fossil pollen record at the top of Stratum XI, echoing the sharp decline in *Pinus* and *Artemisia* pollen known to characterize late Pleistocene to Holocene vegetational shifts in pollen records throughout much of the Great Basin (Mehringer, 1977). This vegetational shift predates human occupation of Hidden Cave and corresponds to the shrinking of Lake Lahontan. The woodland or steppe vegetation was re-

placed at this time by sagebrush or shadscale desert, probably dominant on the slopes near Hidden Cave since 7000–6000 B.P.

Pollen is extremely sparse in Strata X, XI, and XII, indicating the unlikelihood of major contamination by the pollen-rich dust from younger cave deposits.

By about 5500 B.P., climate in the Carson Desert changed sufficiently so that Hidden Cave became dry. But increasingly torrential rainfall carried silt inside as small episodic floods.

The Tsoyawata and Mazama tephras fell about 6900 B.P. and were washed into Hidden Cave. Low pollen values of the Tsoyawata tephra illustrate the rapidity of this deposition; Wigand and Mehringer conclude that this tephra probably remained on the slope for a short time, perhaps only a few days, before being washed into the cave.

All variations in the pollen record above the Tsoyawata and Mazama ashes are attributed to cultural activities inside Hidden Cave, since little sediment accumulated in Hidden Cave between about 5400 B.P. and 4000 B.P.

Stratum IV was created between about 4000 B.P. and 3700 B.P. when humans transported huge quantities of vegetational materials into Hidden Cave.

During a brief episode, about 3700 B.P., summer precipitation brought silt into Hidden Cave to create Stratum III. But this deposition ceased as precipitation became more winter-dominated. Relatively uniform grain size parameters within Stratum III suggest that Hidden Cave continued to be visited periodically by humans between deposition of Strata IV and II.

A second midden unit, Stratum II, was created between 3700 B.P. and 3600 B.P. The pollen record and concentration of macrofossils and coprolites emphasize that the major human occupation at Hidden Cave occurred during the periods represented by Strata IV and II. The abundance of cat-tail pollen and sedge seeds underscores proximity of marsh resources and their degree of utilization by the inhabitants of the cave.

The large quantity of cat-tail pollen also indicates that the cave was utilized at least during midsummer. Coprolite contents demonstrate that Hidden Cave must have been occupied during midsummer and fall. Sedimentary deposition (and presumably human utilization) slowed dramatically between about 3600 and 1500 B.P.

Davis suggests that Stratum I formed between 1500 B.P. and the present, primarily as a result of summer precipitation washing silt into Hidden Cave. The high pollen content of Stratum I samples suggests to Wigand and Mehringer that 2000 or even 3000 years may be a reasonable estimate for the duration of Stratum I.

Today, the modern small mammal fauna of this area is characterized by species adapted to xeric settings. The latest Hidden Cave fauna, composed of both xeric and mesic species, does not fit into this modern picture. Sometime during the deposition of Stratum I, nearby Carson Lake retreated significantly, and the Hidden Cave/Eetza Mountain small mammal fauna became significantly "desertified."

CHAPTER 26. INTEGRATIVE SYNTHESIS: CULTURAL CHRONOLOGY

DAVID HURST THOMAS

In the previous chapter, we approached the sediments of Hidden Cave from a decidedly *chronostratigraphic* viewpoint. In retrospect, the stratigraphic record at Hidden Cave is both outstanding and disappointing. The physical sediments inside the cave are indeed spectacular, and they provide one of the best late Pleistocene/Holocene stratigraphic sections in the American West. Yet, the stratigraphic inferences drawn from those sediments are, frankly, frustrating. We did not learn all we wanted to about Hidden Cave as a geological event, and as a result, some of the paleoenvironmental inferences lack the desired precision.

However, it is possible to set aside the geomorphic difficulties and approach the record at Hidden Cave from a decidedly cultural perspective. This approach provides a rather different set of conclusions than the strictly stratigraphic inferences summarized in the last chapter.

CHRONOLOGY: THE RADIOCARBON EVIDENCE

Twelve "cultural" radiocarbon dates are available from Hidden Cave (table 10) ranging from 810 to 5365 B.P. These dates do not, however, describe a continuous cultural sequence; distinct clustering is evident when the dates are examined individually in terms of the regional cultural chronology (Thomas, 1982, 1983a, 1983b).

In evaluating such radiocarbon evidence one must proceed cautiously, since the available dates are heavily biased. Because archaeologists commonly choose their samples to determine the age of stratigraphic contacts, the dates generally reflect the character of the natural stratigraphic context and rather poorly reflect the "intensity of occupation."

At Hidden Cave, for instance, we were concerned primarily in establishing the age range of each stratum; therefore, we allocated the radiocarbon samples across the various stratigraphic units in roughly equal fashion (despite the obvious fact that nearly all the cultural occupation was restricted to Strata II and IV).

The suite of radiocarbon dates from Hidden Cave is in no way representative, in a quantitative sense, of the cultural chronology of that site. Radiocarbon samples were derived for purely stratigraphic, rather than cultural objectives.

Nevertheless, it is useful to examine the ladder of culturally relevant radiocarbon dates in phase-by-phase fashion.

The Devils Gate Phase (5000–3200 B.P.)

A batch of cultural dates tightly cluster about a mean of 3710 B.P., an interval during the late Devils Gate phase. One date was processed on a tule bag recovered in 1940 from Stratum II: 3900 B.P. ± 110 (WSU-2458). Another date, from Stratum IV, was processed on organics and matting recovered in 1940: 3520 B.P. ± 120 (WSU-2459). The remaining three Devils Gate phase dates were processed on burnt wood and organics recovered in the 1979–1980 excavations in Stratum IV: 3575 B.P. ± 120 (WSU-2451), 3800 B.P. ± 80 (WSU-2454), and 3790 B.P. ± 110 (WSU-2460).

Another culturally relevant radiocarbon date was processed on burnt organic debris from Stratum IV: 5365 B.P. ± 90 (WSU-2452). As discussed elsewhere (Thomas 1981a, p. 33; 1983a, chap. 12; 1983b), the initial date for the Devils Gate phase has been tentatively placed at 5000 B.P., but this estimate could easily be too late. It is entirely possible that date WSU-2452 derives from a Devils Gate occupation at Hidden Cave.

This radiocarbon evidence suggests that, whereas Stratum IV clearly begins in the Devils Gate phase (or perhaps slightly earlier), the cultural usage of this stratum continued well into the Reveille phase (i.e., post-

600 B.P.). It is also possible, of course, that caching from higher strata introduced later artifacts into Stratum IV. At least one artifact that apparently dates to the Devils Gate phase was subsequently redeposited in Stratum II (WSU-2458).

It is unusual that such a large proportion (5 of 12) of the radiocarbon dates derive from the Devils Gate phase. The only comparable Great Basin site is Kramer Cave (Hattori, 1982, pp. 21–22, table 2, fig. 7), which produced a tight suite of 10 radiocarbon dates ranging from 3620 B.P. ± 80 (UCLA-976) to 3900 B.P. ± 200 (UCLA-670). The composite mean age of the Kramer Cave occupation is 3745 B.P., only 38 radiocarbon years earlier than the mean age of the Devils Gate determinations from Hidden Cave.

The Reveille Phase (3200–1200 B.P.)

Five of the Hidden Cave radiocarbon dates derive from the Reveille phase. Two of these were processed on organic materials from Stratum III: 1950 B.P. ± 90 (WSU-2463) and a sample of burnt wood 2225 B.P. ± 95 (WSU-2461). The other three samples were processed on wood and burnt organics from Stratum IV: 1880 B.P. ± 90 (WSU-2453), 3050 B.P. ± 200 (L289-BB), and 3140 B.P. ± 110 (WSU-2462).

Table 17 suggests that a brief episode of summer precipitation, *ca.* 3900 B.P., brought the Stratum III silts into Hidden Cave; correlative grain size parameters suggest that people continued to visit Hidden Cave during this interval. Although little cultural material was contained therein, the radiocarbon evidence suggests that the artifacts in Stratum III belong to the Reveille phase.

The cultural radiocarbon dates indicate that the bottom of Stratum II was probably deposited slightly later, during the Reveille phase; usage continued well into the Underdown phase.

Thus, although sedimentary deposition may have slackened after 3500 B.P. (table 17), people continued to visit and use Hidden Cave (at least sporadically) during the succeeding cultural phases. In fact, roughly half of the Hidden Cave dates derive from the Underdown and Reveille phases, evidence which complements that drawn from the artifact inventories (discussed below).

A number of sites in the Humboldt and Carson sinks have produced radiocarbon dates for this period. Excluding the non-cultural dates on bat guano, roughly two-thirds (11 of 16) of the radiocarbon dates from Lovelock Cave derive from this interval (Heizer and Napton, 1970, table 4). Similarly, about one-third of the cultural radiocarbon dates (13 of 38) from the Winnemucca Lake excavations fall into the Reveille and Underdown phases (Hattori, 1982, table 2), and a nearly identical proportion (13 of 39) is evident in the radiocarbon record from Gatecliff Shelter (Thomas, 1983b).

The Underdown Phase (1200–600 B.P.)

Although table 17 assigns a post-2400 B.P. age to Stratum I, an Underdown phase radiocarbon date from Hidden Cave was processed on a fiber bundle recovered from Stratum II in 1940: 810 B.P. ± 80 (WSU-2457). This date falls toward the end of the Underdown phase.

The Yankee Blade Phase (600–100 B.P.)

None of the radiocarbon dates from Hidden Cave fall within the Yankee Blade phase. This is not an unexpected finding, given the artifact inventory and the historic evidence that the mouth of Hidden Cave was extremely small. Yankee Blade-age radiocarbon dates are generally rare throughout the western Great Basin, and the evidence from Alta Toquima Village (Thomas, 1981b), Painted Cave (Bard, Busby, and Kobori, 1980; Bard, personal commun.), and James Creek Shelter (Clerico et al., 1983) stand as notable exceptions. A well-controlled chronology for the last 600 years B.P. remains a primary challenge facing Great Basin archaeology.

CHRONOLOGY: THE OBSIDIAN HYDRATION EVIDENCE

Obsidian from Hidden Cave has been analyzed both with respect to source and also degree of hydration (chaps. 23 and 24). At

some time in the future, these two analyses can be combined into another independent estimate of age of the Hidden Cave deposits. James P. Green has implanted a high/low thermometer inside Hidden Cave to determine precisely the ambient air and soil temperatures. When these data become available, it should be possible for investigators to compute accurately an ambient temperature figure for Hidden Cave obsidian. It should be a relatively easy matter to compute independent chronological measures by source and by type using known rates of hydration for obsidian from the various sources employed at Hidden Cave (Michels, 1982, 1983a, 1983b).

CHRONOLOGY: THE TYPOLOGICAL EVIDENCE

As outlined in chapter 4, there are two ways of interpreting Hidden Cave chronology. The Roust and Clewlow (1968) chronology argues for a long-term, culturally diverse occupational history. The initial Hidden Cave chronology, developed on the basis of only 38 typable points and without the benefit of supporting radiocarbon evidence, can now be updated and modified on the basis of newly available data.

The Roust and Clewlow Projectile Point Chronology

Although "various circumstances intervened" to preclude complete publication of the 1951 excavations at Hidden Cave, Roust and Clewlow (1968) discussed in detail the typology and chronological significance of the 38 typable projectile points recovered in those excavations: "Due to the fact that some of the Hidden Cave points may occupy a critical position in the Great Basin point sequence, and since . . . the site is blessed with particularly clear geological stratigraphy, we feel that a more complete discussion of the points is in order" (Roust and Clewlow, 1968, p. 103).

That discussion relied heavily on geological interpretations by Morrison (1964) and informal, unpublished discussions with geomorphologist Ernst Antevs regarding the Hidden Cave deposits. Curiously, no reference was made to the two radiocarbon dates available from Hidden Cave, and the considerably larger 1940 collection from this site was not examined.

Provenience information from the 1951 collection was provided by Roust and Clewlow (1968, table 1), and the types were considered stratigraphically:

Anathermal Age Deposits (Stratum IX): Four points typed as Humboldt Concave Base A points were recovered from the Mud Flow Gravels, a late Sehoo Lake deposit of supposed Anathermal age (i.e., about 9000 B.P. to 7000 B.P.). Grosscup (1956) had previously assigned these artifacts to the Hidden Cave phase.

The four Humboldt points were critical to Roust and Clewlow (1968, p. 108) because they required modification of Clewlow's earlier contention (1967, pp. 144–145) that such points might be the temporal equivalent of the Pinto series: "The Hidden Cave evidence conclusively . . . substantiates the position that Humboldt Concave Base A points were made in the Great Basin in Anathermal times, an assumption which is difficult to make for the later Pinto types" (Roust and Clewlow, 1968, p. 108).

The Hidden Cave data thus convinced Roust and Clewlow that Humboldt points predate Pinto points (although they noted that the Humboldt series continued to be used into Medithermal times). Roust and Clewlow also cautioned against routine assignment of surface Humboldt points to Anathermal contexts.

Laminated Aeolian Silt Deposits (Strata VII–V): Two Pinto points were found in the upper portion of the laminated silts, which Grosscup (1956) had assigned to the Carson phase and correlated with the Altithermal period. By the late 1960s, most archaeological data from the western Great Basin suggested that the Pinto series were post-Altithermal in age (e.g., Harrington, 1957, p. 72; Lanning, 1963, pp. 277–280; Clewlow, 1967, p. 145). But on the basis of evidence from Hidden Cave, Roust and Clewlow argued that the Pinto series demonstrably dated to the Altithermal period.

32 Inch Midden (Stratum IV): A variety of point types came from the overlying 32

Inch Midden level at Hidden Cave, interpreted by Grosscup (1956) to represent the Early Lovelock Culture and by Morrison (1964, p. 87) to correlate with the Fallon Formation of the Medithermal. Roust and Clewlow (1968, p. 109) concluded that the 32 Inch Midden points indicate that "the Elko series begins during the middle portion of the Medithermal sequence [O'Connell, 1967] and falls within its expected temporal context at Hidden Cave."

SURFACE MIDDEN (STRATUM II): These Transitional Lovelock deposits contained 26 of the 38 typable projectile points recovered from Hidden Cave in 1951 (Grosscup, 1956). Roust and Clewlow (1968, p. 109) noted that "it is interesting, though not unexpected, that Eastgate and Rose Spring types appear only in this layer."

LATE MEDITHERMAL DEPOSITS: Desert Side-notched and Cottonwood Triangular points were totally lacking from the 1951 Hidden Cave collection. Grosscup's (1956) most recent cultural phase for the Carson Sink, the Dune Spring phase, was taken to represent the Northern Paiute living in open sites on the lakeshore dunes. Although Roust and Clewlow (1968) did not comment on this aspect, Grosscup (1956), among others, used the Hidden Cave data to suggest a settlement pattern shift between Lovelock and Dune Springs cultures.

To summarize, the Roust and Clewlow chronology holds that the Hidden Cave occupation began during Anathermal times—as indicated by the four large Humboldt points—waned during the Altithermal, then blossomed during the early Medithermal with a flurry of types that persisted until about 600 B.P. (Heizer and Hester, 1978). The projectile point data suggested to them that Hidden Cave was abandoned prior to 600 B.P., although Ambro (1966) has described a historically repaired fishnet allegedly found in Hidden Cave (see below). Napton (1969, p. 51) also discussed reputedly historic use of Hidden Cave.

The Roust and Clewlow interpretation of Hidden Cave was incorporated by Napton (1971b, p. 9), who spoke of the "lengthy projectile point sequence and well-stratified deposits [which] form an important reference sequence for the Grimes area." This view of the Hidden Cave sequence has been used by a number of investigators to bolster chronological arguments from throughout the Great Basin (e.g., Orr, 1956; Riddell, 1956; Harrington, 1957; Bennyhoff, 1958; Bennyhoff and Heizer, 1958; Heizer and Baumhoff, 1962; Ambro, 1966; 1967; O'Connell, 1967; Cowan, 1967; Clewlow, 1967; 1968a; Roust, 1967; Napton, 1969, 1971a, 1971b; Tuohy, 1969a; Clewlow, Heizer, and Berger, 1970; Heizer and Napton, 1970; Aikens, 1970, 1978; Ranere, 1970; Thomas, 1971; Hester, 1973; Bettinger and Taylor, 1974; Green, 1975; Davis, 1976; 1978; Davis and Green, 1976; Cressman, 1977; Weide and Weide, 1977; Bettinger, 1978a; Heizer and Hester, 1978; Layton and Thomas, 1979; Bard, Busby, and Findlay, 1981; Hattori, 1982).

THE MONITOR VALLEY CHRONOLOGY

I recently proposed an alternative scheme for classifying the projectile points from the central and western Great Basin (Thomas, 1981a). Relying heavily on the sequence from Gatecliff Shelter and several other sites in Monitor Valley, I suggested reordering somewhat the now-conventional Great Basin typology (cf. Heizer and Hester, 1978). A metric database of roughly 6000 additional points was used for comparison with the Monitor Valley criteria (Thomas, 1981a, 1983b).

But as we were defining these classification criteria, we were simultaneously formulating plans for further analysis and excavation at Hidden Cave. Because of the pending research, we held out all Hidden Cave data from definitions of the Monitor Valley criteria. The thinking was to keep the Hidden Cave data set independent from newly proposed Monitor Valley criteria.

The Hidden Cave data can now provide that independent test. Beginning strictly at the 38 typable points from the 1951 Hidden Cave excavations, we find that the Monitor Valley classification suggests a rather different temporal picture from that proposed by Roust and Clewlow (1968) and amplified by Heizer and Hester (1978).

Unlike the Heizer-Hester scheme, the Monitor Valley criteria do not assign a temporal duration to the Humboldt series; we think that there is too much functional vari-

TABLE 81
Alternative Classifications of the 38 Typable Points Recovered at Hidden Cave in 1951

Roust and Clewlow (1968, table 1)		Monitor Valley Criteria (Thomas, 1981a)	
Type	Frequency	Type	Frequency
Rose Spring Corner-notched	8	Rosegate series	2
Eastgate Expanding Stem	3	Elko Corner-notched	3
Elko Corner-notched	5	Elko Eared	1
Elko Eared	2	Gatecliff Split Stem	16
Pinto Square Shoulder	9	Gatecliff Contracting Stem	8
Humboldt Basal-notched	4	Humboldt Basal-notched	4
Humboldt Concave Base A	7	Humboldt series	4
Total	38		

ability for this series to serve as a fine-grained time marker. Thus, on the basis of projectile point typology alone, the Monitor Valley criteria do not suggest an Anathermal occupation of Hidden Cave (although such usage could, perhaps, be established on the basis of criteria other than projectile point typology).

The Monitor Valley criteria also rather significantly rearrange the typology of the remaining points from the 1951 collection (see table 81).

Creating the Gatecliff series requires a temporal merging of types previously known as Pinto series and Elko Contracting Stem (Thomas, 1981a). Our reclassification of the 1951 collection indicates that fully 80 percent (24 of 30) of the temporally diagnostic points at Hidden Cave belong to the Gatecliff series. The Monitor Valley criteria recognize only four Elko series and two Rosegate points in the 1951 Hidden Cave collection.

The differences between the two classifications are significant on two levels. Strictly in terms of artifact typology, Monitor Valley criteria suggest that the Hidden Cave point collection is considerably more homogeneous than allowed by Roust and Clewlow (1968).

But more important, Monitor Valley criteria suggest a rather different occupational history for Hidden Cave. Prior to the 1979–1980 excavations, the Hidden Cave chronology was based almost exclusively on this very small sample of points; Roust and Clewlow (1968) did not discuss the two radiocarbon dates then available from this site.

Because of this classification scheme, previous investigators emphasized a lengthy, culturally diverse occupation of Hidden Cave. The Monitor Valley criteria, however, suggest that (based strictly on projectile point manufacture and discard) although the usage of Hidden Cave spanned three cultural phases (and approximately three millennia), this utilization was heavily concentrated during the Devils Gate phase.

The hazards of typological dating are well known, and hardly need be reiterated. But the fact is that literally dozens of scientific papers (cited above) have employed the Roust and Clewlow chronological inferences based on a chronology of fewer than 40 projectile points.

A primary objective of our Hidden Cave excavations became to sort out the chronological picture. This was done by generating a much larger sample of temporally diagnostic artifacts, correlating them with a new suite of radiocarbon dates, then examining the two classification schemes to see which method better predicts time.

An Early Holocene Usage of Hidden Cave?

Roust and Clewlow (1968) discuss four concave base points alledgedly found in pre-Mazama contexts (the Mud Flow Gravels) at Hidden Cave (see above). Additional research into these artifacts raises some difficulties. Because of their obvious significance, I asked Dr. Gordon Grosscup about the cir-

cumstances of their discovery, and he kindly provided the following account:

> the points came from a kind of test pit dug into the entrance-way inside the cave where the ceiling was very low. Once we were down a foot, it was very dark. Our main purpose was to expose the stratigraphy in the entrance. I was digging the day when the [four Humboldt] points were found and I think I was using a shovel. The loosened soil was passed up to the others .... It happened that Peg [Wheat] was hauling the loose material out of the cave and dumping it. It was she who spotted the first point and the point fragment.... She alerted me and I checked through the already loosened soil in the pit and found one or two more points. It is possible that one of these was also found by Peg. I did check the sidewall for any evidence of intrusion and found none. The soil in question did derive from near a sidewall, but it is perfectly possible that this apparent cache of points had been buried in a pit entirely within the excavated area, a pit that I completely missed. There will always be a question about the stratigraphic placement of the specimens and that is not fully explained by Roust and Clewlow (Gordon Grosscup, personal commun.)

Our 1979–1980 excavations at Hidden Cave moved several times the amount of dirt excavated in 1951—much of it in pre-Mazama contexts—without finding any *in situ* evidence for an Anathermal usage. This lack of evidence alone would raise some question about the four Mud Flow Gravel points. Grosscup's misgivings, summarized above, cast further doubt on the pre-Mazama evidence. Because of these questions, extreme caution seems in order when discussing the allegedly Early Holocene contexts of these four points at Hidden Cave (cf. Roust and Clewlow, 1968; Heizer and Hester, 1978, among many others).

The 1979–1980 excavations paint a rather different picture. The earliest "cultural" radiocarbon date from Hidden Cave occurs in Stratum IV: 5365 B.P. ± 90 (WSU-2452). If we assume that this organic material was transported by humans into Hidden Cave, this radiocarbon date provides evidence for the earliest demonstrable usage of the site.

Hidden Cave does, however, contain a few earlier artifacts, and these deserve some attention. Most of the early artifacts (below Stratum IV) in the 1979–1980 excavations were associated with rodent disturbance or obvious cache features.

The only item that we consider to have a demonstrably pre-Stratum IV provenience is artifact 20.4/973, a fine percussion obsidian biface. This artifact was found in Stratum VII, a pre-Mazama layer that may be as old as 7500 B.P. (table 17). As Pendleton (chap. 14) has noted, this artifact has parallel margins and wide collateral percussion flaking. This distinctive flake scar pattern, not observed on any other Hidden Cave artifact, is identical with that on Great Basin Stemmed series points recovered from pluvial environments throughout the Desert West (see Pendleton, chap. 14, this volume). SEM examination of edge attrition revealed that this artifact had been subjected to severe weathering. The entire surface was water worn, and dulled by small pits. This is the only artifact recovered from beneath the Mazama tephras during the 1979–1980 excavations. Although we lack external data to indicate how that point was deposited, it seems likely that it was either washed into the cave, or perhaps carried into Hidden Cave as an artifact scavenged from the pluvial lake basin.

A Late Holocene Usage of Hidden Cave?

The late end of the temporal spectrum at Hidden Cave also deserves consideration. The 1951 excavations (as discussed in Roust and Clewlow, 1968) recovered no "late" projectile points; Desert Side-notched and Cottonwood series points were totally absent from the Roust and Grosscup collections. Similarly, Desert series points were not recovered by the Wheelers in 1940 nor by us in the 1979–1980 excavations.

The latest radiocarbon date available for Hidden Cave was obtained on a fiber bundle recovered from Stratum II in 1940: 810 B.P. ± 80 (WSU-2457). Although it is possible that later dates could be obtained on Stratum I or upper Stratum II artifacts, no such determinations have been processed.

To date, the only evidence for a late protohistoric occupation is a cotton-repaired fishing net described by Ambro (1966) and attributed to Hidden Cave (see also Napton,

1969, p. 51).[1] Because this artifact comprises the only extant evidence of historic usage of Hidden Cave, its provenience deserves a bit more attention.

The nets in question came to the Lowie Museum in 1939, as a donation from Mrs. E. W. Blair of Fallon, Nevada (Ambro, 1966, p. 103). Although Ambro assumed that the two nets came from Hidden Cave, he admitted that "very little information is available concerning the provenience and circumstances of the discovery of the nets. All that is known is that they were reported to have come from Hidden Cave . . . . The collector supposedly entered the cave and, finding the nets on or near the surface of the cave floor, carried them off" (Ambro, 1966, p. 103).

As part of our fieldwork at Hidden Cave, we had occasion to meet an individual closely associated with the finding of these nets and their subsequent donation to the Lowie Museum. Although this person asked to have her name withheld, she was quite familiar with the nets and adamantly insisted that both nets described by Ambro (1966) had come from either Fish Cave or Burnt Cave; she felt strongly that the nets were not recovered from Hidden Cave. She pointed out that Fallon townspeople commonly refer to all of the Grimes Point caves as "the Hidden Caves," and suggested that such a casual reference might have led to the mistaken attribution of the nets to Hidden Cave.

Although this tip is hardly iron-clad, it does point up the cloudy provenience of the two fish nets. We suggest that the two nets be regarded as from the Grimes Point area only, and not attributed specifically to Hidden Cave.

This matter is of some importance, since repairs with cotton places the use, if not the actual manufacture of one of the nets within the historic period. As discussed in chapter 4, we think it likely that the entrance to Hidden Cave was closed during historic times. At any rate, these nets of uncertain provenience provide the only hint to date of historic usage of this site.

[1] Actually, we also recovered eight additional woven fibers that seem to date from the historic period: two fragments of corduroy and wool, one 1/2 twill weave, three 1/1 plain weave, and two unspecified woven fibers (Goodman, chap. 19, this volume). We think that all of these items result from very recent visitors to the inside of Hidden Cave (spelunkers, archaeologists, tourists, party-goers, etc.). There is nothing to indicate that these items originated from aboriginal activities.

The Middle Holocene/Neoglacial Chronology of Hidden Cave

Virtually all the material culture from Hidden Cave derives from Stratum IV (the 32 Inch Midden) and Stratum II (the Surface Midden). A total of 440 chipped stone artifacts, for instance, was recovered in the various Hidden Cave excavations (table 50). Of these, 132 points could not be stratigraphically correlated. But for the correlated sample, fully 92 percent (286 of 308) of the bifacial artifacts derived from these two midden levels. Similarly, 85 percent of the shell beads and ornaments (96 of 113; table 58) and all of the correlated wooden artifacts ($n = 196$) came from Strata II and IV (table 63); the same general trend seems to hold for the rest of the perishable remains (table 67).

The vertical distribution of artifacts thus indicates that people were most evident at Hidden Cave during the deposition of Strata II and IV. This inference confirms the available paleobotanical and sedimentological data. Massive quantities of *Typha* were transported into Hidden Cave during this time. Human coprolites and quids are found almost exclusively in these two strata (Wigand and Mehringer, chap. 7, this volume), and the concentration of fossil seeds gives additional support to these conclusions. Seeds are more abundant in Stratum II, perhaps due to the greater volume of sediment excavated from the Top Midden. Wigand and Mehringer also suggest that intensity of occupation may have been greater when the Top Midden was deposited than during deposition of the 32 Inch Midden.

Hidden Cave was not, of course, totally abandoned during the "nonmidden" intervals. The evidence for mixing of the deposits, and the occurrence of abundant *Typha* pollen and the *Pediastrum* colonies led Wigand and Mehringer to conclude that Hidden Cave continued to be visited during the interval between deposition of the 32 Inch and Top

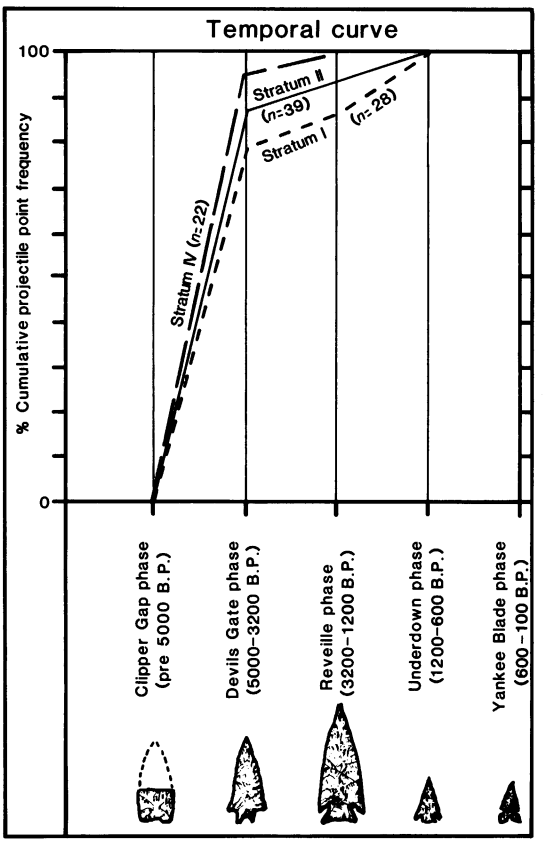

FIG. 117. Temporal distribution of projectile points in three strata at Hidden Cave.

middens; the radiocarbon dates also confirm episodic visitations during Stratum III times.

Regardless, it is clear that humans used Hidden Cave most frequently during periods represented by the midden deposits, hardly a surprising conclusion. Previously, Wheeler (n.d.a.), Roust and Grosscup (n.d.), and Morrison (1964), among others, recognized that most of the occupational history of Hidden Cave was contained within the two organic midden units.

This finding remains of considerable importance because of the material culture contained within Strata I–IV. We know the approximate ages of these materials from the radiocarbon and obsidian hydration evidence. And, as discussed above, the stratigraphic record at Hidden Cave (as now interpreted) simply does not provide the crisp chronostratigraphic boundaries desirable for construction of workable cultural chronologies. But even setting aside these independent chronometric controls, it is of interest to devise a way of comparing temporal distributions on the basis of artifact frequencies alone.

The question is simple: are there significant differences in the stratigraphic distribution of cultural materials at Hidden Cave? Elsewhere (Thomas, in press), I have used cumulative curves to compare overall temporal distribution of artifacts across disparate kinds of archaeological sites. It is possible, after deriving the characteristic *temporal profile* for an assemblage, to compare this profile with other curves to see the relative mean age of each assemblage (provided that the same set of temporally diagnostic artifacts is used in both cases).

Figure 117 plots the distribution of temporally diagnostic projectile points from the three primary cultural units inside Hidden Cave, Strata I, II, and IV. There are subtle differences in the temporal profiles of these three assemblages. In Stratum IV, a single Elko series point occurred; the rest of the time-diagnostic points belonged to the Gatecliff series. When transformed to an ogival format, this temporal profile rises sharply during the Devils Gate phase, and then peaks out during Reveille times.

Because 90 percent of the Stratum II points (35 of 39) belong to the Gatecliff series, the curves for Strata II and IV are very similar. But since Stratum II contained three Elko and two Rosegate points, the upward curve is dampened, and the curve peaks during Underdown times.

Over half (22 of 28) of the Stratum I/Surface assemblage belonged to the Gatecliff series; the additional two Elko series and four Rosegate points merely flatten the temporal profile to denote a slightly later mean date for Stratum I.

The three curves on figure 117 show that all three strata are heavily dominated by Devils Gate phase diagnostics. But as one goes higher in Hidden Cave, the mean age of the cultural assemblages becomes slightly later.

The real question is whether—given the relatively small sample of stratigraphically controlled specimens involved—these per-

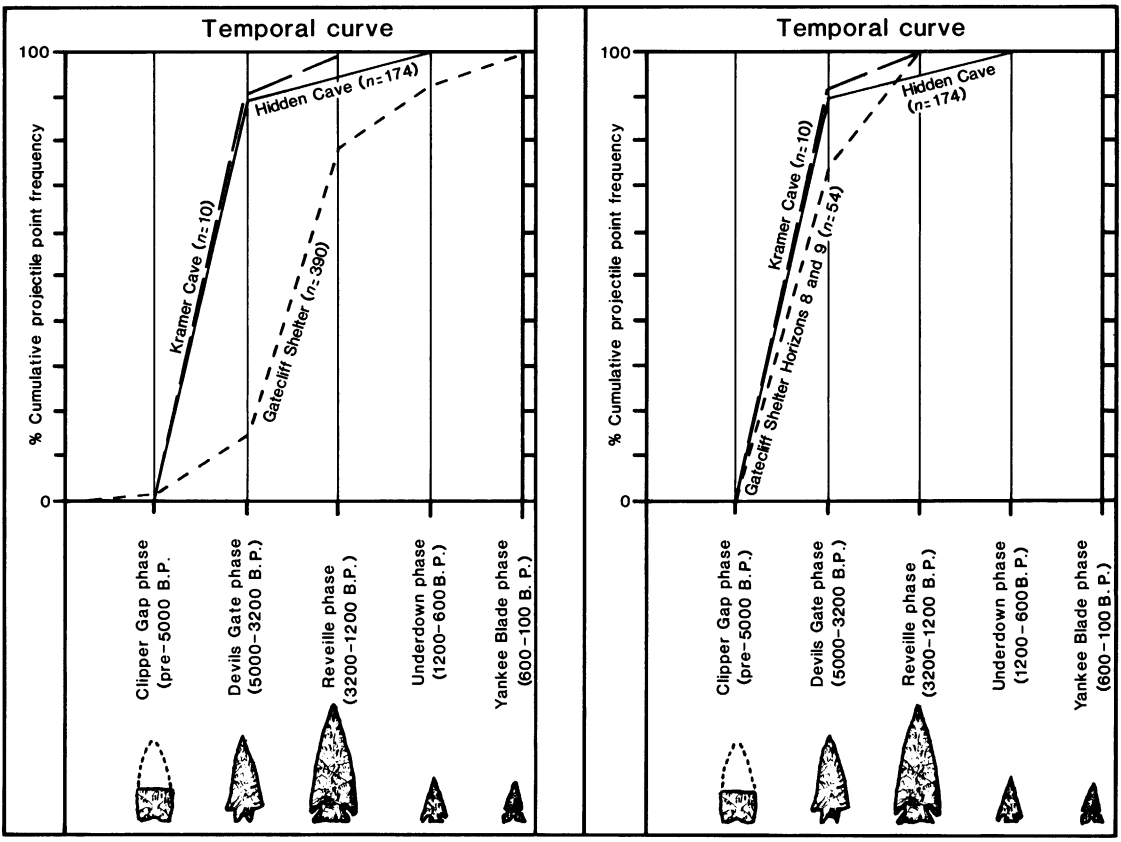

FIG. 118. Temporal distribution of projectile points at Hidden Cave, Kramer Cave, and Gatecliff Shelter.

ceived differences are significant. A Kolmogorov-Smirnov two-sample test shows that Strata II and IV temporal profiles from Hidden Cave cannot be distinguished on a statistically significant basis ($D = 0.082$; $D_{0.05} = 0.363$; $n_1 = 39$; $n_2 = 22$). That is, given the available samples from Hidden Cave, there is no demonstrable difference in the ages of Strata II and IV.

Similarly, a Kolmogorov-Smirnov two-sample test shows no significant difference between the Strata I and Strata IV temporal profiles ($D = 0.172$; $D_{0.05} = 0.387$; $n_1 = 28$; $n_2 = 22$).

Samples from the three major strata at Hidden Cave thus fail to show a significant temporal difference in mean age of occupation. We know from the radiocarbon evidence (discussed above) that such differences in fact exist, *but the level of resolution in the sample of temporally diagnostic artifacts is not sufficient so that we can monitor those differences.*

Looking strictly at time-diagnostics, we are justified, statistically speaking, in pooling the projectile point assemblage from Hidden Cave for comparison with other key sites. This is important for two reasons: (1) potential problems with intrasite stratigraphic relations and possible rodent and cache-pit disturbance can be judged as irrelevant for comparisons, and (2) the "no correlation" artifacts (items recovered from Hidden Cave, but not from datable contexts) can be pooled with the stratigraphically controlled specimens, thereby substantially increasing the sample sizes from this site.

We array the pooled temporal distribution

of time-sensitive projectile points from Hidden Cave on the left side of figure 118. The steep inflection during the Devils Gate phase is the graphic reflection of the fact that Gatecliff Split Stem and Gatecliff Contracting Stem points comprise nearly 90 percent (153 of 174) of the temporally diagnostic points at Hidden Cave.

Note on figure 118 that the temporal distribution of projectile points at Hidden Cave corresponds almost precisely with the temporal range of Kramer Cave (Hattori, 1982, p. 200). Not surprisingly, a Kolmogorov-Smirnov two-sample test shows that the Kramer Cave and Hidden Cave temporal profiles are statistically indistinguishable ($D = 0.055$; $D_{0.05} = 0.442$; $n_1 = 10$; $n_2 = 174$). Figure 118 shows that these two assemblages reflect precisely the same temporal relationships shown by the radiocarbon evidence.

The left side of figure 118 also plots the distribution of time-markers at Gatecliff Shelter. Whereas Hidden and Kramer caves are relatively short-term occupations—with relatively homogeneous assemblages—Gatecliff Shelter contained a 6000-year sequence with marked changes in the time-marker assemblage.

The Gatecliff Shelter profile approximates a sigmoid distribution (meaning that whereas all cultural phases are represented, the overall Gatecliff assemblage is dominated by Reveille phase-diagnostic points); we know that Reveille phase activities dominate other aspects of the Gatecliff assemblage as well (Thomas, 1983b).

A Kolmogorov-Smirnov two-sample test shows that there is a highly significant difference between the Gatecliff Shelter and Hidden Cave temporal profiles ($D = 0.755$; $D_{0.01} = 0.148$; $n_1 = 390$; $n_2 = 174$). Similarly, a Kolmogorov-Smirnov two-sample test discloses that despite the very small sample from Kramer Cave, there is a highly significant difference between the temporal profiles for Gatecliff Shelter and Kramer Cave ($D = 0.774$; $D_{0.01} = 0.522$; $n_1 = 10$; $n_2 = 390$).

The ogival technique can also be used to explore further the matter of temporal differences between these sites. The right side of figure 118 compares the temporal distributions of the Hidden and Kramer Cave assemblages with the curve for the primary

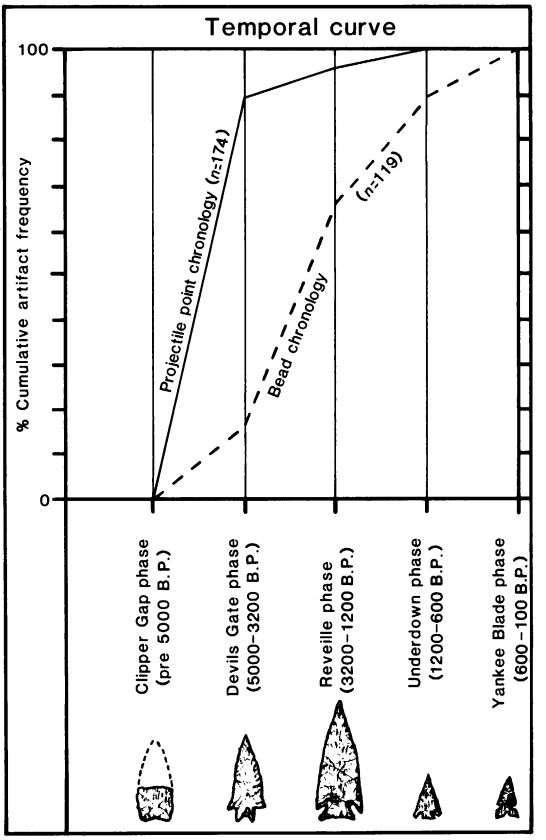

FIG. 119. Temporal distribution derived from projectile point chronology with that derived from shell beads and ornaments at Hidden Cave.

Devils Gate floors (Horizons 8/9) at Gatecliff Shelter. A Kolmogorov-Smirnov two-sample test shows that the Hidden Cave and Gatecliff Devils Gate assemblages are statistically indistinguishable ($D = 0.225$; $D_{0.05} = 0.412$; $n_1 = 22$; $n_2 = 54$).

THE SHELL BEAD CHRONOLOGY AT HIDDEN CAVE

Pendleton (chap. 17, this volume) notes that whereas the Hidden Cave projectile point chronology was heavily weighted toward Gatecliff series points (and hence the Devils Gate phase), the shell bead and ornament chronology was dominated by Reveille phase diagnostics.

The cumulative temporal profile method allows us to assess this possibility in a statistically reliable fashion. In figure 119, we plot

the temporal curves for the two temporally diagnostic artifact chronologies from Hidden Cave. The projectile point profile is plotted as before, based on the presumed temporal distribution of the 174 temporally diagnostic projectile points recovered from Hidden Cave.

This chronological curve can be compared with a profile based on shell ornaments and beads. Because this chronology is more poorly established in Great Basin contexts, it was more difficult to derive this curve. But we assess the chronological range of each type according to criteria presented by Bennyhoff and Hughes (ms.), and then plot them in phase-by-phase frequencies. When a given type spans more than one phase, the bead/ornament frequency was proportionally distributed across the interval.

The two curves appear superficially to be very different: whereas the point chronology reflects the dominance of Devils Gate phase diagnostics, the shell bead curve is more uniformly distributed across the sequence, with the Reveille phase particularly well represented (see Pendleton, chap. 17). A Kolmogorov-Smirnov two-sample test shows this impression to be true—the two curves are different at the 0.01 level ($D = 0.713$; $D_{0.01} = 0.194$; $n_1 = 119$; $n_2 = 174$).

In other words, projectile points (as time markers) tell a somewhat different story than shell beads (as time markers). Figure 119 illustrates that extreme care is in order when results are based on a single set of chronological indicators. Although archaeologists rarely have the luxury of resorting to independent chronologies, they should attempt to avail themselves of that privilege whenever possible.

CHAPTER 27. INTEGRATIVE SYNTHESIS: THE LACUSTRINE BIOME AS VIEWED FROM HIDDEN CAVE

DAVID HURST THOMAS

So far, this volume has been characterized by a great deal of interpretive restraint. We have emphasized the incompleteness of the data and the caution required when dealing with the archaeological record. But after duly recognizing these difficulties, it is time simply to get on with it, to take a stand on what Hidden Cave can tell us about the land, and the people who once lived there.

To do this, I employ *the most probable interpretation,* a concept that "bridges the gap between method and substance. Interpretations stand merely as what I consider to be the best bet when all the presently available evidence is taken into account. Alternatives are entertained whenever possible, and in many cases, it is possible to assess the relative probabilities associated with each interpretation" (Thomas, 1983b, p. 440).

The *most probable interpretation of Hidden Cave* is that this largely single-component site served (1) as a complex, multifunctional node for storage and (2) also as an extremely limited logistic outpost. Adverse conditions of lifespace rule out effective residential usage of Hidden Cave.

The *primary activity* at Hidden Cave was the storage of personal gear that had temporarily passed into a "passive" state (as defined in chap. 2). Evidence for this interpretation derives from multiple sources: the individual artifacts recovered from Hidden Cave are wholly consistent with those from known-function stores of personal gear; the clustered horizontal distribution of items suggests that some artifacts—particularly projectile points, worked wood, and perhaps worked bone—were deliberately cached in rather large numbers; the lithic assemblage contains an extremely high proportion of recycled, reworked, heavily-utilized high cost artifacts, nearly all of which were serviceable at the time of storage; byproducts of on-site fabrication are extremely rare; emptied cache pits are common throughout the cave deposits; pit feature morphology suggests primary use as personal gear caches; coprolites contain direct evidence of resource storage; the large latrine feature implies caching of potential famine food.

This interpretation is also supported by negative evidence: Hidden Cave contained virtually no debris from on-site domestic activities, primary fabrication, or maintenance; habitation facilities were almost totally absent; food bone was quite rare (and that recovered was probably consumed off-site).

Three *secondary activities* can likewise be defined:

1. Hidden Cave occasionally served as a burial locus. At least five people were interred there, but grave goods, if any, are indistinguishable from general artifact population. Pit morphology also supports this interpretation.

2. Hidden Cave occasionally functioned as a *diurnal way station,* a place where logistic parties could "lay over" to escape the temperature extremes of the Carson Sink. Most diurnal usage occurred during the summer months, although a minor winter utilization cannot be ruled out. This interpretation is inferred from the coprolites, quids, and cattail flooring.

3. Hidden Cave may have functioned as a *resource cache,* storing summer-ripening cattail pollen and coprolites for potential second harvest. Pit morphology also supports this interpretation.

It is, moreover, possible to use the Hidden Cave data as a window on the much larger, regional exploitative pattern. Diverse seasonal indicators leave no doubt that Hidden Cave was heavily utilized during the summer months, and probably also during the spring and fall. Hidden Cave thus contrasts with Lovelock Cave and the other Humboldt Sink cave sites. These more northerly sites contain seasonal indicators that suggest utilization from late fall, through the winter months,

into early spring (Napton and Heizer, 1970, p. 108).

The Hidden Cave data document an apparently pervasive regional pattern of food storage, particularly grass and *Scirpus* seeds, piñon nuts, fish, and probably also cat-tail products. There was an extensive regional network of long distance transport of both food and fabrication resources. Although these items were not necessarily stored inside Hidden Cave *per se,* the caches could not have been far away.

As noted above, these inferences make up the *most probable interpretation* of Hidden Cave. The rest of this volume considers the archaeological data supporting these interpretations.

LIFESPACE CONSTRAINTS AT HIDDEN CAVE

Hidden Cave, a minor piece of a complex regional mosaic, offered a number of survival advantages to the knowledgeable. But there were also drawbacks.

Few people ever "lived" in Hidden Cave, as such. Places of continued residence are commonly selected by hunter-gatherers only if they meet certain minimal conditions of human lifespace: food, water, firewood, level ground, adequate shelter, acceptable levels of heat, and light (Binford, 1982, 1983; Thomas, 1983a, chap. 5). These lifespace considerations rendered Hidden Cave a very poor choice as a place to live.

Light may be the most extreme factor limiting the residential potential at Hidden Cave. We know from historical and geological studies that (at least during Strata II and IV times) the entry to Hidden Cave was not significantly larger than when the cave was rediscovered in the 1920s. That is, the quantity of light reaching the inner part of the alcove and central block areas has always been minimal. Without a source of artificial light, one is in complete darkness everywhere but within 5 or 6 m. of the entrance.

Dust is another reason not to live inside Hidden Cave, since the fine silts rapidly turn to powder when trampled or otherwise disturbed. We know from personal experience that unless precautions are taken, dense clouds of dust arise when even a few people walk about inside.

The twin problems of light and breath plagued three generations of archaeologists attempting to excavate inside Hidden Cave (see accounts in chap. 4). None of us were tempted to live inside the site, and similar limiting factors militated against a prehistoric habitation usage of this site.

These considerations derived from mid-range knowledge regarding minimal conditions of human residence. The archaeological record of Hidden Cave supports these suggestions: there is no evidence of residential utilization inside the cave. As detailed below, domestic and fabrication byproducts are virtually absent; except for materials contained in coprolites, food bone is rare; only two minimally utilized "hearths" were encountered (and one of these is merely a faint charcoal stain).

People simply did not "live" inside this dark and dusty cave. But this is not to say that Hidden Cave was undesirable space. The inside temperature is fairly stable, and the cave could readily provide temporary shelter against extreme outside temperature fluctuations. Hidden Cave is relatively cool when the Carson Sink is roasting, and it is relatively warm when the outside hillside is freezing. We think that the endogene cave environment doubtless provided temporary, short-term diurnal shelter.

PRIMARY ACTIVITY: HIDDEN CAVE AS CACHE OF PERSONAL GEAR

Realizing what Hidden Cave is *not,* we now review the evidence supporting the *most probable interpretation,* namely that Hidden Cave functioned as a warehouse for temporarily "passive" implements and gear. A general discussion of caching behavior and its archaeological visibility was set out in chapter 2. We now employ this framework to make sense of the empirical evidence for prehistoric storage at Hidden Cave.

The Character of the Hidden Cave Artifact Assemblage

Hidden Cave is riddled with pits once used for prehistoric storage, and we can tell some-

thing about the function of such pit features from a consideration of their morphology (see chap. 21 and below).

Unfortunately, most of the Hidden Cave cache pits were emptied long ago. We argue in chapter 2 that storage features must be identified archaeologically by their *contexts,* not their *contents.* Once the contexts are destroyed, there remain no distinctive archaeological signatures to define artifacts once cached.

Nevertheless, it is instructive to examine the functional structure of the Hidden Cave artifact sets, since the assemblages retain certain aspects of the social matrix within which they functioned. When discussing artifact function, I am most comfortable with criteria proposed some years back by Howard Winters (1969, chap. IV) in his now-classic analysis of settlement and subsistence patterns of the Riverton culture in the central Wabash Valley of Illinois. Elsewhere (Thomas, 1983a, 1983b) I have discussed these terms in detail, adapting them where necessary to the specifics of Great Basin material culture.

This examination of the roughly 2300 artifacts recovered from Hidden Cave will be conducted in terms consistent with this previous analysis.

GENERAL UTILITY TOOLS: "tools of such generalized nature that they could have been used in connection with a variety of activities . . . [an] admittedly unsatisfactory term" (Winters, 1969, p. 32): knives (stone and bone), scrapers (stone, bone, and horn), choppers, hammerstones, cordage, and containers.

General utility tools comprise roughly 55 percent (1290+ of 2340) of the Hidden Cave assemblage (a figure obviously inflated by the fragmentary nature of the cordage):

scrapers: utilized flakes ($n = 16$)
projectile points: 6 percent (8 of 136) show use as scrapers
concave base points: 12 percent (2 of 17) show use as scrapers
nonprojectile point bifaces: 24 percent (9 of 39) show use as scrapers
knives: utilized flakes ($n = 4$)
projectile points: 9 percent (12 of 136) show use wear as knives
concave base points: 35 percent (6 of 17) show use as knives
nonprojectile point bifaces: 54 percent (21 of 39) show use as knives
hammerstones ($n = 1$)
cordage ($n = 1060$)
tule bags whole ($n = 5$)
fragmentary ($n = 12$)
knotted fibers ($n = 149$)
skin strips: several

WEAPONS: "any implement designed primarily for the killing or procurement of fauna . . . The basic criterion is the possession of properties appropriate to the effecting of an untimely demise of some member of the faunal community . . ." (Winters, 1969, p. 37): bows, arrows, fishing equipment, nets, snares, traps, nooses, rabbit and reptile hooks, disguises, decoys, rabbit clubs.

Weapons comprise roughly 9 percent (215 of 2340) of the Hidden Cave assemblage:

projectile points: 69 percent (94 of 136) show use only as projectiles
concave base points: 24 percent (4 of 17) show use as projectiles
nonprojectile point bifaces: 18 percent (7 of 39) show use as projectiles
discoidals ($n = 4$): probably used as net weights (also possibly as spindle whorls)
atlatl ($n = 1$)
wooden foreshafts ($n = 47$)
cane mainshafts ($n = 7$)
arrowshaft butt ($n = 2$)
snare parts ($n = 5$)
nets ($n = 44$ fragments)

HARVESTING EQUIPMENT: any implement designed primarily to facilitate the untimely demise of some member of the floral community (Thomas, 1983a, p. 72): seed knives (wood, stone, and bone), piñon hooks, seed beaters, seed fans, seed baskets, sickles (horn or bone).

Harvesting equipment at Hidden Cave was limited to 10 broken pieces of wood, each of which had probably been used as a digging stick. It would be possible, of course, to include such perishable artifacts as tule bags, coiled items, and plaited basketry as harvesting equipment; but it is impossible to tell whether these items were deposited as whole, functional implements or merely as fragments. By the most conservative count, this category comprises roughly 0.4 percent of the total Hidden Cave assemblage.

DOMESTIC EQUIPMENT: "any item designed

for use in processing, consuming, or storing food, or whose normal function would be concerned with the maintenance of dwelling or clothing, and items of household equipment" (Winters, 1969, p. 61): milling equipment (manos, metates, mortars, pestles), cooking equipment (bowls of ceramic or stone, basketry containers, mush stirrers), woodworking tools (adzes and axes), firemaking equipment (fire drills, hearths, flint and steel apparatus), all items of clothing (skirts, shirts, dresses, aprons, sandals, moccasins, leggings, caps), spoons (bark and bone), dippers (turtleshell, mountain sheep horn, deer skull, ceramic, basketry), dishes (horn, basketry, stone, and ceramic), water jugs, sleeping mats, ornaments (pendants of stone, bone, or shell, shell and bone beads, bone tubes, bone and hoof tinklers, animal claws and teeth), pipes, blankets, cradles.

Domestic equipment comprises roughly 30 percent (684 of 2340) of the Hidden Cave assemblage:

milling equipment:
- *metate* ($n = 1$)
- *miscellaneous ground stone:* mostly mano fragments ($n = 11$)

ornaments:
- *obsidian tinklers* ($n = 4$)
- *stone bead* ($n = 1$)
- *shell beads and ornaments* ($n = 142$)
- *bone tubes and beads* ($n = 4$)
- *antler pendant* ($n = 1$)
- *bighorn pendants* ($n = 19$)
- *pond turtle pendant* ($n = 1$)
- *incised/punctated bone* ($n = 3$)
- *juniper berry beads* ($n = 61$)

firemaking equipment:
- *drills* ($n = 26$)
- *hearths* ($n = 8$)

basketry ($n = 122$): mostly unusable fragments (But we cannot tell if worn out and discarded or destroyed by rodents after deposition; perhaps also used as cache lining.)

matting (various fragments); *wrapped fiber clothing and fiber braiding*; *fiber brooms*; *fur/skin elements* (roughly 200 items)

leather thongs ($n = 80$): As before, this category is somewhat arbitrary, since we cannot tell in what condition the perishables were deposited.

FABRICATING AND PROCESSING TOOLS: "Any implements utilized primarily in the alteration or assembling of raw materials for use in the various stages of manufacture of other implements or equipment" (Winters, 1969, p. 47). In other words, fabricating artifacts are tools used to make other tools: flakers, perforating tools (bone or cactus spine awls, drills, perforators, gravers), sewing implements, weaving tools (such as shuttles for making nets), shaft straighteners, edge-abraded cobbles.

Fabricating and processing items comprise roughly 5 percent (119 of 2340) of the Hidden Cave assemblage:

discoidals ($n = 4$): possible spindle whorls for drills
drills ($n = 7$)
projectile point drills: 4 percent (5 of 136) show drill use wear
pressure flaked biface gravers ($n = 1$)
worked flakes ($n = 6$)
core ($n = 1$)
unmodified debitage ($n = 56$)
bone awls ($n = 28$)
pressure flakers ($n = 7$)
thatching needle ($n = 1$)
wood mesh gauge ($n = 2$)
hammer/pecking stone ($n = 1$)

CEREMONIAL EQUIPMENT: "Probably any definition of a category such as ceremonial items will be unsatisfactory . . . . We shall define our category as composed of artifacts the use of which can be assumed from primary and secondary attributes to be associated with sacred or secular rituals, either personal or communal, or to be symbols of status within an organized group" (Winters, 1969, p. 68): flutes, ocher, grave goods, shaman equipment (such as feathers, eagle down, clay, dewclaw or hoof rattle, sucking tubes).

Ceremonial equipment comprises roughly 0.3 percent (7 of 2340) of the Hidden Cave assemblage:

crystal ($n = 1$)
palette ($n = 1$)
red ocher fragments ($n = 2$)
bird bone whistle ($n = 1$)
effigies? ($n = 2$)

RECREATIONAL EQUIPMENT: "The very concept of a category of recreational equipment derives from a defective and particularizing view of the nature of such artifacts in primitive societies. All that we can say at

present is that the similarity of these items to ethnohistoric examples of recreational equipment seems to provide a better basis for inclusion of these artifacts in [this] . . . category than in any other" (Winters, 1969, p. 83): gaming items (cane dice, counting sticks, hand-game bones), pucks (stuffed skin or braided hide), bullroarers, drums, flutes, rattles, toys.

Recreational equipment comprises roughly 0.3 percent (7 of 2340) of the Hidden Cave assemblage:

stone tablet ($n = 1$)
stone cylinders ($n = 2$)
marble ($n = 1$)
tabular bone artifacts ($n = 3$): could be gaming pieces or possibly mesh gauges

These categories are neither exhaustive nor mutually exclusive, but they do illustrate the extremely diverse nature of prehistoric material culture as deposited at Hidden Cave.

There are no distinctive archaeological signatures to define artifacts that were once cached. The act of caching simply reflects the transition of a given artifact from "active" to "passive" status. Nevertheless, it is clear that the extremely diverse artifact assemblage of Hidden Cave is dominated by insurance and personal gear—roughly 85 percent of the assemblage consists of domestic and general utility items. It is worthwhile to note, however, the near absence of gear specifically designed for marshland exploitation—duck decoys, fishing tackle, bunt points for taking waterfowl, harvesting equipment; these items were, by contrast, well-represented in the Lovelock and Humboldt Cave assemblages.

The great diversity in the Hidden Cave assemblage is not surprising; such variability is wholly consistent with expectations from available mid-range theory (chap. 2). Although functional composition is insufficient to define a cache's contents, the known range of gear caches and grave furniture (the afterlife cache) could readily be subsumed within the Hidden Cave assemblage.

The Distribution of the Hidden Cave Artifact Assemblage

Ingbar (chap. 22) defines two trends in the distribution of Stratum IV artifacts. Projectile points, worked wood, and worked bone were concentrated in the east-central portion of the site. Beads, and to some extent cordage, cluster toward the peripheries of the central floor. Flakes fall between these two areas.

Stratum II artifacts are distributed rather differently. First, artifacts found to be spatially discrete in Stratum IV are clustered together in Stratum II. The Stratum II concentrations also occur somewhat closer to the entrance. In addition, the extreme western margin of Stratum II was almost empty—probably because the increasing midden deposition raised the floor, so that this area was very close to the low roof.

These overall artifact distribution patterns tell us that the extensive and obvious rodent disturbance did not totally homogenize the deposit. Had rodents been moving the Stratum IV projectile points about the site, for instance, then the points should not be so clumped together. Given the low level of resolution employed here, the degree of horizontal rodent disturbance can be considered minimal.

Artifact distribution maps also suggest which artifacts may have been intentionally placed in Hidden Cave in quantity. Based on this distinctive clustering, we conclude that projectile points, worked wood, and perhaps worked bone could have been deliberately placed in rather large caches of personal gear.

Beads were also clustered in Hidden Cave, but they were more likely introduced into the midden collectively in a few strings that were subsequently broken and scattered. It seems likely that beads, pendants, and other ornaments entered the cave as caches of personal items, as accidental losses, or as grave goods.

The Condition of the Hidden Cave Artifact Assemblage

So far, we have asked two questions of the Hidden Cave assemblage: (1) What artifacts were found there? and (2) Where, exactly, were the artifacts found?

Consider now a third inquiry: (3) What was the condition of the artifacts? Artifact condition is, of course, a product of both behavioral and postdepositional factors. Consider, for instance, the cordage recovered from Hidden Cave. Goodman (chap. 19) describes 1060 individual pieces of cordage in the Hidden Cave assemblage. But we have no idea

how many individual pieces of cordage were deposited initially in behavioral contexts. Similarly, although 44 pieces of netting were recovered, we cannot tell how many nets actually "stand behind" these 44 pieces, nor do we know how many baskets are represented by the 122 pieces of basketry described in chapter 19.

Perishable industries are particularly subject to postdepositional destructive factors—not only differential preservation, but also fire, rodent disturbance, and reuse. Because of these biasing forces, we restrict this section to an examination of lithic artifacts. Although lithics can indeed be broken and reworked into other forms, the subtractive nature of lithic technology makes it easier to define such curation in stone.

Although comparable data are difficult to find, it is abundantly clear that the Hidden Cave lithic assemblage is unique. Particularly striking is the extremely high frequency of intact stone tools (Pendleton, chap. 15). Excluding concave base points, fully 88 percent of the projectile points are unbroken and completely serviceable—precisely what is expected in cache contexts. Further, most of the broken points in Hidden Cave were broken by usage rather than during manufacture.

The rest of the lithic assemblage mirrors this trend, though in a less extreme form. Fifty-eight percent of the concave base points are complete; 53 percent of the Humboldt Basal-notched bifaces are unbroken; roughly 60 percent of the remaining bifacial lithics are unbroken. In fact, virtually *all* lithics were still serviceable (though not necessarily for the original functions).

In other words, only usable tools were discarded inside Hidden Cave—exactly what one expects in the storage situation. It is generally the serviceable artifact that makes the transition from "passive" to "active" status (chap. 2).

Not only were the Hidden Cave lithics relatively complete, but they were also heavily reused. Fully one-third (67 of 201) of the typable projectile points were resharpened at least once; Pendleton estimates (conservatively) that at least 5 percent (11 of 201) of the Hidden Cave points had been resharpened repeatedly. Eight Gatecliff and Elko series projectile points were reworked into other forms (seven as drills, and one had been sharpened specifically for cutting). Nearly one-quarter of the additional bifaces and biface fragments were also resharpened.

Technological evidence thus demonstrates a high curation rate of Hidden Cave lithics, and the obsidian hydration study confirms this tendency (Jackson, chap. 24). Three obsidian artifacts—two Gatecliff Split Stem (20.4/555 and 20.4/955) and one Rosegate series point (20.3/930)—contained both an "older" hydration band (more than 3 microns thick) and a "younger," considerably thinner band. These points obviously reflect two distinct episodes of flintknapping, separated by several centuries. This later episode of renewal would suggest scavenging or recycling of older materials, perhaps from flake caches or by renovating previously manufactured bifaces obtained from tool caches or scavenged from surface contexts.

Although one cannot tell where such reworking occurred, the virtual absence of debitage indicates that lithic refabrication did not occur inside Hidden Cave. Only one core and three pieces of bifacial shatter have been recovered. Debitage was also extremely rare at Hidden Cave; only 56 waste flakes were recovered from the entire site. This is an astonishingly small number—we found more than three times as many whole projectile points!

The Hidden Cave lithics are also severely worn. Eighty-eight percent (157 of 178) of the American Museum point sample was heavily utilized—mostly as projectile points, but also as scrapers, knives, and drills (Pendleton, chap. 15). Over half of the remaining nonpoint bifaces were also utilized (18 percent as projectile points, 24 percent as scrapers, and 6 percent as gravers).

The Hidden Cave lithic assemblage is thus a relatively uniform, heavily reworked and resharpened collection of finished bifacial artifacts, manufactured primarily from exotic raw materials—exactly what one would expect when artifacts are shuttled between "active" and "passive" status.

The Character of the Hidden Cave Pit Features

More than two dozen cultural features were excavated at Hidden Cave, and most are merely scooped out pits. These pit features

certainly appear to be "caches," but interpretation is complicated because most of them were emptied of contents millennia before archaeologists excavated them.

The most common Hidden Cave feature is wide and shallow (Ingbar, chap. 21). Many such pits exhibit a certain degree of planning, some being lined, and others utilizing flat stones to protect the contents. Based strictly on morphology, Ingbar argues that these wide, shallow pits were probably used for storage of personal gear kits (see also chap. 2); the Hidden Cave artifact inventory is consistent with this suggestion.

Hidden Cave seems to be a rather complex cache facility, probably used mostly for storage by individuals. The site also contains eight deep-narrow, relatively high-volume pit features. Such deep-narrow features were originally excavated as grave pits, as at Lovelock Cave (see below); these facilities may also have stored corporate gear or bulk foodstuffs.

But What Are Coprolites Doing in a Cache Cave?

The storage hypothesis will not, however, explain all of the Hidden Cave data. If Hidden Cave was strictly a storage site, then what is the function of the so-called latrine feature? Does it make sense for people to climb halfway up Eetza Mountain (hundreds if not thousands of times) merely to defecate indoors?

Exposed as Feature 11 in 1951, this archaeological facility certainly impressed the excavators—a pit roughly 2 m. in diameter, carefully lined with large rocks transported into the cave from the Eetza Mountain hillside. This deliberately prepared pit contained "coprolites in profusion" (1951 field notes).

Years later, University of California archaeologists found other prehistoric latrines. While excavating at Lovelock Cave in 1965, Robert Heizer and his students encountered a concentration of more than 500 coprolites: "it is likely that the crevice was used as a latrine by some of the latest occupants of the outer rockshelter" (Heizer and Napton, 1970, p. 12). Two years later, another University of California crew ran into a second latrine—this one containing more than 1500 coprolites—in the west alcove of Lovelock Cave (Heizer and Napton, 1970, p. 29).

Heizer puzzled over these unusual features, eventually offering two rather different explanations. On the one hand, Heizer attributed the massive concentration of coprolites in the west alcove

> to the fact that the crevice at the back of the alcove is the sort of place to which *Homo sapiens* characteristically retires for such purposes . . . (Heizer and Napton, 1970, p. 29). Lovelock Cave, a nearly enclosed chamber, cannot have been a very pleasant place to live in if we are to judge by the quantity of fecal remains present and the odors these release after they have been rehydrated preparatory to being analyzed. The only justification for such habits that I can think of is that the cave may have been lived in during periods of extreme low temperature in the winter . . . . The people may have been unwilling to leave the cave unless it was absolutely necessary, and if it was their decision that it was not required to go outside the cave to defecate, that may be the reason we have available the rich archaeological harvest of coprolites (Heizer, 1967, p. 11).

This oddly ethnocentric appeal to innate human tendencies conflicts with known ethnographic practices in the Great Basin and elsewhere. While traveling in the eastern Great Basin, Simpson, for instance, (1876, p. 56) noted:

> Near our camp I visited one of their [the Gosiute] dens or wick-e-ups . . . . It was an inclosure, 3 feet high, of cedar-brush. The offal around, and in a few feet of it, was so offensive as to cause my stomach to retch, and cause a hasty retreat. Mr. Bean told me the truth when he spoke of the immense piles of *faeces* voided by these Indians, about their habitations, caused doubtless by the vegetable, innutritious character of the food.

Obviously the Gosiute did not share these sensitivities.

Heizer also offered a rather more innovative explanation for the deliberate concentrations of thousands of coprolites inside Lovelock and Hidden caves. Employing an analogy to hunting and gathering groups of Baja California, Heizer (1967, pp. 6–7) suggested that people might have deliberately defecated in latrines so that they might, in

times of famine, return to retrieve and consume the undigested seeds contained in the desiccated feces.

Heizer apparently proposed this suggestion tongue-in-cheek, and did not, to my knowledge, pursue the so-called second harvest hypothesis in later considerations of lacustrine subsistence practices. This is unfortunate because I think that Heizer hit upon a firstrate idea.

The second harvest concept seems to derive from the firsthand early accounts by explorers, missionaries, and military men who observed the practice among the Guaicura of Baja. Heizer briefly discussed the journal of a Jesuit missionary, Father Johann Jakob Baegert who arrived at Mission San Luis Gonzaga in 1751 (Baegert, 1952), not far from the tip of Baja, where he remained until 1767, when the Society of Jesus was expelled from the New World. Baegert's observations, originally published in 1771, are apparently rather accurate, having been written while his experiences were fresh in his mind (Brandenburg and Baumann, 1952). Because of its relevance to the archaeology of Hidden Cave, Baegert's account of the second harvest among the Guaicura is cited in full:

> At this point I ask permission of the patient reader to mention something of an exceedingly inhuman and repulsive nature, the like of which has probably never been told of any other people in the world. . . . The pitahayas [cactus] contain a great many small seeds, resembling grains of powder, which for reasons unknown to me are not consumed in the stomach but passed in an undigested state. In order to use these small grains, the Indians collect all excrement during the season of the pitahayas, pick out these seeds from it, roast, grind, and eat them with much joking. This procedure is called by the Spaniards the after or second harvest! . . . It was difficult for me, indeed, to give credit to such a report until I had repeatedly witnessed this procedure. . . . They will not give it up . . . (Baegert, 1952, pp. 67–68).

Geographer Homer Aschmann (1959) has drawn on these, and other, data to reconstruct the cultural ecology of the Central Desert of Baja California, and he specifically considers the practice of second harvesting:

> when the pitahaya dulce [*Pachycereus thurberi,* a great columnar cactus] was ripe, food was so abundant that the Indians could remain in one place for some weeks. They made a practice of defecating in a selected spot. When the feces were dry they were collected in flat baskets, ground up by hand, and the undigested pitahaya seeds winnowed out. These seeds were then toasted, ground on metates, and eaten. This known reserve of food, to be utilized when other sources gave out, may have been of critical importance in maintaining the population through the spring, the season of minimum food availability (Aschmann, 1959, p. 77).

This account provides a graphic example of an *embedded procurement strategy* (after Binford, 1979, p. 257). The basic notion is quite simple: food and raw materials for the manufacture of implements are continually being set aside for future need, even when that stockpiling is incidental to basic subsistence tasks. Survival-minded hunter-gatherers might carry some suitable lithic raw materials when returning from a hunting trip. A broken obsidian biface might be saved anyway, to be fashioned into a smaller implement sometime when raw materials are scarce. Kindling might be tucked away inside a rock-shelter to be used someday when dry wood was difficult to find.

Such "insurance" items are transported and set aside with little effort or cost (chap. 2; see also Binford, 1979, p. 258). And yet, it is precisely such scavenged stores that can save lives. As Binford's Nunamiut informant put it:

> Catch things when you can, if pass good stone for tools, pick 'em up, if pass good wood for sled runner, catch 'em then. Good man never think back and say, "If I had just pick 'em up last summer" or something like that. If too much trouble pack 'em, put 'em some place where you catch 'em later. Every dead Eskimo can remember something he not pick up when it was around" (Binford, 1979, p. 258).

Second harvesting provides the most acceptable explanation for the deliberate concentrations of coprolites in Hidden and Lovelock caves. This extremely low cost insurance policy was a cheap way of creating (in effect) an accessible cache of famine food (Colson, 1979). As it turns out, the latrines are but one

example of the famine foods utilized at Hidden Cave (see below).

SECONDARY ACTIVITY: HIDDEN CAVE AS A BURIAL SITE

Larsen (chap. 13 and Appendix B) has examined the relatively sparse sample of human skeletal and dental specimens excavated from Hidden Cave, concluding that the remains represent a minimum of three adults (based on relative differences in dental attrition) and at least two preadults (one younger than six months old, and the other between six months and one year old at death). Although isolated human bones could have been introduced by carnivores, it is much more likely that these remains derive from deliberate human interment inside Hidden Cave (as a person-cache, if you will).

Lacking contextual evidence, there is no way to distinguish the artifacts deposited as grave goods from those cached, discarded, or simply lost. As argued in chapter 2, grave goods can profitably be viewed as specialized "afterlife" caches; at least part of the artifact assemblage at Hidden Cave can be explained as grave furniture, subsequently dispersed both laterally and vertically. The entire artifact inventory accompanying the Ross burial (Appendix C, this volume), for example, is quite comfortably subsumed within the Hidden Cave assemblage.

SECONDARY ACTIVITY: HIDDEN CAVE AS A DIURNAL WAY STATION

Prehistoric people seem to have cached personal gear, coprolites, and perhaps raw materials inside Hidden Cave. But caches are easily made and quickly retrieved. If Hidden Cave were strictly a cache and burial locus, then we would not expect to find piles of unmodified cat-tails hauled up the hillside and spread out inside the cave.

Although lifespace considerations rule out a residential usage of Hidden Cave, these same conditions create an ideal setting for people to "lay over" to escape the temperature extremes of the desert surrounding Hidden Cave. Summer air temperatures in the Carson Sink, one of the lowest spots in the Great Basin, commonly soar above the 45°C. mark, with ground temperatures in excess of 55°C. not uncommon.

It comes as small surprise that people around the world seek to avoid the heat of the day, looking for shady areas to sit it out—inside a ventilated structure, under a tree, beneath a sunshade or ramada. Working in Australia, Richard Gould graphically describes the pattern:

> The summer heat has reached its full strength, and the sandhills near Partjar seem to be enveloped in a shimmering pink haze. The thermometer I am carrying registers 118 degrees Fahrenheit in the shade. Nothing moves except the flies, yet the sandhills seem to bob and dance as oven-hot air slides over them. I can feel the heat penetrating the soles of my tennis shoes, and drawing a deep breath causes my tongue to dry out like a potato chip. Clearly it was a mistake to go exploring around at midday, and I think it best now to follow the advice of Noel Coward ["Mad dogs and Englishmen go out in the noonday sun"] and return to camp. The Aborigines are still snoozing under whatever shade they can find . . . . It is a time to conserve one's strength, to take a nap or just lie in the shade (Gould, 1969, pp. 3, 19; see also Gould, 1980, p. 20).

Identical behavior is noted among the !Kung San: "In the . . . months of heat, the sand is so hot it burns the soles of your feet. Walking in the sun you can lose a half kilo of body weight per hour through sweating . . . . The routines of camp life proceeded [accordingly]: up at dawn; a quick breakfast . . . ; down to the water hole to see the cattle being watered and to catch up on the day's events; hiking to one of the !Kung villages for a morning of talk; back to camp for lunch and a rest in the hottest part of the day" (Lee, 1979, p. 21). Similarly, Tanaka (1980, p. 29) observed that, "the pattern of hunting and gathering activities varies greatly with the season and the type of food sought. In the hot summer, the ≠Kade people go out only during the cool of the morning and evening, usually spending the scorching midday napping or chatting in the shade of a tree." Among the G/wi, "the amount of time required to collect a day's ration for a household varies according to season and locality . . . . Approximately half of the working day is given up to periods of

rest, during which snacks of freshly gathered food are eaten. Very hot weather precludes movement. Between about 10:30 A.M. and 4 P.M. everybody rests and sleeps in whatever shade he or she can find" (Silberbauer, 1981, p. 200; see also Yellen, 1977, p. 92).

Similar warm weather behavior has been observed in the Great Basin. DeQuille (1963, pp. 2–36) noted that Northern Paiute task groups preferred to traverse the Carson Sink at night, obviously avoiding the heat of the day. Wheat (1967, p. 31) observed that even during the fall—a relatively cool time—the Northern Paiute napped in the shade while the sun was high, working primarily in early morning and late afternoon.

We suspect that Hidden Cave was used prehistorically as a diurnal way station, as a place to escape the heat of the day. Aside from the occasional riparian stand, the Carson Sink contains little natural shade. Not only are caves and rock-shelters permanent and well-known shaded areas, but Hidden Cave maintains a virtually constant interior temperature of 14.5°C. (chaps. 6 and 26).

The pollen evidence from Hidden Cave fill and coprolites documents that the cave was heavily utilized during the summer months. The natural conditions of lifespace, plus the abundance of quids and cat-tail flooring, also demonstrate that Hidden Cave must have functioned as something more than a warehouse. Logistic parties probably used Hidden Cave as a temporary, daytime resting spot.

Why So Many Quids Inside Hidden Cave?

Hidden Cave contained more than 300 *Scirpus* and *Typha* quids, restricted almost exclusively to the midden deposits, Strata II and IV (Goodman, chap. 19). DeQuille (1963, p. 141) provides an early account of how (and why) such quids were "constructed" by Northern Paiute of the Hidden Cave area: "They gather the large stalks of these rushes and peeling off the rind, chew the succulent pith. We often met them on the trails with handfuls of this plant, which they seemed to use as often as they were thirsty, in room [lieu] of water, in the same manner that the natives of tropical countries carry with them on their journeys, stalks of the sugar cane." Jennings (1957, pp. 225–226) recovered nearly 2000 quids from Danger Cave, and his experiments with *Scirpus* deserve mention:

> The bulrush juices were evidently a form of food. Both leaves and roots yield a starch. Neither Professor Cottam nor I could detect any narcotic or stimulant effect resultant from the chewing, although both of us were aware of a slightly sweet and a very refreshing flavor in the juices. Although I chewed only a few pieces—for a total of perhaps an hour—Mr. Cottam subsisted for one day upon the stuff as he cruised the area making flora collections. He reported feeling neither thirst nor hunger pangs all day.

These unlovely chewed wads reinforce the noncache interpretation of Hidden Cave. The Hidden Cave quids also recall the speculation of Heizer and Napton (1970), that relatively low-ranking lacustrine resources were commonly employed as a kind of low-quality trail food, providing both nutrients and moisture in an arid habitat.

Unlike coprolites, quids cannot be recycled. Their presence suggests deliberate discard in the place of utilization. This means that people must have spent a significant period of time actually *being* inside Hidden Cave. The storage hypothesis does not account for an extensive on-site presence.

Why So Many Cat-tails Inside Hidden Cave?

The matrix of Strata II and IV at Hidden Cave comprises huge quantities of well-preserved cat-tail stalks, vegetal material that must have been human-transported. Additionally, analysis of fossil pollen contained in these strata documents the overwhelming abundance of cat-tail pollen in these two major midden units (Wigand and Mehringer, chap. 9). Observed absolute pollen counts exceed, by thousands of times, the amount of *Typha* pollen that could conceivably have blown in from the valley marshes. There is no question that large quantities of two species of cat-tail (and their hybrids) were transported into Hidden Cave during the summer when cat-tails flower. But why?

Some of these cat-tails were being cached as food (see below). But it seems likely that *Typha* was also hauled into the cave as rough

flooring to keep the ubiquitous dust under control while people utilized the site. Wigand and Mehringer also found rather large quantities of freshwater, acid-resistant algae (*Botryococcus* and *Pediastrum*) in the Hidden Cave fill. While low percentages of algae could have been transported by wind from a seasonally dry nearby lakeshore, it is more likely that the algae were "riders" on more massive, high bulk vegetal matter. Such materials—tules, cat-tails, and even algal mats—were used prehistorically to line storage pits and to cover living floors, as at Shinners Site A on Falcon Hill (Hattori, 1982, p. 11). Some living surfaces of both Gatecliff (Thomas, 1983b) and Triple T shelters (Thomas, in press) were so prepared with dense coverings of high bulk organics (in that case, sagebrush fiber). This explanation would also account for the layer-like distribution of cat-tails across the former surfaces of Hidden Cave.

It is also true that the Hidden Cave features tend to cluster in the cone-shaped lens of exterior light filtering in from the entrance of the cave (see fig. 101). It is in this area where the greatest concentration of organic matting occurs. If *Typha* was transported to create a relatively dust-free work area, this is exactly where ambient light and fresh air were most abundant.

High bulk, human-transported organic matting is one additional bit of evidence that cannot be accounted for by the caching hypothesis. Quids and cat-tails probably document short-term, temporary utilization of Hidden Cave as a logistic way station.

SECONDARY ACTIVITY: HIDDEN CAVE AS A RESOURCE CACHE

Hidden Cave may also have been a storehouse where comestible resources were stockpiled for future use. Not only does pit feature morphology suggest use as resource storage features (chap. 22), but the second harvest hypothesis implies that coprolites were deliberately and repeatedly voided in specific latrine areas to provide an emergency food supply.

The coprolites also show conclusive evidence that *Typha* pollen was eaten in quantity. It is possible that the vast stores of pollen-bearing *Typha* stalks found in the Hidden Cave midden strata had been transported inside as foodstuff, perhaps to be processed in the cool protected cave interior during midsummer, or perhaps to be stockpiled for subsequent processing. This strategy of resource storage would explain both the masses of lacustrine organics, and also the extremely high densities of economic plant pollen found in the midden strata.

PROCUREMENT STRATEGIES AT HIDDEN CAVE

We subscribe to a multifunctional explanation for utilization of Hidden Cave: as a warehouse for items of personal gear and food resources, as an infrequent burial cave, and as a diurnal way station.

But regardless of how the site functioned at any given point in time, Hidden Cave simultaneously articulated with a much larger settlement system. Certain aspects of this regional network can be inferred by examining the Hidden Cave data in an ecological framework.

The best single source of data regarding resource procurement strategies derives from the literally hundreds of coprolites found inside Hidden Cave. Quite independent of the question of why coprolites were deliberately cached is the direct dietary evidence contained in each specimen.

The initial study of Hidden Cave coprolites was conducted by Norman Roust, who subjected a sample of 85 human coprolites to nondestructive analysis (Roust, 1967; see also Ambro, 1967; and Napton and Heizer, 1970, p. 89). Although Roust's analysis was nondestructive, the previous sample of Hidden Cave coprolites could unfortunately not be located for study; Heizer (in Roust, 1967, p. 51) thought they had been lost sometime during the 1950s.

Seventy-four of the coprolites, recovered from the latrine feature, contained an abundance of seeds (mostly *Scirpus*) plus *Scirpus* fiber and bones of *Gila bicolor,* the small, locally available chub (called *Siphateles* by Roust, 1967). Although Ambro (1967, p. 43) suggested that this suite of coprolites spanned the last 2000 years, with the more refined chronological evidence now available, we

think that Roust's 32 Inch Midden coprolites were probably deposited from 3000 to 3500 years ago.

Roust's second coprolite sample derived from rat nest and surface contexts (Roust, 1967, p. 52). This batch of feces contained about the same constituents as the 32 Inch Midden sample, except that the "rat nest sample" coprolites were somewhat larger by weight, containing more bird bone and relatively more seed than fiber. Ambro (1967, p. 43) ascribed this sample to the protohistoric or historic period, correlating the "rat nest sample" from Hidden Cave with the "entrance lot" at Lovelock Cave. Although we cannot be certain, our stratigraphic and chronometric studies would suggest that Roust's second sample may be considerably older, probably deposited before 2000 B.P.

As part of our 1979–1980 investigations, another series of 26 human coprolites from Hidden Cave were examined by Wigand and Mehringer (chap. 9, this volume). Their primary objective was to extract and count pollen contained within the coprolites. As before, cat-tail pollen dominated the Hidden Cave coprolites; and at least two species, *Typha latifolia* and *T. angustifolia* were present. One sample (HC-554) contained an extremely high Gramineae (grass) pollen percentage. The presence of Chenopodiineae pollen suggests perhaps that specific chenopods (e.g., *Allenrolfea* or *Chenopodium*) were eaten (although the pollen could simply have been introduced as a contaminant). *Artemisia* pollen is rare in most coprolites, and completely absent from 10 samples. In only one was *Artemisia* pollen high enough to suggest that the meal was eaten in the spring of the year.

Pollen densities varied considerably from sample to sample, but the overall results suggest that cat-tail pollen was ingested directly, a practice known from both the protohistoric period (Hopkins, 1883; Loud and Harrington, 1929, pp. 156–158; Wheat, 1967; Napton and Kelso, 1969, p. 22) and also the archaeological record (Loud and Harrington, 1929, p. 159; Napton and Kelso, 1969, p. 21). Train, Henrichs, and Archer (1941, p. 97) note that the young, flowering heads of *Typha* were sometimes eaten to stop diarrhea. Unlike previously known archaeological samples, the Hidden Cave coprolites contained unscorched pollen.

Additional data regarding Hidden Cave coprolites derive from an unusual source—the fish fauna (Smith, chap. 12, this volume). Roughly one-third of the fish bones in Hidden Cave derive from Stratum IV (the 32 Inch Midden), and virtually all these bones have been identified as small tui chub, *Gila bicolor obesus*. Utilizing atomic absorption spectrometry, Smith demonstrates that these bones have passed through a (presumably human) digestive tract.

That is, a large portion of the fish fauna in Stratum IV were probably deposited initially in subsequently dispersed human coprolites. These distinctive bones are those of small fishes, 10 to 14 cm. long, which were bitten into segments smaller than 15 or 20 mm. in diameter, chewed, and then swallowed. Most of these tui chubs were ingested during the spring.

Coprolite analysis thus provides data on prehistoric procurement practices, techniques of food preparation and storage, and seasonality. Heizer and Napton (1970) previously observed that the *Scirpus* seeds contained in coprolites from the Humboldt and Carson sinks commonly lack evidence of milling, and the Hidden Cave coprolites also contained unmilled seeds. Like the ingestion of unscorched pollen, this negative archaeological evidence conflicts with the extensive milling and preparation documented for protohistoric times. These investigators put forth an interesting explanation of this "alternative method of food preparation" to account for the Lovelock Cave evidence (Heizer and Napton, 1970, p. 107). Because water may have been scarce in the Carson/Humboldt area at times, *Scirpus* seeds may have been merely heated and swallowed whole: "occupants [of Lovelock Cave] can be seen as travelling light—'camping out' as it were" (Napton and Heizer, 1970, p. 107). The same would seem to hold for those at Hidden Cave.

Seasonal indicators thus derive from a variety of sources, some more reliable than others. Although the sample size of coprolites examined from Hidden Cave is very small, we can derive some limited seasonal inferences and some very compelling evidence for resource storage.

At the simplest level, five bits of evidence are immediately relevant:

1. Abundant *Typha* pollen in Strata II and IV indicates that people brought cat-tails into Hidden Cave during the summer months.

2. The dominance of cat-tail pollen in Hidden Cave coprolites shows that people were eating pollen that had been collected during midsummer.

3. The presence of sedge seeds in coprolites shows that people were eating fruits that had been collected in the early fall.

4. The presence of piñon nut hull fragments in Hidden Cave coprolites shows that people were eating food harvested during the fall.

5. Annual growth ring studies on fish bones derived from coprolites show that people were eating fish collected primarily during the spring, secondarily during the fall, and occasionally during the summer.

The only foolproof seasonal indicator is pollen from the cave fill. There is no doubt that large quantities of two species of cat-tail (and their hybrids) were transported into Hidden Cave during midsummer when cattails flower.

All seasonal indicators contained within coprolites—*Typha* pollen, seeds of *Scirpus* and *Pinus,* and the bones of *Gila bicolor*—originate in resources that could have been (and probably were) stored in quantity. The presence of any such indicator in a given coprolite indicates only *when that resource was harvested, not necessarily when the coprolite was defecated.*

After this is said, it seems clear that the pooled seasonal indicators point toward a utilization of Hidden Cave during the summer, and probably in the spring and fall as well. This finding contradicts available seasonal evidence from nearby Humboldt Sink, to the north, where "the majority of the foods represented in the coprolites . . . suggest that Lovelock Cave was occupied in late fall, during the winter months, and in early spring" (Napton and Heizer, 1970, p. 108).

But these data have potential beyond mere seasonality. Coprolite HC-2344, for instance, is of interest because it contains a great diversity of food: roughly one-third grass, one-third *Typha* pollen, and one-third chenopod pollen (plus abundant charred seeds of *Scirpus maritimus*). *Typha* pollen can only be collected in the spring, and mature fruits of *Scirpus maritimus* are available only in the late summer or early fall—at least six weeks later. Wigand and Mehringer see this as evidence of food storage; either *Scirpus* seeds remained from the previous fall, or *Typha* pollen was cached for several weeks or months. This coprolite could also have resulted from a midwinter or spring meal—in which case *both* sedge seeds and cat-tail pollen had been cached.

Here is clear-cut evidence for food storage; in at least one isolated case, we can see caching operating to solve the temporal incongruities of the Hidden Cave landscape, by lengthening the availability of key resources through storage.

A second Hidden Cave coprolite, analyzed by Roust (1966, p. 66) makes a rather different, if related, point regarding the cultural geography of Hidden Cave. This specimen likewise contained a diversity of food items: a piece of piñon shell, several *Scirpus* seeds, a fish bone (presumably tui chub), and additional unidentified seeds.

This coprolite demonstrates a coping strategy to overcome spatial incongruities in the resource suite of the Carson Sink. Although piñon and *Scirpus* ripen at almost exactly the same time, they do so in topographically distinct, widely separated microenvironments.

There are a number of possibilities to explain how piñon and *Scirpus* could have been combined into a single meal, but it is clear that the piñon nut must have been transported from at least 30 km. away, and quite possibly from several times that distance (see discussion in chap. 2). Evidence of long-distance piñon transport was also found in Lovelock Cave, both as piñon nuts scattered throughout the midden, and in three Lovelock Cave coprolites (Cowan, 1967, p. 92). Heizer (1951) also found piñon shells in the Leonard Rockshelter deposits.

Smith (chap. 12) has demonstrated that a number of the fish bones recovered at Hidden Cave must have been transported some distance to reach Hidden Cave. During Strata IV and II times, Lahontan cutthroat trout (*Salmo clarki henshawi*), and cui-ui suckers (*Chasmistes cujus*), were no longer available

in the immediate Hidden Cave catchment. The larger lake fish were probably caught at least 5–10 km. from Hidden Cave.

The point is not to belabor a *Scirpus* seed or a piñon nut hull. Rather, these rude relics of meals past speak very clearly of the strategic mix of which Hidden Cave was part. Both storage and long-distance transport were demonstrably practiced; to what degree we do not know.

Big Game Procurement

It is impossible to distinguish bones of "natural" from bones of "cultural" origin in most caves and shelters of the Desert West. This problem plagues us at Hidden Cave as well, and each of the paleontological analyses (chaps. 10–12) proceeds as if we did not know how the bones arrived inside the cave.

But even given this problem, it is clear that the faunal assemblage from Hidden Cave is unusual. Most Great Basin faunal assemblages are dominated by the ubiquitous *LBF* (unidentifiable artiodactyl long bone fragment)—badly broken, and often charred. These fragments are generally considered to be "food bones," discarded from previous episodes of food preparation and consumption.

Hidden Cave provides a different impression because artiodactyl long bone fragments are virtually absent: only the smallest fraction of the Hidden Cave bone is burnt; individual elements tend to relatively intact. That is, "food bones"—in the traditional sense—are conspicuously absent at Hidden Cave.

The truth is that artiodactyl remains (of any sort) are virtually absent at Hidden Cave. The faunal assemblage from Hidden Cave consists of 18,764 identifiable mammal, bird, reptile, amphibian, and fish elements (chaps. 10–12). I find it extraordinary that out of this relatively large faunal sample, only 15 elements were identified as artiodactyl: two deer bones, 11 pronghorn tooth fragments and bones, one bighorn bone, and one bison bone.

This is not to say, of course, that many rabbit, rodent, and fish bones did not result from human meals; we know that some did. I merely wish to emphasize that the faunal assemblage of Hidden Cave is very different from most "habitation" sites, which commonly contain thousands of whole and broken artiodactyl bones and teeth.

By way of comparison, the faunal inventory of Gatecliff Shelter (Thomas, 1983b) contained a total of 22,006 identifiable bones, and nearly 40 percent (8475) of these were broken, splintered, and burnt artiodactyl bones. At Danger Cave, roughly 74 percent (2337 of 3179) of the recovered "food bones" were from ungulates (Jennings, 1957, pp. 223–224, table 21). Similar proportions exist at most "habitation sites" in the Desert West.

By this measure, the Hidden Cave fauna is clearly nonhabitational. Unfortunately, archaeologists have spent little time looking at faunal remains from "nonhabitational" sites. The Hidden Cave fauna is most closely paralleled by that at Humboldt Cave—an obvious cache cave—where only 16 percent (27 of 172) of the identifiable bird and mammal bones were artiodactyls (Brooks, 1956).

Although not wishing to oversimplify the complex processes that shaped the faunal inventories at these diverse sites, the virtual lack of "food bones" at Hidden Cave is noteworthy. There is no question that this site is almost lacking in the domestic debris common at most habitation sites: people did not discard much food trash inside Hidden Cave.

As a result, this site has little to tell about game procurement strategies. People utilizing Hidden Cave may have spent a great deal of time hunting game animals; but evidence of such procurement is virtually absent at this particular locus.

Fish Procurement

By contrast, the Hidden Cave faunal assemblage is most informative about fishing strategies. Unlike the other faunal remains from this site, at least the fish bones from upper strata can be directly correlated to human activities.

The earlier strata (below Stratum V) are dominated by the remains of relatively large lake fish. Bones of Lahontan cutthroat trout (*Salmo clarki henshawi*) found in the Hidden Cave strata derived from relatively large individuals, ranging from 20 to 60 cm. in length. Surprisingly, cui-ui (*Chasmistes cujus*), a large

planktivorous sucker endemic to Lake Lahontan and now restricted to Pyramid Lake, accounts for only about 2 percent of Hidden Cave fauna, and most of the cui-ui remains were found in the lower levels (Strata V–XIV).

Most of the fish bones found below Stratum V were probably deposited while the lake level was high; it is also possible that fish were washed up on the beach and dragged to the cave by carnivores. There is little reason to suspect that these faunal remains were introduced by humans.

Beginning with Stratum V times, lake fishes such as *Chasmistes cujus, Gila bicolor pectinifer* probably became locally extinct as lake waters receded from the Eetza Mountain area. These taxa are very rare in the upper strata of Hidden Cave.

Stratum IV, the 32 Inch Midden, signaled a major change in the fish fauna. Roughly one-third of the fish bones from Hidden Cave occurred in this stratum, and 95 percent of these are the small tui chub, *Gila bicolor obesus* (a stream and marsh dweller reaching lengths of only 10 to 30 cm.). As noted above, many (if not most) bones of *G. b. obesus* were probably introduced during the spring of the year in human coprolites which have subsequently disintegrated.

The smaller (and considerably more common) fish, especially *G. b. obesus,* could have been obtained from slough tributaries to the Carson River, probably about 3 km. to the west and north. Quantitative dominance of *G. b. obesus* and the surprising absence of normally abundant benthic forms, such as *Catostomus platyrhynchus* and *Rhinichthys osculus,* suggest that available local aquatic habitat (from which fish were obtained) was decidedly sloughlike.

It is interesting that the fish bones in Stratum IV average slightly smaller (and correspondingly younger) than those in Stratum V, possibly indicating heavier resource cropping during Stratum IV times.

Absence of small fish (individuals less than 15 mm. in diameter) suggests that fine-mesh nets were not employed. Although several netting fragments recovered from Hidden Cave have mesh sizes as small as 5.5 mm., average mesh size is about 25 mm. (Goodman, chap. 19, this volume). Fish biologists commonly use the "stretch mesh" of a net to estimate the minimum fish size a given net will hold (Gerald Smith, personal commun.); a 5.5 mm. net will stretch to roughly 11 mm. in actual use. Even a 5.5 mm. square mesh would not catch many small fish, though it might be large enough to hold *adults* of the two smallest species.

A few large trout occur in Stratum IV. By this time, Lahontan cutthroat trout and cui-ui were no longer available in the immediate Hidden Cave catchment. Smith suggests that the larger taxa probably derived from a lake habitat (such as Carson Lake), more than 5 to 10 km. from Hidden Cave.

Based on relative frequencies of faunal elements, it would seem that the heads of these large fish were removed before they were taken to Hidden Cave (chap. 12). An analogous method of field butchering the large, bony cui-ui sucker was practiced recently by the Northern Paiute at Pyramid Lake:

> Only a four-inch square fillet near the head is boneless. Today only this fillet is saved; the remainder of the fish is dragged off and buried .... Working on the shore of the lake [Katy Frazier, a modern Northern Paiute woman] ... first removed the large, ugly heads. She then cut the cui-ui down the back on both sides, enabling her to remove the entrails and the backbone at the same time. Then she trimmed off the fins and, finally, washed the fish thoroughly before setting it out to dry (Wheat, 1967, pp. 62–64).

Cui-ui and Lahontan cutthroat vertebrae are found in the upper levels of Hidden Cave, but the cranial elements are rare. It seems that the fish were load-lightened by removing the head, but that filleting was not as complete as that described above. Wheat (1967, p. 61) thinks that complete filleting is a relatively recent practice among the Northern Paiute: "In the early days, when every morsel of food was conserved, the entire fish was saved"; in this case, however, the head would have been utilized as well, but perhaps offsite.

Relatively low frequencies of trout bones in the midden levels suggest that they were obtained only infrequently, perhaps during the spring spawning runs into creeks (Smith, chap. 12).

The Biocultural Evidence

Larsen (chap. 13 and Appendix B) examined human skeletal materials from Hidden Cave and from eight additional prehistoric sites in the area. Although data are sparse, and chronological controls almost entirely lacking, a few biocultural generalizations are in order.

Although tooth wear is extreme, dental health in general was rather good, showing minimal evidence of caries or premortem tooth loss. Of 82 teeth examined, only two showed cariogenesis, probably reflecting a low carbohydrate diet. Skeletal infections were quite rare, likewise suggesting that health in general was rather good.

Craniofacial bones indicate masticatory stresses, probably the result of both dietary and nondietary factors. These people likewise experienced rather severe physical stress, at least relative to daily mechanical demands placed on the body. Postcranial elements show marked robusticity and advanced degenerative arthritis in older individuals.

CULTURAL GEOGRAPHIC IMPLICATIONS

We began by discussing the forager-collector continuum, with specific reference to polar *limnosedentary-limnomobile* alternatives. Both hypotheses enjoy a certain degree of currency, and the Hidden Cave exercise was undertaken largely to explore how people harnessed the desert lacustrine habitat. Although any single site will disappoint from a regional perspective, Hidden Cave does create certain impressions regarding the larger cultural geographic matrix.

We examined the available protohistoric data, attempting to derive a relevant mid-range theoretical framework. Although data are limited and nebulous, it would appear that the Toedökadö Nothern Paiute employed a mixed strategy of residential and logistic mobility to exploit the protohistoric Carson Sink. In most years, these Carson Sink groups, following a fission-fusion pattern, established relatively stable winter residential camps in either marshland or upland settings. This residential decision depended on availability of fall resources, quantity of comestibles cached during the previous summer, and overall transport costs involved. Inherent year-to-year marshland instability almost certainly fostered a flexible, annually variable approach to overwintering.

During the rest of the year, various Northern Paiute groups split into small fusion encampments that lasted through the summer and into the fall. Fall/winter settlements undoubtedly involved considerably more residential permanence than the summer and spring portion of the seasonal round.

The highly diverse topography and hydrology within protohistoric Toedökadö extended range provided an ecological buffer against failure of individual resource patches, fostering a measure of long-term stability. But the major foodstuffs—e.g., spring fish runs, spring/fall marshside harvests, fall/winter piñon—were high bulk, and the transport costs often excessive, reflecting the marked degree of spatial incongruity in this landscape. The Toedökadö must have often faced the decision of whether to transport resources or people.

This protohistoric pattern relied heavily on the seasonal interplay between storage and transport. The spring through summer portions of both strategies are clearly evident in the archaeological record of Hidden Cave. Subsistence data demonstrate the wide range of food items procured: grasses, particularly grass and *Scirpus* seeds, piñon nuts, fish, and probably also cat-tail products. Coprolites show that at least some of these resources had been stored—if not in Hidden Cave, then not far away. These caches lengthened the availability of key resources through storage, thereby alleviating some of the temporal incongruities of the Carson Sink resource base.

The people using Hidden Cave also coped with the spatial inequities of their habitat. Although some foods ripened simultaneously, they often did so in widely separated microenvironments. Evidence of long-distance piñon transport is available from both the Carson and Humboldt sinks. Fish were transported to Hidden Cave for considerable distances. In short, the Hidden Cave subsistence data make it clear that storage and long-distance transport occurred, but to what degree we do not know.

Hidden Cave was also a place to store possessions, and the artifact assemblage is dominated by insurance and personal gear. Intrasite distribution maps suggest that projectile points, worked wood, and perhaps worked bone were deliberately placed in large, well-defined cache pits.

The Hidden Cave lithics are particularly distinctive. Unlike habitation assemblages, nearly all the stone tools were left at Hidden Cave in fully usable condition; in fact, we found more complete projectile points than waste flakes. Many artifacts had been resharpened and reworked to serve secondary functions. This relatively uniform and heavily recycled collection of finished tools is exactly what one expects of items shuttling between "active" and "passive" status.

Curiously, Hidden Cave contained few of the implements specifically designed for marshside exploitation—the duck decoys, fishing tackle, bunt points for waterfowl, and harvesting equipment that are relatively common at the cache caves of the Humboldt Sink. Hidden Cave was used earlier than the Humboldt Sink sites, so it is possible (but not likely) that this difference can be attributed to paleoenvironmental or technological change. The difference is more likely due to differential local scheduling; we now know that Hidden Cave was utilized primarily in the spring and summer, whereas Lovelock was apparently utilized mostly during the winter.

Hidden Cave contains multiple evidence of embedded procurement: food and raw materials for the manufacture of implements were incidentally set aside for future need. The second harvest, if practiced, would provide an extremely low cost insurance policy and a cheap way to stockpile a cache of cheap food. The quids discarded throughout Hidden Cave illustrate extensive use of low-ranked resources. Ingestion of unmilled *Scirpus* seeds and unscorched cat-tail pollen implies a rough-and-ready mode of food preparation, what Napton and Heizer (1970, p. 107) have termed "camping out."

Recourse to low ranked, expediently prepared food can be variously interpreted. Perhaps the quids and coprolites reflect use of trail food by logistically mobile task groups. DeQuille (1963, pp. 2–36, 71) encountered one such party returning to a Carson Sink base camp from the mountains to the east. Traveling at night, sleeping during the day, and chewing rush stalks to sustain themselves as they went, these Northern Paiute left an archaeological record fully consistent with that in Hidden Cave.

But the same data are likewise consistent with a pervasive back-up strategy, using low-ranked resources as emergency food, hoarding every scrap of potential food—including their own feces—as insurance against possible famine. The artifact inventory at Hidden Cave contains similar lithic and perishable insurance policies.

Whatever the correct interpretation, it is clear that the Hidden Cave settlement pattern was highly variable. Extensive use of trail food implies geographic variability from season to season. Excessive concern with famine food and backup tool kits implies variability from year to year.

Hidden Cave was also a summertime way station, a place to escape the heat of the day. Not far from Hidden Cave, Simpson (1876, p. 85) observed an early summer base camp, where two Northern Paiute pursued local marshside resources, seined fish, and used decoys to procure ducks. Aside from the occasional riparian stand, the Carson Sink contains little natural shade. Not only do caves and rock-shelters provide permanent and well-known shaded areas, but Hidden Cave maintains a virtually constant interior temperature. The natural conditions of lifespace, plus the abundance of quids and cat-tail flooring, all underscore the fact that Hidden Cave must have functioned as something more than a warehouse.

And yet, Hidden Cave was not utilized during the protohistoric period. Perhaps the entrance was sealed by that time, but it may also be that the cultural geography changed significantly over the millennia.

We cannot distinguish between these alternatives at present, due in part to the frustratingly coarse grain size of the Hidden Cave data (particularly when viewed from a cultural geographic perspective). Such regional issues are not resolved from a single site.

But Hidden Cave does point up the bankruptcy of the extreme *limnosedentary* and *limnomobile* positions. This site would have

been of little use to foragers; there is simply too much preplanned storage and recycling to fit with a model of extreme residential mobility. But on the other hand, Hidden Cave surely does not reflect a lacustral Garden of Eden; there is too much evidence pointing toward logistic mobility and backup planning.

The limited regional data from Hidden Cave reflect the multiple strategies of fission-fusion settlement—neither pure foragers nor pure collectors. The regional geography of Hidden Cave appears to be consistent with that of the protohistoric Toedökadö Northern Paiute. But these parallels must not be pushed too far. We know almost nothing about the degree of logistic and residential interplay or the degree of seasonal and annual variability involved in either system. These insights will require a considerably improved regional research perspective over that which is presently available.

The Hidden Cave story is undeniably complex. This was an obviously well known, desirable locale visited for at least a millennium and perhaps much longer. At times, Hidden Cave was a prehistoric warehouse where people left food and tools to be retrieved later. Hidden Cave was also a graveyard, where people left deceased loved ones, never to be retrieved. Hidden Cave was also a welcome warm-weather refuge, in which people could momentarily escape the oppressive Carson Sink summer.

Hidden Cave: a great place to visit, but nobody wanted to live there.

APPENDIX A. CULTURAL RESOURCE MANAGEMENT AT HIDDEN CAVE

BRIAN W. HATOFF[1] AND DAVID HURST THOMAS

Although this monograph stresses our research objectives at Hidden Cave, it is appropriate to mention that the 1979–1980 excavations were also guided by specific cultural resource management objectives. Without these, the research project never would have been undertaken. This archaeological fact of life was clearly recognized by S. M. Wheeler in his work at Hidden Cave over four decades ago (see chap. 4, this volume), and it is worthwhile to mention at this point how the 1979–1980 Hidden Cave excavations actually came about.

Prior to the American Museum research at the site, the last professional excavation at Hidden Cave occurred in 1951. Although the Bureau of Land Management technically maintained authority over the site, in reality the BLM was neither equipped for, nor interested in, managing Hidden Cave (Hatoff and Thomas, 1982). By the mid-1970s cultural resource management was being integrated into numerous governmental agencies, as well as many academic programs. The BLM was no exception, adopting cultural resource management as a *bona fide* program in the 1970s. Accordingly, bureaucratic changes were initiated which allowed for the following steps to be taken:

1. The Grimes Point Archaeological Area (which includes Hidden Cave) was placed on the National Register of Historic Places.

2. A plan was developed by the BLM which called for protection and interpretation of the known cultural resources; this, incidentally, was the first cultural resources management plan adopted by the BLM in Nevada.

3. The Grimes Point petroglyph site itself was established as an *in situ* interpretive area, with self-guiding trail, environmental study area, and protective exclosures. Teachers' study guides, brochures, interpretive and positive protection signing, and ranger patrols are all part of the integrated program of management and protection presently taking place in the area (see Hatoff, 1977). Federal increases in funding levels for protection and stabilization projects under the Carter administration provided the final impetus for the latest phase of excavation at Hidden Cave.

In October 1978, the two of us discussed the possibility of undertaking a jointly sponsored major excavation at Hidden Cave. We had each visited the site over a period of years and agreed that the research potential of the remaining deposits was sufficient to justify at least one field season.

We then outlined an integrated approach to address research, management, and public needs without compromising any one aspect for the sake of the others. Basic to this approach was the development of a contracting program that would maximize potential funding for the project, while minimizing the potential pitfalls of CRM funding (e.g., Hatoff and Thomas, 1982; Raab et al., 1980). Armed with this mutually expressed interest from both the American Museum of Natural History and the BLM—plus a commitment for funding, logistical support, and materiel from both parties—the BLM proceeded with a sole source justification for issuance of the contract to the American Museum of Natural History. In addition to the obvious savings to the taxpayer resulting from such a joint private-public arrangement, the American Museum of Natural History had demonstrated a long-term research interest in the Great Basin. Therefore, noncompetitive procurement, which is frequently very difficult to implement in government contracting, became a relatively straightforward task.

The Nevada Division of Historic Preservation and Archaeology was then approached to explore the possibilities of obtaining matching funds for that portion supported by private (AMNH) funding. In addition to real dollar expenditures, such items as volunteer time, staff salaries, etc. were also eligible for matching funds. Funding was ultimately secured from the Nevada Division of Historic Preservation and Archaeology, and the scope of the project was expanded still further. Additional indirect funding and manpower were obtained by participation of a University of Nevada, Reno archaeological field class (1979, 1980), and some private funding came from the Speidel Foundation and Sun Energy Development Corporation. Paralleling the funding effort was an intensive recruiting drive in the local community to solicit support from the local Naval Air Station, the Churchill County Museum, the Churchill County School District, the National Guard, and private individuals, all of whom generously assisted the project.

Finally, after assessing the unique location and archaeological significance of Hidden Cave, we decided to maximize publicity and to encourage regulated visitation to the site. Archaeological projects are sometimes carried out behind a veil of secrecy; although this practice is occasionally de-

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fensible, too often unnecessary secrecy serves only to increase animosity, hostility, and misunderstanding between professional archaeologists and an interested public.

An aggressive program of maximum exposure for the project was pursued, including a popular article written by Thomas (1980); this was deliberately timed to appear on Nevada news stands immediately prior to the 1980 field season to publicize and promote organized tours of the site and field laboratory. The tours not only encouraged rapport with the local community but to some degree instilled a self-policing ethic in the local population. Total visitation at Hidden Cave during the 1979–1980 excavations was approximately 1200 people.

In this volume, we report on the reexcavation and reanalysis of Hidden Cave relative to our initial objectives.

1. The Research Objectives Have Been Met
   This monograph results from extensive field and laboratory research at Hidden Cave, including both cultural and paleoenvironmental data. Previously excavated collections were reanalyzed; the BLM provided partial funding for this aspect of the research as well.
2. The Management Objectives Have Been Met
   The continuing threat to the remaining deposits has largely been mitigated through excavation. A series of witness blocks has been left *in situ*; these will not only allow qualified researchers to return to the original deposits for restudy, but these unexcavated portions have been incorporated into an on-site interpretive exhibit (described below).
3. The Public Objectives Have Been Met
   Upon completion of excavation it became readily apparent that the enthusiastic response by the public to the opportunity to view the cave and the process of archaeological excavation warranted further study of possible avenues the BLM could take to permit permanent public access to the site. The objective was to ensure the integrity and preservation of the remaining deposits while providing a meaningful interpretive experience for the lay visitor. As a first step in this process the American Museum of Natural History was contracted by the BLM in 1981 to provide a feasibility study which detailed construction, security, and interpretive requirements based on three hypothetical funding levels. With this document (O'Brien and Thomas, 1981) and a budget well under $10,000 the Carson City BLM began construction in 1982.

The double-edged problem of simultaneously providing maximum security and ready access was resolved by construction of a concrete bunker-like entrance with a 400-lb. plate steel door. Once this secure access was established, construction within the cave took place over the next six months. A wooden ramp and stairways were built to form a loop through the cave providing visitors a close-up view of the stratigraphy and other points of interest (fig. 120). An interpretive panel depicting aboriginal use of the cave and environs is the first stop on the loop. The second stop is an exposure of the complete stratigraphic profile explicated by various informational markers showing key depositional levels, radiocarbon dates, volcanic ash layers, and major shifts in floral and faunal composition. The third and final stop is a mock-up of an archaeological excavation unit showing the tools and techniques used in the excavation process.

The lighting system was perhaps the most challenging aspect of construction at the site. The exorbitant costs of bringing in power or using solar power left us with only one option—a self-contained generating system. The system finally devised consisted of a 5000-watt gasoline powered generator which can be rolled outside the cave to a concrete bay during operation. Lighting is provided by six 500-watt quartz halogen lamps and supplemental fluorescent lights.

Concurrent with the developments at the cave, a permanent exhibit on Hidden Cave was built and installed by the American Museum of Natural History at the Churchill County Museum (fig. 121). This exhibit provides a capsule summary of the archaeological research conducted at Hidden Cave over the past four decades: the way in which archaeologists do archaeology, the nature of the desert lacustrine resource base, the role of the paleoenvironmental specialist in interdisciplinary archaeological research, an artist's reconstruction of the Native American lifeway at Hidden Cave approximately 2000 B.C., and a consideration of the professional archaeologist-interested amateur interface.

September 29, 1982 marked the formal opening of Hidden Cave to the public. In order to efficiently accommodate public interest in tours of the site, a cooperative tour guide program was established between the Carson City BLM and the Churchill County Museum. BLM guides and volunteer guides from the Churchill County Museum trained by the Carson City BLM District archaeologist escort groups through the site on a scheduled basis. Visitors not only view Hidden Cave and the exhibit at the museum, but are also exposed to a variety of archaeological and geological phenomena on a 1.5 km. interpretive trail which leads up to Hidden Cave. As a result the tour participants experience

FIG. 120. Brian Hatoff explaining stratigraphy of Hidden Cave to a group of students from the Fallon area.

a comprehensive, integrated view of the regional cultural and natural history of the western Great Basin.

In addition to the scheduled public tours, the BLM has actively encouraged special tours to the site by school groups and other interested educational and civic organizations. In the first 12 months of operation approximately 4500 individuals participated in the tour program. It is particularly rewarding that almost 60 percent of the visitorship comes from western Nevada secondary and elementary school students. The average monthly figure of 375 is nothing short of remarkable given the remoteness of the site and its controlled access.

As a final note we emphasize that since its inception the key to the success of this project has been a willingness on the part of all participants, agencies, institutions, and individuals to work together for one goal in spite of financial constraints, logistical impediments, and bureaucratic regulations. The Hidden Cave project has, admittedly, its unique qualities, but we think that certain aspects of this cooperative effort are relevant to the broad spectrum of cultural resource management. Highly regulated requirements of bureaucratic entities do not preclude flexibility, creativity, and innovation.

Recently Raab and his colleagues (1980, p. 548) have argued that a research orientation in government archaeology requires the "support of colleagues outside government." Taking this argument one step further, we think that the Hidden Cave case illustrates what can be achieved when diverse yet complementary goals are explored and pursued.

FIG. 121. Two local Fallon residents examining Hidden Cave exhibit at Churchill County Museum.

APPENDIX B. HUMAN REMAINS FROM THE CARSON SINK

CLARK SPENCER LARSEN

We have already described materials recovered from Hidden Cave by Wheeler in 1940, by Roust and Grosscup in 1951, and, most recently, by Thomas in 1979 and 1980 (chap. 13, this volume). This section provides a description of the additional human remains recovered from mortuary localities in the Carson Sink, Nevada. For a detailed discussion of the mortuary archaeology of the Carson Sink, the reader is referred to the excellent presentation by Kobori (1981). A portion of these materials has also been included in a larger Great Basin data set (Galliher, 1978; Stark, 1983; see also Tuohy, n.d.).

Including the materials from Hidden Cave, a total of 18 burials as well as a number of isolated bone fragments and isolated teeth was examined.[1] A summary of the remains and their age and sex is provided in table 82. Metric observations excluding Hidden Cave—cranial, dental, and postcranial—are presented in tables 83, 84, and 85. Stature estimates, based on regression formulae provided by Genovés (1967), are shown in table 86. Site locations are provided in figure 122.

THE SITES

Spirit Cave

Spirit Cave was excavated in 1940 for the Nevada State Park Commission by S. M. Wheeler and G. N. Wheeler (Wheeler and Wheeler, 1969). The rock-shelter is approximately 7.6 m. wide, 4.6 m. deep, and 1.5 m. high. Near the rear wall, a finely twined, large mat was found wrapped around several human bones (see also chap. 2). Under this burial, a sagebrush-lined burial pit measuring 1.8 m. in depth, 1.2 m. in width, and 1.1 m. deep was exposed. Within this pit lay a semi-flexed burial resting in a fur blanket. The upper and lower halves of the burial were contained inside separate woven mats. When exposed, the individual was found to be partially mummified with most of the scalp adhering to the skull.

Three m. to the south of this burial pit was a crematory pit measuring 1.5 m., by 1.8 m., by 0.8 m. At the bottom and rear end of this two bags, an upper and a lower, were located. The upper bag is closely twined and made of split tule; the lower bag is made of native hemp, also closely twined.

It is doubtful that this shelter was ever inhabited for any length of time. This site was probably used only for burial and storage (cf. Wheeler and Wheeler, 1969).

The following skeletal remains were examined:

AHUR 748: Adult right innominate. The bone is probably that of a male in that the pubic ventral arc is absent, there is no subpubic concavity, and the medial portion of the ischio-pubic ramus is flat (Phenice, 1969). The lack of fusion of the iliac crest and beginning fusion of the ischial tuberosity suggests an age of 15 to 18 years at death (Krogman, 1962).

AHUR 770: An adult left pubis, right cuboid, five metatarsals, three metacarpals, rib fragments, three cervical vertebrae, and three thoracic vertebral neural arch fragments. Because these remains vary in color, texture, and degree of preservation, more than one individual is represented.

AHUR 752, AHUR 773: Two cremations comprising small to medium-sized bone fragments. The bones are burned black, and in some instances individual skeletal elements are calcined. The color of the latter category of specimens suggests that temperatures in excess of 800°C. were reached in the combustion of bone elements (see Van Vark, 1970). Each cremation appears to contain most bones of the skeleton. There is no indication that more than one individual is present in either of the cremation receptacles.

Fish Cave

Fish Cave is about 1.6 km. to the north of Spirit Cave. The exogene component of the rock-shelter is more than 15 m. wide and 6 m. high. Much of the roof had collapsed following the regression of Lake Lahontan. Toward the rear of the cave, the main chamber abruptly ends, diverging into several smaller galleries (Napton, 1971b). Excavations by S. M. and G. N. Wheeler for the Nevada State Park Commission in 1940 and later excavations by L. K. Napton for the University of California, Berkeley, in 1971 have produced most of what is known about the prehistoric use of the site (cf. Wheeler and Wheeler, 1969; Napton, 1971b).

At the rear wall of one of the galleries, approx-

[1] All specimens described in this Appendix were observed in the collections of the Department of Anthropology, University of Nevada, Las Vegas. Thanks are extended to Dr. Sheilagh T. Brooks and graduate students Carolyn Stark and Cary Stevens for their kind assistance in the use of the UNLV facilities.

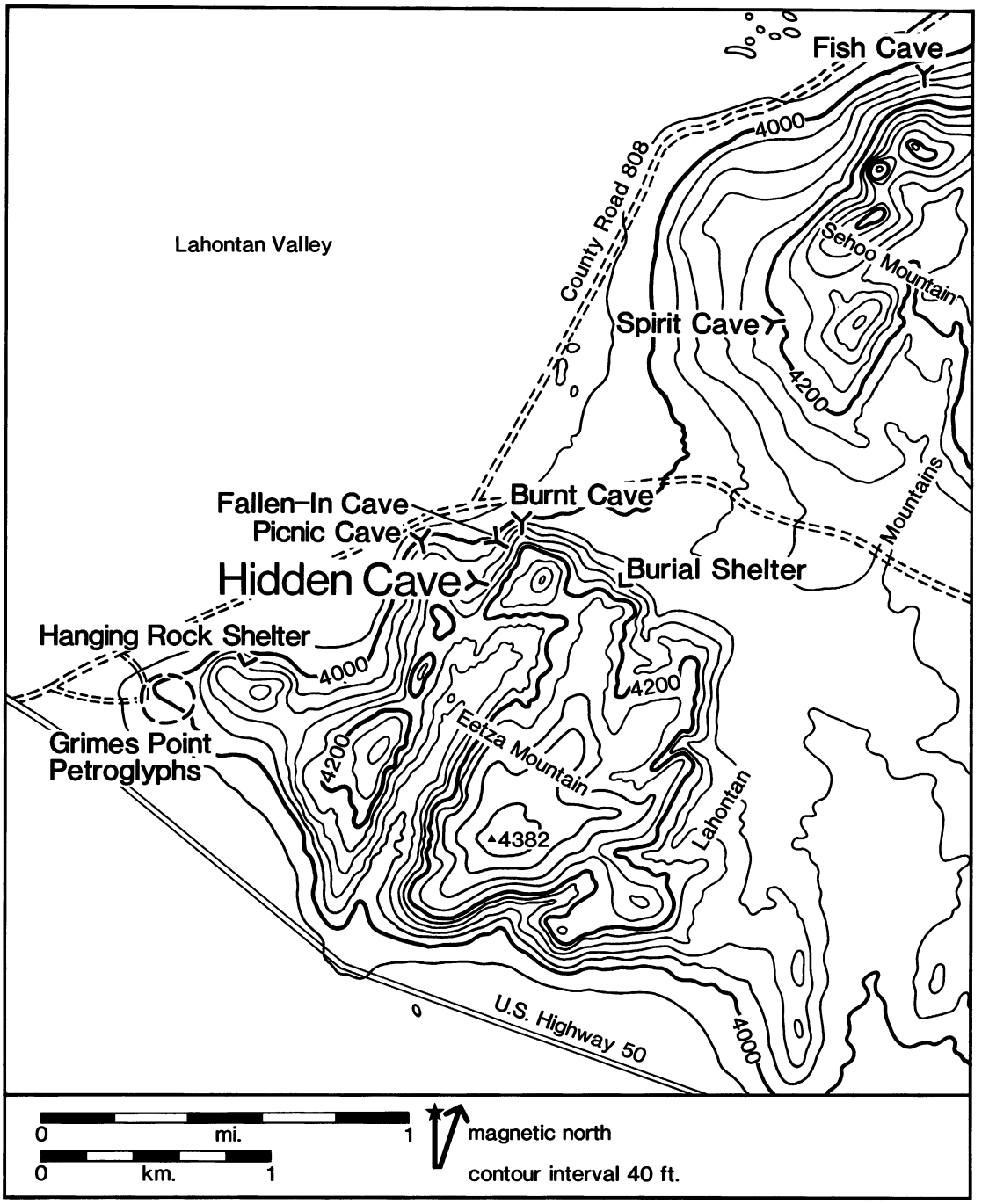

FIG. 122. Locator map of some prehistoric burial sites discussed in this section.

imately 25 m. back from the cave entrance, the Wheeler party located a semiflexed burial wrapped in a fur blanket, with a shallow, coiled basket placed over the feet and hips. The body was found to be partially mummified, and the feet were nearly complete. The burial had been found in a prepared

TABLE 82
Human Remains from the Carson Sink[a]

Site	No. of Burials	Isolated Bone Fragments	Isolated Teeth	Hair	Sex			Age	
					Female	Male	?	Preadult	Adult
Hidden Cave[b]	0	44	7+	39	1	2	16+	3	23+
Spirit Cave	4	0	0	0	0	1	3	1	3
Fish Cave	2	0	0	0	1	0	1	1	1
Burial Crevices	5	0	0	0	2	0	3	2	3
Burial Shelter	2	0	0	0	0	0	2	2	0
Grimes Point	1	0	0	0	0	0	1	1	0
Sand Hill	1	0	0	0	0	1	0	0	1
The Island	2	0	0	0	1	1	0	0	2
Pelican Island	1	0	0	0	0	0	1	1	0
Total	18	44	7+	39	5	5	27+	11	33+

[a] See text for complete descriptions.

[b] Observations for skeletal materials only; number refers to the number of bones that are female, male, or indeterminate sex, and preadult or adult.

pit measuring 1.07 m. long and 76 cm. wide. The following skeletal remains were examined:

AHUR 757: Individual, most likely a female in that the pubic ventral arc is well defined, the subpubic concavity is large and visible, and a ridge exists in the medial portion of the ischiopubic ramus (Phenice, 1969); moreover, the sciatic notch is wide and the cranium and postcranium show a generally gracile morphology. Age at death for this individual can be determined on the basis of the metamorphosis of the pubic symphyseal face. The overall erosion and eratic surface of the pubic symphysis suggests an age at death of at least 50 years (Todd, 1920). The skeletal elements present include: a cranial vault with associated fragments of frontal, temporal, maxilla, mandible and complete dentition, zygoma, occipital; left clavicle, left humerus, left radius, left ulna, left and right femora, left patella, right tibia, right fibula, left and right calcanea, tali, naviculars, cuboids, right first cuneiform, right second cuneiform, left and right third cuneiforms, 10 metatarsals, six proximal foot phalanges, left scaphoid, left lunate, left fourth metacarpal, three proximal hand phalanges, four ribs, sternum, seven cervical vertebrae, nine thoracic vertebrae, five lumbar vertebrae, sacrum. Several pathologies are present on some of these materials. These included marginal lipping (degenerative arthritis) on the bodies of the fourth lumbar, fifth lumbar, and first sacral vertebrae. In addition, large periodontal abscesses are present near the buccal and lingual roots of the maxillary right second molar and the mandibular left second molar.

A number of isolated skeletal elements not reported by Wheeler and Wheeler (1969) are also present in the Fish Cave sample: an adult left proximal radius, adult left ulna, adult proximal foot phalanx, and a burned infant left tibia. Based on the maximum length of the latter skeletal element (table 85), the infant was less than six months of age at death (cf. Ubelaker, 1978). All these isolated remains were catalogued under the same number as the main burial from Fish Cave (AHUR 757). Two isolated preadult (probably infant) cranial fragments (AHUR 758) –a parietal and frontal— were also observed.

The Burial Crevices

As part of the Wheeler and Wheeler Nevada State Park Commission survey of the Carson Sink area, a site or sites denoted as The Burial Crevices were investigated. The fragmentary remains of at least five individuals were recovered. The following remains were examined:

AHUR 745: Adult fragments of unidentifiable long bone, scapulae, right radius, ulna, femur, ribs, thoracic vertebrae, four complete metatarsals, one proximal foot phalanx, and one cervical vertebra. All bones are burned.

AHUR 746: Preadult fragments of left and right clavicle, scapulae, and humeri; three metatarsals, one proximal hand phalanx, 11 ribs, manubrium, sternum, five cervical vertebrae, six thoracic vertebrae, sacrum.

AHUR 747: Three individuals—two adults and one preadult. Adult remains include left and

TABLE 83
Carson Sink Human Cranial Dimensions (in Millimeters)

Measurement[a]	Fish Cave (AHUR 747)	Burial Shelter (AHUR 743)	Sand Hill (12-2-6A,B)	The Island (AHUR 735)	The Island (AHUR 729)	Pelican Island (AHUR 1208)
Face-Masticatory Complex						
Masseter origin length	–	27.4	–	41.4	33.6[b]	–
Zygomatic arch thickness	–	24.3	–	34.7	24.7	–
Cheek height	–	21.9	–	28.7	29.5	–
Upper facial height	–	58.5	–	78.1	65.6	–
Biorbital breadth	–	86.0	101.6	100.6	(92.8)[c]	–
Orbital breadth	–	34.4	–	37.6	38.7	–
Orbital height	–	33.1	–	35.8	32.0	–
Infratemporal fossa depth	–	19.9	–	22.5	23.1	–
Infratemporal fossa length	–	39.2	–	43.2	41.2	–
Temporalis length	–	132.6	154.0	143.4	132.9	–
Temporalis height	–	70.7	105.0	94.1	83.0	–
Palate length	–	41.3	–	53.4	44.1	–
Palate breadth	39.6	34.6	–	42.2	36.0	–
Bizygomatic breadth	–	113	–	145	133	–
Minimum frontal breadth	–	88.2	149.0	95.2	91.5	–
Frontal chord	–	109.8	–	114.4	98.6	109.5
Frontal arc	–	125	–	122	107	126
Bicondylar breadth	–	–	–	128.8	(118.2)	–
Condylar breadth	19.2	–	–	22.5	21.9	–
Bigonial breadth	–	–	–	109.6	(107.9)	–
Ascending ramus height, coronoid process	58.6	–	–	72.9	53.4	–
Ascending ramus height, condyle	54.5	–	–	68.3	55.8	–
Ascending ramus, minimum breadth	37.1	–	–	38.7	33.5	–
Symphysis height	–	–	–	40.9	31.0	–
Symphysis thickness	–	–	–	20.5	17.2	–
Mandibular length	–	–	–	112	100	–
Vault						
Parietal chord	114.7	97.7	113.6	120.1	104.4	111.3
Occipital chord	98.7	102.6	104.8	100.6	96.1	–
Lambda-inion chord	66.1	–	70.5	72.3	–	–
Inion-opisthion chord	45.0	–	46.0	40.5	–	–
Biasterionic chord	–	102.9	(104)	113.4	104.8	101.8
Parietal arc	123	105	127	134	118	124
Occipital arc	116	126	125	121	111	–
Lambda-inion arc	76	–	78	84	–	–
Inion-opisthion arc	44	–	48	39	–	–
Biasterionic arc	–	124	(120)	132	123	118
Bregma-inion	148	–	153	158	–	–
Bregma-opisthion	152	143	155	149	140	–
Lambda-basion	–	118.8	124	121	113	–
Nasion-lambda	–	167	–	180	169	171
Basion-nasospinale	–	89	–	99	91	–
Cranial height	–	130	143	134	126	–
Maximum cranial length	–	176	192	189	175	179
Maximum cranial breadth	–	130	138	136	134	134

[a] See Larsen (1982) for definitions of measurements.
[b] Underlined items are right side measurement.
[c] ( ) = measurement estimate.

TABLE 84
Carson Sink Human Dental Dimensions (in Millimeters)

Tooth	Dimension[a]	Side	Fish Cave (AHUR 757)	Burial Crevices (AHUR 747)	Burial Shelter (AHUR 743)	Grimes Point (AHUR 740)	The Island (AHUR 735)	The Island (AHUR 729)
Maxilla								
I1	breadth	l	*[b]	8.0	—	—	*	*
		r	*	—	—	—	*	*
I2	breadth	l	*	—	—	—	*	*
		r	*	—	—	—	*	*
C	length	l	*	—	—	—	*	*
		r	*	—	—	—	*	*
	breadth	l	8.3	—	—	—	*	*
		r	8.6	—	—	—	*	*
P3	length	l	*	—	—	—	*	*
		r	*	—	—	—	*	*
	breadth	l	*	—	—	—	*	*
		r	*	—	—	—	*	*
P4	length	l	*	—	—	—	*	*
		r	*	—	—	—	*	*
	breadth	l	*	—	—	—	*	*
		r	*	—	—	—	*	*
M1	length	l	*	—	11.4	—	*	*
		r	*	—	11.2	10.4	*	*
	breadth	l	*	—	12.3	—	*	*
		r	*	—	12.1	11.5	*	*
M2	length	l	*	—	—	—	*	*
		r	*	—	—	—	*	*
	breadth	l	*	—	—	—	*	*
		r	*	—	—	—	*	*
M3	length	l	*	*	—	—	*	*
		r	*	—	—	—	*	*
	breadth	l	*	*	—	—	*	*
		r	*	—	—	—	—	—
dM1	length	l	—	—	7.4	8.9	—	—
		r	—	—	6.8	—	—	—
	breadth	l	—	—	9.9	9.5	—	—
		r	—	—	9.4	—	—	—
dM2	length	l	—	—	10.1	—	—	—
		r	—	—	8.8	—	—	—
	breadth	l	—	—	10.7	—	—	—
		r	—	—	10.9	—	—	—
Mandible								
I1	breadth	l	*	—	—	—	—	*
		r	*	—	—	—	—	*
I2	breadth	l	*	—	—	—	*	*
		r	*	—	—	—	*	*
C	length	l	*	—	—	—	*	*
		r	*	*	—	—	*	*
	breadth	l	*	—	—	—	*	*
		r	*	8.5	—	—	*	*
P3	length	l	*	—	—	—	*	*
		r	*	—	—	—	*	*
	breadth	l	*	—	—	—	*	*
		r	*	—	—	—	*	*

TABLE 84—(*Continued*)

Tooth	Dimension[a]	Side	Fish Cave (AHUR 757)	Burial Crevices (AHUR 747)	Burial Shelter (AHUR 743)	Grimes Point (AHUR 740)	The Island (AHUR 735)	The Island (AHUR 729)
P4	length	l	*	—	—	—	*	*
		r	*	—	—	—	*	*
	breadth	l	*	—	—	—	*	*
		r	*	—	—	—	*	*
M1	length	l	*	—	—	—	*	*
		r	*	—	—	—	*	*
	breadth	l	*	—	—	—	*	*
		r	*	—	—	—	*	*
M2	length	l	*	—	—	—	*	*
		r	*	—	—	—	*	*
	breadth	l	*	—	—	—	*	*
		r	*	—	—	—	*	*
M3	length	l	*	—	—	—	*	*
		r	*	—	—	—	—	*
	breadth	l	*	—	—	—	*	*
		r	*	—	—	—	—	*
dM1	length	l	—	—	—	—	—	—
		r	—	—	—	—	—	—
	breadth	l	—	—	—	—	—	—
		r	—	—	—	—	—	—
dM2	length	l	—	—	—	10.6	—	—
		r	—	—	—	—	—	—
	breadth	l	—	—	—	8.7	—	—
		r	—	—	—	—	—	—

[a] See Larsen (1982) for definitions of measurements.
[b] * denotes occlusal surface that is too worn for accurate measurement.

right clavicles (one pair), left scapula, left and right humeri (one pair), radius fragments, right femoral condyles, tibial shaft fragments, right distal tibia, left calcaneus, left talus, left navicular, two left first cuneiforms, six metatarsals, and six proximal foot phalanges, two middle foot phalanges, left lunate, five metacarpals, four proximal hand phalanges, one middle hand phalanx, one distal hand phalanx, three cervical vertebrae, three thoracic vertebrae, three lumbar vertebrae. Preadult remains include a left ulna, left fourth metacarpal, middle hand phalanx, two thoracic vertebrae. The generally gracile character of the adult skeletal elements suggests that both individuals are female. Precise determination of age for these remains is not possible. Three unassociated teeth were present, including a mandibular right canine and a maxillary left central incisor and third molar. The latter shows a large cervical carious lesion.

AHUR 746 remains were located in a stratigraphic position above AHUR 745 and AHUR 747 and were found in association with historic period artifacts (Tuohy, n.d.).

Burial Shelter

Burial Shelter was found during the Wheeler and Wheeler 1939–1940 Carson Sink investigation, and was denoted as "Cave 16" (Tuohy, n.d.). No other information is presently available with regard to provenience or mode of excavation. Two individuals were located in this mortuary locality:

AHUR 743: The permanent first molars are completely erupted and show slight occlusal wear; the permanent second molars are unerupted; the deciduous first and second molars are present and show marked dentinal exposure. The eruption stage of development of the permanent molars and the degree of wear on the deciduous molars suggests an age of nine years (Ubelaker, 1978). The skeletal remains present for this individual include a complete cranium, left ilium, left ischium, left pubis, right clavicle, left scapula, left humerus, left and right radii,

TABLE 85
Carson Sink Human Postcranial Dimensions (in Millimeters)

Measurement[a]	Side	Fish Cave (AHUR 757)	Fish Cave (AHUR 757, miscell.)	Burial Crevices (AHUR 745)	Burial Crevices (AHUR 746)	Burial Crevices (AHUR 747)	Burial Shelter (AHUR 743)	Sand Hill (12-2-6A, B)	The Island (AHUR 735)	The Island (AHUR 729)
Femur										
Head diameter	l	39.4	—	—	—	—	—	46.6	48.9	40.6
	r	39.8	—	—	—	—	—	48.3	48.2	41.8
Neck vertical diam.	l	26.1	—	—	—	—	—	30.5	33.2	31.4
	r	26.8	—	—	—	—	—	30.7	32.7	30.2
Neck horizon. diam.	l	22.3	—	—	—	—	—	28.6	26.4	29.9
	r	—	—	—	—	—	—	28.0	26.5	22.8
Maximum length	l	403	—	—	—	—	322	459	(450)[b]	415
	r	412	—	—	—	—	321	457	448	(419)
Midshaft ant.-post.	l	24.1	—	—	—	—	20.1	29.0	31.2	26.2
	r	27.6	—	—	—	—	20.4	29.6	33.0	27.1
Midshaft trans.	l	23.6	—	—	—	—	17.4	26.2	28.8	25.5
	r	25.3	—	—	—	—	18.2	26.3	28.7	25.4
Midshaft circum.	l	75	—	—	—	—	60	88	93	81
	r	—	—	—	—	—	61	88	96	82
Subtroch. ant.-post.	l	20.2	—	—	—	—	20.1	25.7	25.9	23.9
	r	—	—	—	—	—	20.9	26.9	25.7	24.3
Subtroch. trans.	l	29.3	—	—	—	—	24.7	32.7	34.9	31.3
	r	—	—	—	—	—	24.7	32.2	34.5	31.4
Bicondylar breadth	l	(71.5)	—	—	—	—	—	82.6	—	—
	r	(73.0)	—	—	—	—	—	82.1	82.3	—
Tibia										
Maximum length	l	—	(80.6)	—	—	—	(255)	374	381	341
	r	344	—	—	—	—	(259)	376	—	343
Midshaft ant.-post.	l	—	10.3	—	—	—	22.0	32.5	33.8	26.0
	r	27.9	—	—	—	—	22.0	34.5	—	27.6
Midshaft trans.	l	—	8.1	—	—	—	14.4	20.7	23.4	20.5
	r	22.0	—	—	—	—	15.0	20.9	—	19.2
Midshaft circum.	l	—	—	—	—	—	58	86	91	74
	r	79	—	—	—	—	60	89	—	75
Fibula										
Maximum length	l	—	—	—	—	—	253	370	367	—
	r	332	—	—	—	—	255	367	—	324
Clavicle										
Maximum length	l	134	—	—	119	133	—	166	164	—
	r	—	—	—	118	(136)	113	164	160	132
Humerus										
Maximum length	l	(277)	—	—	—	286	228	329	328	—
	r	—	—	—	—	289	—	333	327	300
Max. diam., mids.	l	18.7	—	—	—	20.1	14.0	23.7	23.0	18.3
	r	—	—	—	—	20.9	—	24.3	24.0	19.1
Min. diam., mids.	l	12.9	—	—	—	16.1	11.7	18.1	19.4	15.1
	r	—	—	—	—	16.0	—	18.9	20.4	15.4
Circum., mids.	l	54	—	—	—	62	44	71	71	58
	r	—	—	—	—	62	—	73	74	58
Head diameter	l	—	—	—	—	38.0	—	47.6	45.0	—
	r	—	—	—	—	38.0	—	—	44.5	42.7

TABLE 85—(*Continued*)

Measurement[a]	Side	Fish Cave (AHUR 757)	Fish Cave (AHUR 757, miscell.)	Burial Crevices (AHUR 745)	Burial Crevices (AHUR 746)	Burial Crevices (AHUR 747)	Burial Shelter (AHUR 743)	Sand Hill (12-2-6A, B)	The Island (AHUR 735)	The Island (AHUR 729)
Biepicondylar br.	l	51.5	—	—	—	52.6	—	62.6	64.3	—
	r	—	—	—	—	52.7	—	63.8	64.1	57.3
Radius										
Maximum length	l	—	—	—	—	—	177	253	262	—
	r	—	—	—	—	—	176	257	264	227
Head diameter	l	19.5	19.2	19.2	—	18.9	—	22.7	25.0	—
	r	—	—	—	—	—	—	22.6	24.5	20.2
Max. diam., crest	l	14.6	13.1	—	—	14.2	11.5	16.0	16.4	14.4
	r	—	—	—	—	—	11.5	18.0	18.0	13.7
Min. diam., crest	l	10.4	8.9	—	—	10.2	7.5	11.7	12.1	9.3
	r	—	—	—	—	—	8.0	11.6	12.3	10.0
Ulna										
Maximum length	l	—	251	—	—	—	(193)	277	286	—
	r	—	—	—	—	—	193	283	288	248

[a] See Larsen (1982) for definitions of measurements.
[b] ( ) = measurement estimate.

ulnae, femora, tibiae, fibulae, right talus, all ribs, two cervical vertebrae, five thoracic vertebrae, three lumbar vertebrae.

AHUR 744: Represented by a left clavicle and unfused humerus head of an adolescent.

Grimes Point

The Grimes Point site, perhaps best known for the large number of petroglyphs (cf. Heizer and Baumhoff, 1962; Heizer and Clewlow, 1973), was investigated by the Wheelers, and, in the process, the skeletal remains of one very incomplete individual were collected:

TABLE 86
Carson Sink Human Stature Estimates (in Centimeters)

Burial	Bone	Sex	Stature
Fish Cave (AHUR 757)	l. femur	female	154.1 ± 3.8
Sand Hill (12-2-6A, B)	l. femur	male	170.1 ± 3.4
The Island (AHUR 735)	l. femur	male	168.1 ± 3.4
The Island (AHUR 729)	l. femur	female	157.2 ± 3.8

AHUR 740: The presence of a fully erupted and unworn maxillary left first deciduous molar and mandibular left second deciduous molar as well as a maxillary right first permanent molar tooth crown with no root development indicates an age at death of about two years (Ubelaker, 1978). In addition to these teeth, other remains present include a left frontal fragment (orbit only), occipital, maxilla, left mandibular corpus, sphenoid, and miscellaneous squama fragments, scapula spine fragment, and rib fragments.

Sand Hill

About 1.5 km. south of the Wheat Ranch on the Carson River near Sand Hill (Tuohy, n.d.), the remains of most of one adult individual were recovered by local archaeological collectors:

12-2-6A, B: Examination of the symphyseal faces of the pubes indicate an age at death of 40 to 50 years. The marked robusticity of the cranium and postcranium as well as the absence of the pubic ventral arc, slight development of the subpubic concavity, and the presence of a flat medial aspect of the ischio-pubic ramus just inferior to the pubic symphysis (cf. Phenice, 1969) strongly suggest that this individual is a male. Skeletal remains present include a cranial vault missing the face and mandible, a maxillary alveolus with the right first and second premolars,

left and right innominates, clavicles, humeri, radii, ulnae, femora, tibiae, fibulae, left patella, all foot and hand bones, and vertebrae. Several pathological conditions are present, including marginal lipping (degenerative arthritis) on all lumbar vertebrae, on three cervical vertebrae, and on the right humerus head. In addition, the last skeletal element shows a moderate degree of degenerative pitting from mechanically related attrition.

The Island

An area designated as "The Island" (Ch180) was excavated by the Nevada State Museum under the direction of Donald R. Tuohy (Tuohy, personal commun.). The excavation in this area yielded the remains of two individuals. The area is located in the White Plains section east of the Jessup underpass on Interstate 80 (Tuohy, n.d.). The following remains were examined:

AHUR 735: The close similarity of the pubic symphyseal face to Todd's (1920) Stage X pubic metamorphosis suggests an age in excess of 50 years at death. The marked robusticity of the cranial and postcranial remains as well as the absence of the pubic ventral arc and slight subpubic concavity and the flat medial aspect of the ischio-pubic ramus inferior to the symphysis (Phenice, 1969) indicate that this individual is male. Skeletal remains present include a complete skull with mandible and dentition, hyoid, left and right innominates, clavicles, scapulae, humeri, radii, ulnae, femora, right patella, left tibia, left fibula, left calcaneus, left talus, left navicular, left cuboid, left first, second, and third cuneiforms, five left metatarsals, five proximal foot phalanges, two distal foot phalanges, right scaphoid, left and right lunates, triquetrals, pisiforms, greater multangular, lesser multangular, capitates, hamates, four hand sesamoid bones, five right metacarpals, four left and four right proximal hand phalanges, five left and three right middle hand phalanges, three left and three right distal hand phalanges, all ribs, manubrium, sternum, all vertebrae. Pathological conditions include marginal lipping (degenerative arthritis) on the distal left calcaneus, distal fourth right metacarpal, right triquetral, right greater multangular, distal left first metacarpal, right patella, three cervical vertebrae, all thoracic and lumbar vertebrae, and medial clavicle. In addition, there are nonunion fractures associated with two right ribs (fig. 123). One rib shows a nonunion fracture 53 mm. from the sternal end; the other rib shows a nonunion fracture 44 mm. from the sternal end and a nonunion fracture 70 mm. from the vertebral end. Apical abscesses are associated with the mandibular right canine, right central incisor, and right first molar.

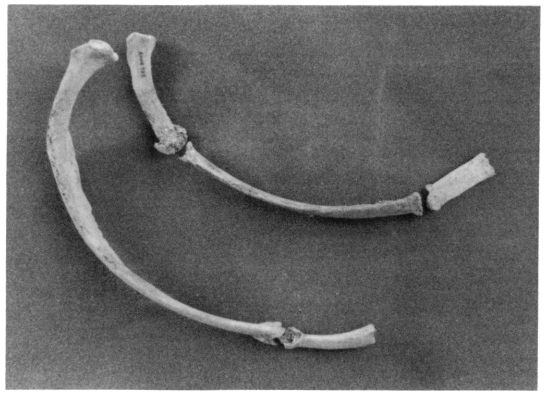

FIG. 123. Nonunion fractures of ribs found at The Island site (AHUR 735) in Carson Sink.

AHUR 729: Examination of the symphyseal face of the pubes indicates an age consistent with Todd's (1920) Stage IX (45–50 years). The gracile features of the cranial and postcranial remains, as well as the presence of a wide sciatic notch, pubic ventral arc, large subpubic cavity, and ridged medial aspect of the ischio-pubic ramus (Phenice, 1969) strongly indicate that this individual is female. The skeleton is nearly complete. Both the left and right temporal tympanic plates are perforated. The fourth and fifth lumbar vertebrae show slight margin lipping.

Pelican Island

From approximately 1.5 km. to the southeast of this well-known landmark, about 20 km. northeast of Fallon, John T. Reid acquired a cranial vault in the fall of 1927. The specimen (AHUR 1208) is that of a juvenile, either an older child or early adolescent. No other information on this individual is available.

Although several other human burials are known from the Carson Sink (see Tuohy, n.d.; and Appendix C, this volume), they were not observed by me.

INTERPRETATIONS AND CONCLUSIONS

What can the few bits and pieces of human remains described here and in chapter 13 tell us about the biology and adaptation of the prehistoric human populations that occupied the Carson Sink? Although the data are severely limited, a number of preliminary observations can be made.

First, although dental wear is extreme, dental health, nonetheless, was probably quite good. That is, there is minimal evidence of dental caries or premortem tooth loss. With respect to the former, of the 82 teeth examined in this series, only two teeth or 2.4 percent were affected by cariogenesis. Carious lesions are present on a third molar of a female mandible from Hidden Cave (20.4/1272) and a maxillary third molar from the Burial Crevices (AHUR 747). This reflects the low carbohydrate diet that undoubtedly characterized Great Basin populations throughout much of prehistory. There are no examples of premortem tooth loss. Indeed, this is also reflective of oral—and, in particular, dental—health that is excellent.

Second, the presence of few instances of skeletal infection (two infant long bones from Hidden Cave) reflects good skeletal health.

Third, examination of skeletal elements from the craniofacial complex suggests that the masticatory apparatus was subject to continuous and severe mechanical stresses, stresses that were related to both dietary and nondietary factors. Evidence for this includes dental enamel chipping, extreme tooth wear, and marked development of the bony attachment sites for the muscles of mastication (e.g., temporalis and masseter).

Fourth, marked physical stress as it relates to daily mechanical demands placed on the body in general is apparent for these Great Basin peoples in that the postcranial sample shows marked robusticity and the presence of advanced degenerative arthritis in older individuals.

In summary, although the number of skeletal and dental samples from the Carson Sink are meager, the materials that are present indicate that the human groups occupying this region of the Great Basin were robust in size and health, reflecting an active, physically demanding existence. Preliminary analyses of human skeletal samples from other parts of the Great Basin—such as that provided by S. Brooks, M. Galliher, C. Stark, and others (cf. Stark, 1983)—represent important work toward the completion of a picture of paleo-adaptations in this area. One preliminary difficulty associated with human remains from the region is lack, for the most part, of precision in chronological control. Future work will demand tighter stratigraphic control in order that changing adaptations be more clearly understood.

APPENDIX C. THE ROSS BURIAL SITE

LORANN S. A. PENDLETON AND DAVID HURST THOMAS

Although archaeologists have been excavating sites in the Humboldt and Carson sinks for over six decades, most of this activity has focused on the relatively rich cache caves of the area (Loud and Harrington, 1929; Heizer, 1951, 1956; Grosscup, 1956; Heizer and Krieger, 1956; Baumhoff, 1958; Roust, 1966; Napton, 1969, 1970; Tuohy, 1969a; Wheeler and Wheeler, 1969; Heizer and Napton, 1970; Roust and Grosscup, n.d.). This volume is no exception to this long-standing tradition.

The problem is that artifacts found in such sites typically are part of a highly curated technology, involved (at least peripherally) in the exploitation of marshside resources. Because so much research has been directed at the Carson/Humboldt cache cave complex, the extensive surface scatters in the Humboldt and Carson sinks have received only cursory treatment (as previously noted by Heizer and Napton, 1970, p. 43).

The American Museum of Natural History has attempted, in part, to redress this balance. Although we spent much time digging Hidden Cave, we also tried to transcend this rather narrow perspective. In one such effort, Robert L. Kelly has initiated a regional random sample of the Carson Sink area, endeavoring among other objectives to place the numerous lacustrine cave sites in a more realistic regional context. Part of the study includes examination of the diverse amateur collections from this area (Kelly, 1983a). Although these collections have limitations, they are a potentially important data base.

While observing this research, we were impressed with the diversity and abundance of artifacts in such amateur collections. Especially striking were materials recovered from the "sandhills" which dot the Carson and Humboldt sinks. The massive collections of lithic, bone, and shell artifacts leave little doubt that these sandhills have been intensively utilized for millennia.

Unfortunately, the sandhill complex of the Carson and Humboldt sinks is only occasionally discussed in the archaeological literature (Harrington, 1927; Loud and Harrington, 1929; Elsasser, 1958; Grosscup, 1960; Cowan and Clewlow, 1968; Heizer and Clewlow, 1968; Heizer and Napton, 1970; Stanley, Page, and Shutler, 1970).

We describe here an additional sandhill site from the Carson Sink. Although the information is quite limited, this is a step toward making such data available to the archaeological community.

THE ROSS BURIAL SITE

During a family picnic, about 1973, Mrs. Joanna Ross noticed a curious reddish stain on the ground. At first she thought the stain was merely a rusting tin can, but on closer inspection, she found that the color was red ocher or hematite, and she decided to look further. Roughly 20 cm. below the hematite, Mrs. Ross found a concentration of artifacts and human bones in a vaguely defined pit, approximately 45 cm. square. Thinking that the burial was in danger of exposure and trampling by cattle, she decided to remove it immediately. The entire mass of bone, artifacts, and sand was removed intact and transported to her ranch south of Fallon. The hematite lumps were also bottled and saved. Later, examining the contents of the bottle, Mrs. Ross discovered two small blue faceted glass trade beads contained within the ocher.

The burial occurred in a blowout on the south side of a partially stabilized sand dune approximately 3 m. in height, about 9 km. south of Fallon, Nevada, in a pasture dominated by alta fescue grass. The area had been cleared and irrigated by Mr. Jack Ross in 1960. Previously it had contained typical shadscale vegetation with a sparse cover of *Atriplex confertifolia, Sarcobatus vermiculatus,* and *Suaeda torryana* (sp.). This vegetation community continues to dominate nearby nonirrigated portions including the sandhills.

The burial itself was somewhat below the top of the dune, approximately 2 m. above the pasture level. Roughly 25 m. to the northwest was a fairly dense artifact scatter weathering out of the south side of the same dune, containing two hammerstones, two biface fragments, a number of grinding stone fragments, a scatter of broken *Anodonta* (sp.) shell, and a concentration of chert debitage. Mrs. Ross had previously found a complete Rosegate projectile point on this site (see fig. 124c). Other than several obviously recent rusted tin cans and a few pieces of bottle glass, this site lacks evidence of historic aboriginal occupation.

Sites such as this are fairly common throughout the area, often found in blowouts on south-facing dune slopes.

MATERIAL CULTURE

Exact provenience for individual artifacts within the burial pit remains problematic, but the three observers present when the burial was removed

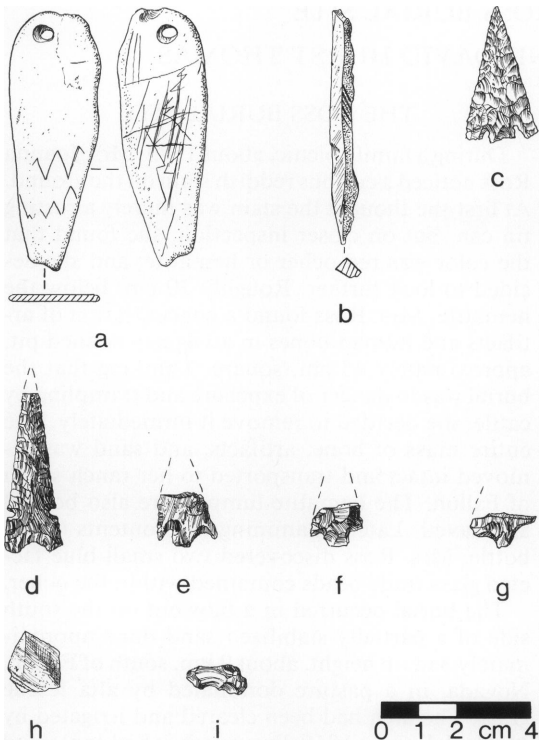

FIG. 124. Stone artifacts associated with Ross burial. a. incised stone pendant; b. obsidian prismatic; c. Rosegate series projectile point found 25 m. from burial; d. Desert Side-notched projectile point; e, f. Rosegate series projectile points; g, i. unidentifiable point fragments; h. flake.

agree that the artifacts were directly associated with the bones. Over 700 bone tube beads, 21 phalange bone beads, three spatulate bone objects, one sharpened bone splinter, an obsidian prismatic, an incised slate pendant, a chert flake, and four obsidian point fragments were found in the burial pit (figs. 124–126) along with several small long bones similar to those used for the beads.

The beads were in closest association with the skeletal remains. One observer remembers them entwined with the infant; the other two think that the beads were found just below the burial. The ring beads were not arranged in any particular pattern, but the small bone tube beads were strung between the bone phalanges into a necklace. The phalanges were strung lengthwise, and a ring bead remains imbedded within one phalanx cavity; so the ring beads were probably part of the necklace. The other artifacts were found together on the northeast side of the infant.

STONE ARTIFACTS

OBSIDIAN PRISMATIC (fig. 124b): This specimen is a natural, thin rectilinear, black obsidian prism, pointed at one end and blunt at the other. It is neither flaked nor abraded; however an unidentified red pigment (probably hematite) adheres to small portions of the surface.

PROJECTILE POINT FRAGMENTS (fig. 124d–g, i): Five biface fragments are portions of projectile points, classified according to criteria presented elsewhere (Thomas, 1981a). Four are manufactured from black obsidian, and one is made from black chert. Two of these seem to be Rosegate points, one is a Desert Side-notched point, but the other two are too fragmentary for accurate classification.

The Rosegate fragments are small, quite similar to the small points recently recovered from various locales in the Carson Sink (Kelly, 1983a, p. 33). They were manufactured from extremely thin flakes, randomly pressure flaked on both faces. The shoulders were formed by small parallel notched flakes. Both points were broken in half by end shocks. They may have been snapped or "killed" prior to their burial, or perhaps they were broken in manufacture.

The Desert Side-notched point was made from a larger obsidian flake, with fine bifacial chevron pressure flaking on both faces. The base is concave, and the shoulders are notched on both margins with bifacial lever notches. The tip has been snapped, and there is also a break at the midsection. The cause of the breaks could not be determined.

FLAKE (fig. 124h): The burial contained one pink chert flake that was neither retouched nor utilized. It has a minute platform and bulb on the ventral surface giving it the appearance of a large pressure flake. But precise identification of the method which produced this isolated flake is not possible.

INCISED SLATE PENDANT (fig. 124a): The slate pendant is thin and rectilinear with rounded margins and a biconically drilled perforation; both faces are incised. The predominant motif is the zigzag, present on both sides. Several other motifs have been superimposed on one face, but the reverse face contains only the zigzag.

This slate was very carefully manufactured. The surface of the pendant was smoothed with a soft abrasive that left minute striae on both faces. Zigzags were first applied, running the width of the pendant on one face and lengthwise on the opposite face. Subsequently, a series of deep, long incisions were superimposed across the longitudinal zigzags. The pendant margins are well-worn, more highly polished than either face. Several motifs are quite faint, perhaps from extensive han-

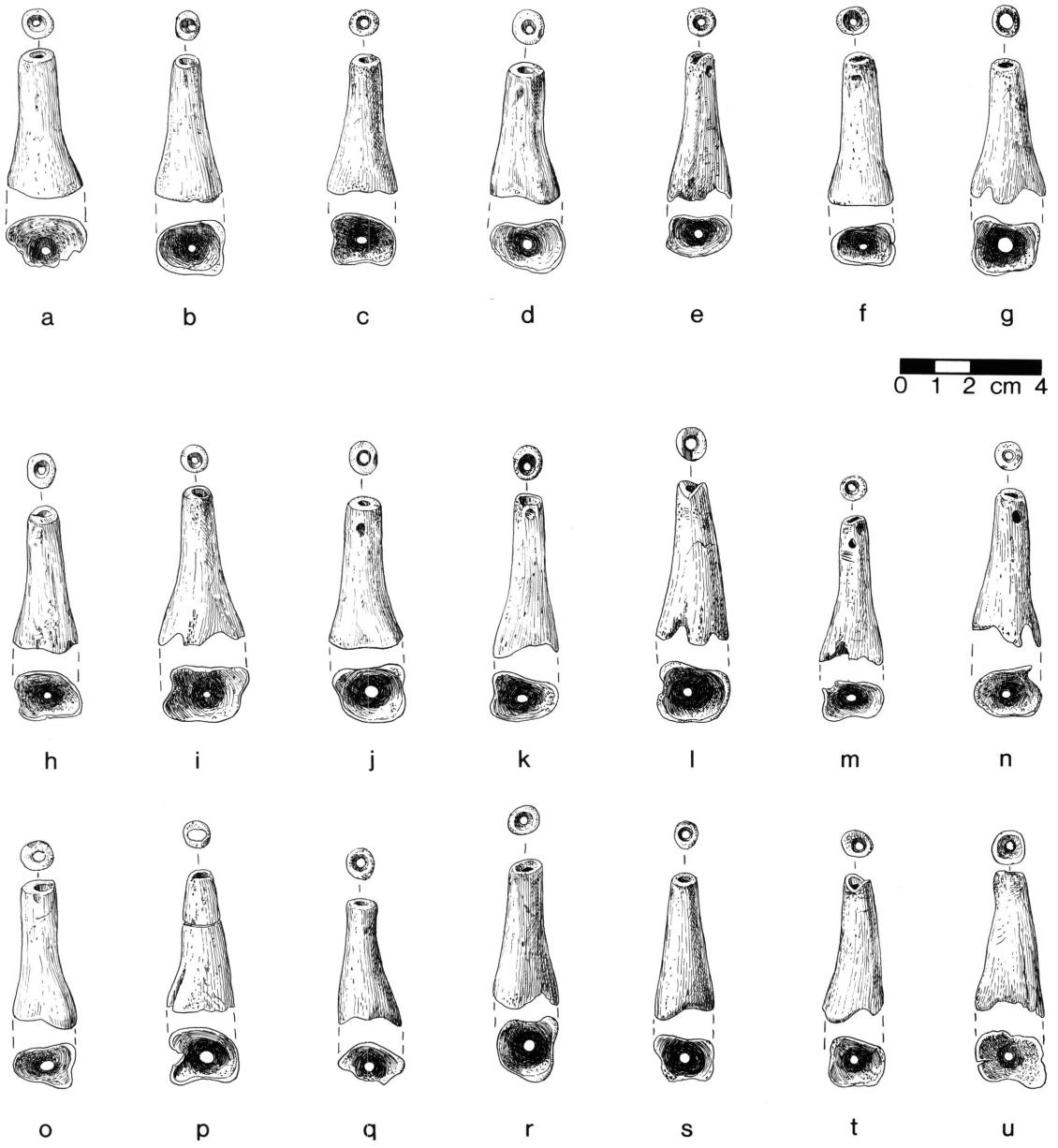

FIG. 125. Bone phalanx beads associated with Ross burial.

dling, or possibly from an attempted retrieval of the face for additional incising (cf. T. Thomas, 1983).

BONE ARTIFACTS

BONE PHALANX BEADS (fig. 125): Twenty-one artiodactyl phalanges were modified into beads. The method of production generally consisted of cutting and grinding both epiphyses to produce a smooth, flat surface; however, four of the beads have cutmarks on the proximal epiphysis, forming a V-shaped surface. The bone interior was reamed into a hollow cone. The exterior shape of the phalanx is basically maintained although the surface

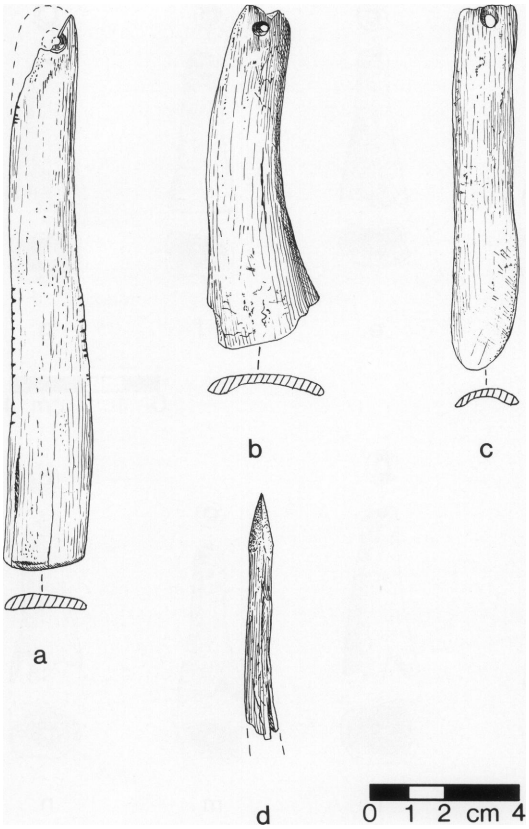

FIG. 126. Additional bone artifacts associated with Ross burial. a–c. spatulate bone objects; d. pointed bone.

has been smoothed and polished. Exterior incising is minimal, consisting of an unbroken line circumscribing the proximal end of one phalanx and several small zigzag marks cut on a second phalanx. Both incisings were most likely produced by a sharp flake. Two of the beads are perforated on the posterior proximal end, but the perforations appear to have resulted from natural causes.

BONE TUBE BEADS: Over 700 individual beads were manufactured from bird and rabbit long bone fragments (modifications to the bone preclude a more precise identification). Beads were recovered in several stages of manufacture, revealing production methods. Apparently, a long bone was modified into a tube by removing the expiphyses. Incised bands circumscribe the exterior, dividing the long bone into small rings that were snapped apart into individual ring beads. Some of the larger rings were ground on both ends, leaving them with smooth flat surfaces. The colors range from light beige to black. The dark brown and black beads apparently were stained and tend to be thicker than the lighter colored beads.

POINTED BONE (fig. 126d): This awl was manufactured from a thick artiodactyl long bone splinter. The interior concavity and exterior surface are unmodified; however, modifications to the margins have produced a trapezoidal cross section. One end has been highly polished into a sharp point.

SPATULATE OBJECTS: Two of the three spatulate artifacts (fig. 126a, b) are manufactured from horn, with proximal biconical perforations and polished surfaces, similar to Gifford's type AE 2 (1947, p. 131).

The third artifact (fig. 126c), longer than the other two, is manufactured from an artiodactyl rib, the surfaces and margins of which have been smoothed. The perforated proximal portion was broken, probably prior to burial, as the tip formed by the break is highly polished. The lateral margins are incised by perpendicular notches that suggest episodic incising. The marks vary in depth, width, length, and angle. Thirty-nine notches are easily visible on the margins and several more are visible with minor (10×) magnification.

HUMAN REMAINS

Although Mrs. Ross carefully saved all the human remains, they subsequently disappeared and are unavailable for study.

INTERPRETATION

There is limited relevant ethnographic data available to assist in the interpretation of infant burials in the Great Basin. Lowie (1924, p. 280) cites a brief account of a Shoshone boy buried with items that he had treasured. Steward (1941, p. 257) notes that the Shoshone buried their dead in soft earth. The deceased's possessions were usually destroyed or buried with him, because "to leave them around would cause unhappiness to relatives." Steward (1933, pp. 291–297) also recorded Owens Valley Paiute burial practices, noting that infants were buried near close relatives.

Yarrow's (1881, pp. 142–143) account of Great Basin burial practices also notes the care accorded the deceased. "The body of the deceased is dressed in the best clothing, together with all the ornaments most admired by the person when living" (Dr. O. G. Given, quoted in Yarrow, 1881, p. 142). Yarrow also suggested that northern Nevada tribes buried their dead in cairns of rocks or rubbish.

Infant burials are not uncommon in the archaeological record of this area (see also Appendix B, this volume). Heizer (1951, p. 92) found a newborn infant dated to 3786 ± 400 B.C. buried on basketry and covered with rocks at Leonard Rock-

shelter in the Humboldt Sink area. The remains of a five-year-old child were recovered from a burial in Lovelock Cave nearby (Morbeck, 1970, p. 191). Loud and Harrington (1929, pp. 14–15, 32) discovered the skeletal remains of 16 people, three of whom were under six years of age, in cave burials near Lovelock. Several were wrapped in nets with "unusually excellent" artifacts, including rattles, baskets, moccasins, stone balls, and an atlatl dart with an obsidian point (Loud and Harrington, 1929, pp. 16–17).

Riddell (1960, pp. 80–83) recovered several infant burials at the Karlo Village site in northeastern California associated with items similar to those from the Ross Burial. Davis (1959, p. 69) reports the burial of a child, approximately five years of age, with grave goods of bone awls and pendants near Mono Lake in the far western Great Basin. Casjens (1973, p. 13) discusses a small child's skeleton wrapped with a bundle of cotton cloth and apparently loosely associated with Rosegate and Desert Side-notched points at Itsy Cave in the eastern Great Basin.

In Death Valley, Wallace excavated the remains of a child, three or four years of age, buried with 18 projectile points, two polished bone objects, "three nondescript bone spatulas" with smooth tips and broken bases, with a bone tube or bead with ground ends (Wallace, Hunt, and Redwine, 1959, pp. 2–7). At another site in Death Valley, a one-year-old infant was buried with several chert flakes (Wallace and Taylor, 1959, pp. 9–11).

Material culture similar to that accompanying the Ross burial was associated with a "shaman" burial at Pyramid Lake: slate pendants, three perforated bone pendants, and an awl (Tuohy and Stein, 1969, pp. 106–109). Beardsley (1971, pp. 168–175) reports the association of ground slate pendants and obsidian cores (prismatics) in burials from the Middle Horizon of central California. He believed that the slender prismatics may have been tinklers or bangles. Similar artifacts have also been found in association with burials from the Early and Late horizons of the California coastal province and from the early Windmiller Phase in interior central California.

Bone beads similar to those found in the Ross burial area described by Powers as used by the Paiute as a medium of exchange, "a string of very short sections of the bone of a duck's leg is legal tender" (Fowler and Fowler, 1970, p. 129). Powers describes a *Ta-ka-wan* as being a woman's necklace made of the phalanges of mountain sheep, although he does not attach any further significance to the artifact (Fowler and Fowler, 1970, p. 141).

Lowie (1924, p. 269) notes infant cradles were often decorated with beaded pouches that held the umbilical cord.

Lewis and Clark observed that it was only children who wore beads about their necks (Lowie, 1909, p. 181). Hopkins (1883, pp. 9, 57) discusses several instances in which beads performed a significant function in relation to children, but also notes that on very special occasions beads were exchanged between men and women at dance ceremonies in the Great Basin. Beads were considered valuable gifts, ranking with horses when strung into necklaces (Lowie, 1909, p. 221).

Although little more can be said about the Ross burial, we think that presentation of such primary data is a first step toward understanding the utilization of sandhill areas in the Carson Sink and elsewhere.

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