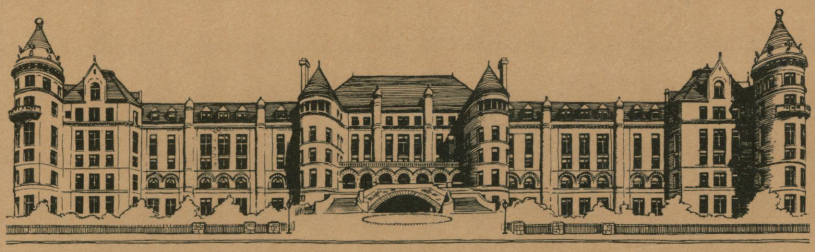

THE ARCHAEOLOGY OF PINYON HOUSE, TWO EAGLES, AND CRATER MIDDENS: THREE RESIDENTIAL SITES IN OWENS VALLEY, EASTERN CALIFORNIA

ROBERT L. BETTINGER

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ABSTRACT

The results of archaeological excavations undertaken between 1978 and 1981 are reported as the second phase of the Owens Valley Project, a long-term investigation of aboriginal man-land relationships in eastern California. These excavations test simple models of prehistoric subsistence and settlement advanced as summary interpretations of archaeological data obtained by probabilistic surface survey in central Owens Valley during the first phase of this regional research program (Bettinger, 1975a, 1977a). The three residential sites excavated in the second phase of research—Pinyon House, Two Eagles, and Crater Middens—furnish a splendid record of the late prehistoric subsistence-settlement system in Owens Valley and provide a sound basis for inferences regarding the formation and evolution of that system.

Situated in the northern Inyo Mountains, Pinyon House was evidently occupied as a short-term hunting camp between approximately 3000 B.C. and A.D. 300 and as a fall or fall-and-winter pinyon camp from A.D. 300 into historic times. Site macrofossils assure that pinyon procurement was a primary motive for its occupation. The bulk of the archaeological assemblage at Pinyon House, however, relates to altogether different activities including the acquisition of resources other than the pine nut and the production of gear for use at other times in other places. Pinyon House is, thus, most interesting for the light it sheds on the manner in which a specific and reasonably demanding economic activity (pinyon procurement) is integrated into a larger annual round.

Two Eagles (CA-Iny-1756) is located at the foot of the Inyo Mountains approximately 5 km southwest of Pinyon House. There is evidence of sporadic use as early as 1200 B.C. but the bulk of occupation seems safely dated from A.D. 600 to historic times. The remains of numerous makeshift dwellings and an impressive array of specialized milling equipment suggest seasonal occupation by groups of perhaps one to five families who used it as a base of seed procurement. A ragged assortment of chipped stone implements and debris shows that males hunted while females were engaged in the primary site activity—the gathering and initial processing of seeds. Hunting and gathering are often in conflict with regard to the places and times at which they can best be done; the archaeological record at Two Eagles suggests that in the central Owens Valley case gathering took precedence over hunting.

Crater Middens (CA-Iny-1700) lies at the foot of the eastern slope of the Sierra Nevada almost due west of Two Eagles. Five separate clusters of cultural material, termed middens, disclose the presence of a large, intensively occupied village inhabited between 0 B.C./A.D. and historic times. Floral and faunal remains suggest occupation year-round with a diet dominated by seeds and small mammals. Variation in the degree to which activities were separated in space within the site and in the composition of archaeological assemblages during successive phases of occupation suggests intensification in regional subsistence and settlement patterns after A.D. 1300. These patterns are especially clear in artifact categories that in one way or another link the central base settlement of Crater Middens to its more specialized satellite settlements and, in a broader sense, its social and economic environment.

Pinyon House, Two Eagles, and Crater Middens can be regarded as functionally distinct aspects of a single subsistence-settlement system (the Crater Middens subsistence-settlement system) employed by approximately 30 individuals headquartered at Crater Middens. This system formed in the late Cowhorn phase and dissolved with the abandonment of Crater Middens somewhere around A.D. 1872. Subsistence patterns were evidently more intensive and generalized, and settlement patterns more centralized, in the Klondike phase than in the preceding late Cowhorn and Baker phases. The nature of this intensification would suggest it is a regional rather than local phenomenon and that it was in large measure a response to population growth.

Obsidian hydration rim measurements suggest dates that are consistently too old for the archaeological assemblages recovered at Pinyon House, Two Eagles, and Crater Middens. This is explained as resulting from the aboriginal scavenging of prehistoric sites for tools and usable flakes and as such is directly related to the balance between tool demand and tool supply, which is the principal force behind scavenging. The pattern of variation in another measure of tool demand/supply, artifact completeness, parallels the degree of skewness in obsidian hydration dating between Pinyon House, Two Eagles, and Crater Middens.

Together these excavations suggest that summary interpretations of prehistoric developments in central Owens Valley previously advanced to account for archaeological patterns observed from surface survey erred with regard to the inferred basic stability of land use but were correct with regard to: (1) the establishment of the ethnographic pattern of a centralized settlement system anchored at Desert Scrub villages and dependent on Desert Scrub resources at the beginning of the Christian era; (2) the inception of intensive pinyon procurement after A.D. 600; (3) the diminished

importance of large game after A.D. 1000; and (4) intensification in land use between 3500 B.C. and historic times.

In larger perspective this research (1) documents the accuracy of archaeological inferences developed on the basis of surface surveys; (2) refutes the received wisdom (e.g., Eggan, 1980) that abundance of resources explains the pattern of social, political, and economic complexity observed ethnographically in Owens Valley; and (3) supports recent inferences regarding the spread of Numic speaking peoples into the Great Basin from Owens Valley or very near by and suggests some possible mechanisms for this spread.

INTRODUCTION

Until very recently, the most widely accepted model of aboriginal man-land relationships in the Great Basin was Jennings' Desert Culture (Jennings and Norbeck, 1955; Jennings, 1957, 1964, 1968). In simplest terms, this model holds that technological and environmental conditions imposed on the prehistoric inhabitants of the Great Basin had produced an adaptation characterized by intensive, but unspecialized, subsistence patterns, transhumant settlement patterns, and rudimentary sociopolitical organization centering on the family band rather than larger groupings based on unilateral descent. This adaptation was thought to have changed very little from 8000 B.C. to historic times, being the prehistoric equivalent of the ethnographic Great Basin adaptation described by Steward (1938a, 1955, 1970).

In the late 1960s and early 1970s several archaeological research projects put the Desert Culture model to the test in various parts of the western Great Basin. The Owens Valley Project, organized in 1971, was one of these. The early Owens Valley research relied heavily on extensive surface surveys, a procedural decision grounded in the assumption that the Desert Culture was a model of *regional* subsistence-settlement systems that were not fully expressed, and hence could not be adequately tested, at any single site. Regional surveys offered the opportunity to examine the full range of seasonal and functional variability within prehistoric adaptive systems. This variability was the central issue in testing the Desert Culture model.

The results of the Owens Valley survey tended to contradict expectations derived from the Desert Culture and these differences appeared to be the result of shifting balances between population and resources. Unfortunately, the quality of these surface data limited the range of inferences that could be drawn and these limitations made findings speculative in many respects.

In 1978, a second phase of research was undertaken in which key sites were excavated in order to test the model of Owens Valley that had been proposed on the basis of the surface survey. The recovery of plant and animal macrofossils that would shed light on subsistence patterns and the seasonality of site occupation was a principal target of this work.

Pinyon House, a large pinyon camp in the Inyo Mountains and the first site tested in this program, was excavated by field crews from New York University in 1978 and 1979 (U.S.F.S. Antiquities Permit 70-05-04-53/54-). During roughly the same period, excavation was also carried out at Two Eagles, a large occupation site in the Inyo Mountain foothills not far from Pinyon House (U.S.F.S. Antiquities Permit 70-05-04-53/54-). Unfortunately, plant and animal remains were not as abundant as had been hoped at Two Eagles and in order to obtain adequate samples of these materials, work was begun in 1979 on a second lowland occupation site, Crater Middens, situated in the Sierra Nevada foothills on the west side of Owens Valley (Federal Antiquities Permit #79-CA-124). Supported by a National Science Foundation research grant (BNS-8017798), the project returned to Crater Middens in 1981 (Federal Antiquities Permit #81-CA-058). That season completed the excavation of the site and with it the second phase of the Owens Valley

Project, the results of which are reported and interpreted here.

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The following individuals participated in the 1978 field excavation of Pinyon House and Two Eagles: Sharon Bettinger, Robert Kelly,Theodore Nicholis, Arnold Pickman, Kathy Riley, Richard Weaver, and Philip Wilke.

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A variety of scientific specialists provided expert analyses of materials recovered in connection with this project and in no small part are responsible for its success. Mary DeDecker, Independence, Calif., identified thatching material from the standing structure at Pinyon House. Kim Harper and Rick Collins, Department of Botany and Range Sciences, Brigham Young University, identified and reported on the plant macrofossils from Pinyon House, Two Eagles, and Crater Middens. Donald K. Grayson, Department of Anthropology, University of Washington, Seattle, identified and analyzed the faunal remains from these same sites. R. E. Taylor, Department of Anthropology, University of California, Riverside, performed the radiocarbon assays from Pinyon House, Two Eagles, and Crater Middens. Rob Jackson did the obsidian hydration studies for all three sites. Richard Hughes sourced obsidian samples from Crater Middens. Tom and Margie Latham, Department of Geology, University of California, Davis, provided expertise in the identification of lithic materials. Michael Delacorte processed and cataloged the bulk of the material from these sites and provided invaluable technical assistance and advice throughout the project. Dennis O'Brien prepared the maps of sites and structures and Nicholas Amorosi and Todd Ruhstaller drew many of the artifact illustrations. Nancy McLaughlin typed most of the manuscript and Gayle Bacon, Sandra Williams, and Jane Foster all contributed to its preparation. Lisa Bedell and Sally Jeppson kindly acted as proofreaders. Finally, James A. Bennyhoff identified all our shell, stone, and glass beads.

Throughout this volume I use the terms "we" and "our" rather than "I" and "my." Should there be any doubt in the matter, in all such cases except where accompanied by a specific reference indicating the contrary, the relevant research and ideas are solely my responsibility—errors, inconsistencies, and all. My use of the terms "we" and "our" is not an attempt to shun such responsibility but rather to recognize the important contributions countless others have made to my research and my thinking.

CHAPTER 1. BACKGROUND, SCIENTIFIC CONTEXT, AND RESEARCH DESIGN OF THE PROJECT

The Owens Valley Project began in 1971 as a long-term archaeological study of aboriginal man-land relationships in Owens Valley and surrounding areas of eastern California (Bettinger and King, 1971). The initial phase of this research program was devoted to the systematic collection of basic data regarding the nature and distribution of archaeological sites in that locality and the development of a simple model of prehistoric subsistence and settlement patterns that would account for these data. To accomplish this, in 1972 and 1973 probabilistic surface surveys were conducted in a large transect centered on the modern town of Big Pine, California. The archaeological assemblages and natural settings of the 107 sites located during our survey of the Big Pine transect were used to establish a functional taxonomy of prehistoric settlements consisting of five categories that differed in terms of their season of occupation, resident group size and composition, duration of occupation, subsistence patterns, and the range of activities they sustained (Bettinger, 1975a, 1977a, 1979a). These five settlement categories were: *lowland occupation sites, pinyon camps, riverine temporary camps, desert scrub temporary camps,* and *upland temporary camps* (Bettinger, 1977a). Chronologically sensitive artifacts recovered from these sites were used to isolate groups of settlement categories in contemporaneous use in each of four major time periods between 3500 B.C. and historic times. These four time periods, termed phases, were: *Clyde phase,* dating between 3500 and 1200 B.C. and characterized by projectile points of the Little Lake series; *Cowhorn phase,* dating between 1200 B.C. and A.D. 600 and characterized by projectile points of the Elko series; *Baker phase,* dating between A.D. 600 and 1300 and characterized by projectile points of the Rose Spring and Eastgate series; and *Klondike phase,* dating between A.D. 1300 and historic times (about A.D. 1860) and characterized by projectile points of the Cottonwood series and Desert Side-notched type. The groupings of sites in use within each phase, in combination with knowledge of the individual settlement categories they represented, provided the framework for inferences about aboriginal subsistence-settlement systems during each of the four prehistoric phases. Comparisons between successive prehistoric systems and between the last of these and the terminal precontact system as inferred from ethnographic accounts led us to propose a model of human adaptation through time in Owens Valley and to suggest possible explanations for the adaptive changes that were observed (Bettinger, 1976, 1977a).

As summarized elsewhere,

> This research showed that many elements of the prehistoric adaptation remained relatively constant through time. In particular, it was demonstrated that permanently inhabited *lowland occupation sites* served as base camps for groups of 50 to 150 individuals and were the focus of most activities in the spring, summer, early fall, and most winters throughout the period of prehistoric occupance. It was also shown that subsistence patterns in each phase revolved around the exploitation of lowland root and seed resources. . . . Similarly, the evidence points to the consistently small contribution of animal foods in the annual diet.
>
> In contrast to these stable patterns, site analysis indicated that three important changes in the prehistoric subsistence-settlement patterns had occurred.
>
> First, a shift in the emphasis of plant exploitation from riparian to desert scrub resources between 1200 B.C. and A.D. 600 is reflected by a change in the location of lowland occupation sites from predominantly riverine settings to desert scrub localities. . . . One possible reason for such a transition might be an increase in local population that forced a diversification of the subsistence base, this accomplished by supplementing riparian resources with dryland plant species. Alternatively, it might reflect a climatic change to more moist conditions that increased the productivity of dryland plants, making them more attractive as a subsistence source than in preceding phases.
>
> A second adaptive change was the inception of intensive pinyon exploitation between A.D. 600 and A.D. 1000. . . . as shown by the appearance of *upland pinyon camps* inhabited by

one to three families for brief intervals during the late fall pinyon harvest and occasionally throughout the winter months as well. . . . This was interpreted as an attempt to maintain balance between resources and population by broadening the subsistence base to include previously unexploited pinenut crops following (1) an increase in population densities due to immigration or local recruitment, or (2) a decrease in the productivity of desert scrub plants necessitating the use of new food resources.

Finally, a decrease in large game hunting after A.D. 1000 was reflected by the disuse of *upland* and *desert scrub temporary camps* used as hunting stations. . . . This may reflect a scheduling conflict between hunting and the tending of large scale irrigation systems that are recorded in historic and ethnographic accounts. . . . and which may have been initiated at this time.

Overall, the prehistory of Owens Valley is dominated by an evolution in subsistence adaptation from a highly specialized pattern focusing on a few abundant resources to a more diversified pattern incorporating new subsistence resources and, with the beginnings of food production in late prehistoric times, more intensive use of traditional food sources. Despite these changes, however, subsistence remained dependent on lowland plant resources and relatively stable social groups continued to inhabit lowland occupation sites year round, patterns that Owens Valley shares in common with Surprise Valley and the Lower Humboldt Valley. (Bettinger, 1978a: 34–36)

This model continues to be the most straightforward and parsimonious interpretation of what is known about the archaeological record in Owens Valley. Some criticisms of the model have been raised on various procedural and statistical grounds (McGuire and Garfinkel, 1976; Munday and Lincoln, 1979; D. Madsen, 1981; Hall, 1981), but on the whole these are unpersuasive and offer no equally satisfactory alternative model (Bettinger, 1977c, 1978c, 1979b, 1981a, 1981b). Indeed, substantive archaeological research has furnished support for many elements of the present interpretation (e.g., Bettinger, 1980a; Garfinkel and Cook, 1980).

All the same, it was never intended that the model, derived as it was from surface assemblages, be a final statement regarding human ecology in Owens Valley. During the planning of the survey, we were aware that the data likely to be obtained by these means would be limited in kind and that because of this any reasonably comprehensive model of subsistence and settlement patterns developed from them would require certain inferences for which archaeological support would be lacking. That is, many aspects of prehistoric human behavior would have to be deduced not from the nature of surface assemblages we encountered directly, but from what was the most likely or consistent with what was known or could be reasonably inferred from other aspects of subsistence and settlement patterns for which data were available. As anticipated, these gaps in the information provided by surface survey made our model of prehistoric human adaptation in Owens Valley weak in three respects.

The first important problem was chronology. Sites, settlement categories, and, in turn, adaptive changes were all dated by means of well-established time-markers, primarily projectile points. For a variety of reasons, these were not especially abundant at Owens Valley sites. Further, even were it assumed that the sample recovered by our survey was adequate, reliance on these time-markers restricted our temporal assessments to the four broad time periods to which these items could be assigned. Since there is no compelling reason to believe that adaptive change necessarily coincided with changes in projectile point shape, our dating of adaptive changes was only approximate.

The second gap lay in the absence of specific information about subsistence patterns. Inferences of this sort were made on the basis of lithic assemblages in conjunction with knowledge of potential resources available within a 2-hour walk of individual sites, i.e., the site catchment (Vita-Finzi and Higgs, 1970). This procedure is insensitive to variations in dietary selectivity, especially where site catchments are complex, a feature characterizing most lowland settlements in Owens Valley.

The third gap was the lack of evidence about the seasonality of site occupation. Inferences of this kind were derived indirectly by ascertaining the seasons of availability for subsistence resources thought to have been exploited from individual sites. Accordingly, all

the reservations that apply to our interpretation of subsistence patterns extend to our interpretations of site seasonality as well.

Despite these deficiencies, the Big Pine survey provided the basic data needed to sustain inferences about the simple framework of subsistence and settlement patterns, and thus achieved its desired purpose. Additional surface survey, however, although it might allow certain refinements in our interpretation, would not close any of the qualitative gaps that existed in our archaeological data.

This could only be done by excavating a series of sites representative of major Owens Valley settlement categories and the recovery by this means of two kinds of evidence. The first was aboriginal food waste in the form of plant and animal remains (macrofossils) which would disclose patterns of site seasonality and subsistence; the second was a broad range of archaeological materials susceptible to chronometric analysis by radiocarbon and obsidian hydration assay.

There was little point in attempting this at temporary camps, which uniformly lacked subsurface deposits. Base camps, i.e., occupation sites and pinyon camps, were more suitable in this regard and, not coincidentally, it was around these sites that the major patterns of subsistence and seasonal movement as well as successive adaptive changes were thought to revolve.

A large number of potential sites were considered for excavation, but we ultimately settled on three: a pinyon camp, Pinyon House, and two occupation sites, Two Eagles and Crater Middens (fig. 1.1). All three sites are situated within the Big Pine transect and two, Crater Middens and Two Eagles, were among the sites located in sample tracts during our initial survey. Pinyon House was also found during these surveys, but lay just outside the set of tracts designated for study. Because their surface assemblages were incorporated in the model of Owens Valley subsistence and settlement set forth earlier, excavation of these sites provided a direct test of that model.

Although specific sampling strategies followed are discussed in those chapters devoted to the individual sites, certain basic procedures dictated by the goals of our project and the nature of the sites themselves deserve mention here. As indicated above, throughout the project particular attention was given to the recovery of plant and animal fossils and datable archaeological materials. The problem in accomplishing this lay not so much in the methods and procedures of recovery, which were routine, but in obtaining samples in relatively clear temporal context where disturbance and mixture were minimized. As in semiarid regions generally, soil formation proceeds slowly in Owens Valley. This being the case, even where aboriginal activity was intense and refuse production high, cultural deposits developed slowly and in the course of this development were frequently mixed and reworked by subsequent aboriginal activity and by burrowing rodents attracted to these spots by their vigorous weed growth and uncompacted soils. Because of this the usual correlation between time and stratigraphic depth—and hence the assumption of contemporaneity of items found at similar depths—is subject to frequent exception and holds only in a statistical sense. This made it difficult to test a model in which even slight mixture of different components might alter the interpretation of subsistence and seasonality and changes in these patterns through time. To minimize the problem of mixture, two simple sampling strategies were followed. First, excavation and recovery of plant and animal macrofossils were most intensively pursued in contexts less subject to mixture, where cultural associations were most secure. Well-defined features, especially structural remains and hearths within them, where these conditions obtained, were given high priority both as a criterion for site selection and in the excavation strategy pursued at each site. At Pinyon House and Two Eagles our excavations were confined to features of this sort entirely, there being no midden formation to speak of at either site despite an abundance of features at both.

Features were also abundant at Crater Middens but a substantial midden deposit, evidently well mixed in many places, was also present. In sampling this midden, we intentionally increased sample saturation in those parts of the site where the deposits were the deepest and where as a result there was maximum stratigraphic separation between early

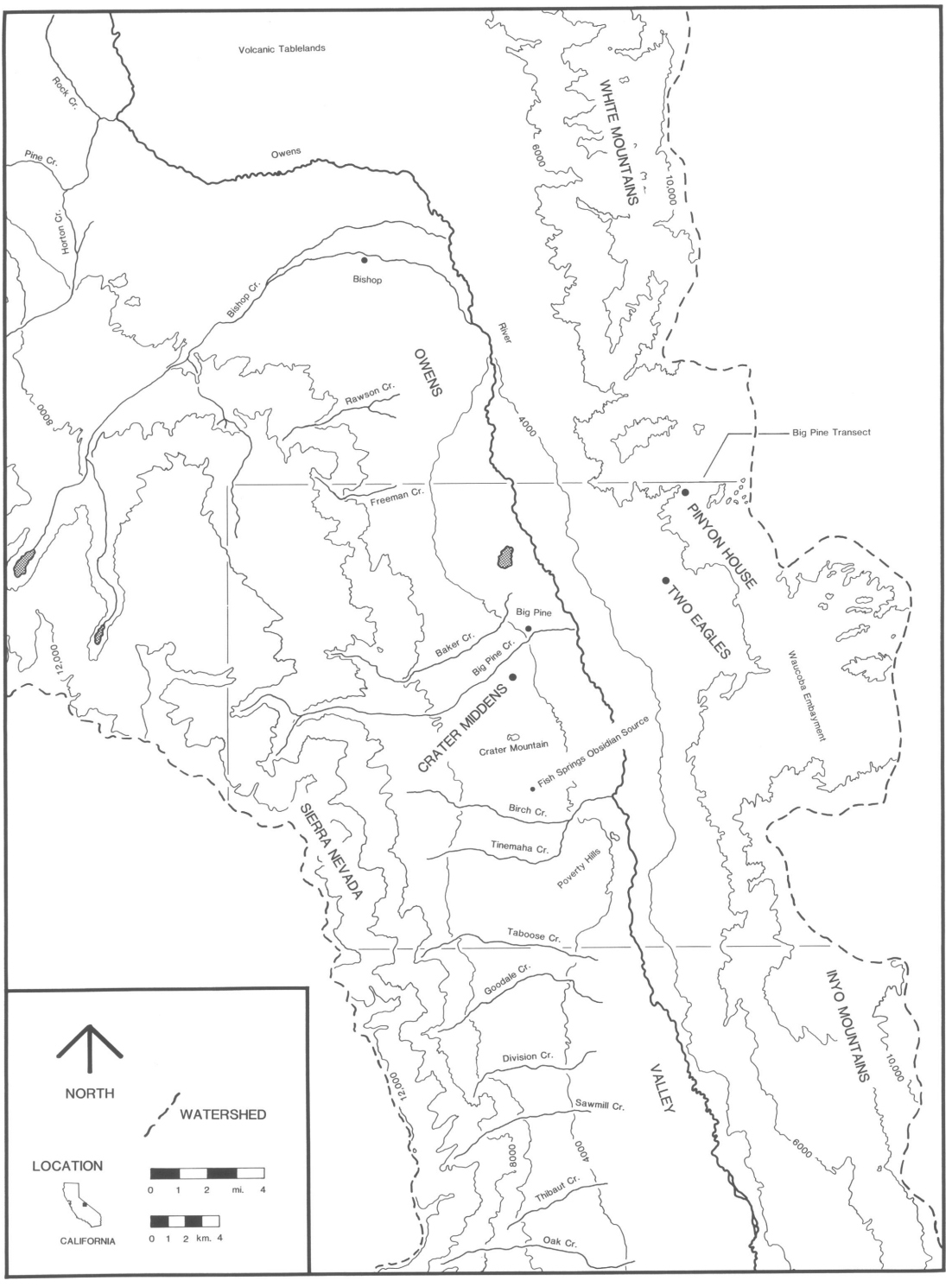

Fig. 1.1. Map of northern Owens Valley showing location of Pinyon House, Two Eagles, Crater Middens, and major geographical features mentioned in text.

TABLE 1.1
Correspondence Between Artifact Number and Provenience for Pinyon House

Artifact number	Provenience
O- 34 - 79	Surface
O- 80 - 126C	Structure 14
O- 127 - 210	Structure 1
O- 211 - 324	Structure 3
O- 325 - 347	Structure 4
O- 348 - 359	Structure 5
O- 360 - 383	Structure 10
N- 1	Surface
O-1172 -1288B	Surface
O-1289 -1299	Surface, north of main site
O-1301 -1541	Surface
O-1542 -1677	Structure 2
O-1678 -1709	Surface, Pinyon House South
O-1710 -1733	Structure 1, Pinyon House South
O-1759 -1760	Structure 1
O-1762	Structure 1
O-1765	Structure 3
O-1767 -1768	Structure 10
O-1778 -1784	Structure 1
O-1785 -1800	Structure 3
O-1801	Structure 4
O-1802	Structure 5
O-1803	Structure 10
O-1804 -1807	Structure 2
O-1808A	Structure 1, Pinyon House South
O-1808B-1810	No provenience

TABLE 1.2
Correspondence Between Artifact Number and Provenience for Two Eagles

Artifact number	Provenience
O- 1 - 8	Surface
O- 9 - 15	Structure 10
O- 16 - 32	Structure 2
O- 33	Surface
O- 809 -1065	Surface
O-1066 -1067B	Structure 3
O-1068A-1068B	Structure 6
O-1069 -1152	Structure 8
O-1153 -1157	Structure 9
O-1158 -1159	Structure 15
O-1160A-1160B	Structure 17
O-1161 -1163	Structure 19
O-1164 -1168B	Structure 21
O-1169A-1169B	Structure 23
O-1170	Structure 9
O-1171	Off-site: surface
O-1734 -1756	Structure 8
O-1758	Structure 2
O-1769 -1776	Structure 2
O-1811 -1815	Surface

and late occupational debris. Thus, deep midden deposits are disproportionately well represented in the Crater Middens sample, though not to the exclusion of samples from shallower parts of the deposit. In addition, at Crater Middens an explicit goal of the excavation strategy was to maximize the total number of sample units and by this means increase the possibility of recognizing on statistical grounds potentially important stratigraphic variations in the contents of the deposit that might go unnoticed with a smaller sample. Apart from its scientific merits, the latter seemed justified on the grounds that excavation draws unwanted attention to archaeological sites and often results in subsequent depredation by vandals and souvenir hunters making further research impossible.

Excavation procedures, the retrieval of cultural materials, and the extraction of carbon and flotation samples were the same at all three sites. All structures were excavated in natural levels, except that individual depositional units greater than 10 cm in thickness were excavated in arbitrary 10 cm levels. All squares, either 1 × 1 m or 2 × 2 m, were excavated in arbitrary 10 cm levels, there being no obvious physical stratigraphy in the midden deposits sampled at Crater Middens, the only site where a subsurface deposit was present and thus the only site where squares were employed. All excavated material was passed through ⅛ in. screens from which all cultural material, floral remains, and faunal remains were retrieved and bagged separately by excavation level and unit. All carbon occurring in pieces large enough to be useful in radiocarbon assays was collected. In addition, flotation samples of approximately 2 liters were extracted from nearly all excavation levels. These materials were processed at New York University between 1978 and 1980 and at the University of California, Davis, after 1980. The artifactual materials were accessioned under the designation *O*. Surface artifacts not collected but counted or measured in the field were accessioned under the designation *N*. The flotation samples were cataloged under the designation *F*, and the carbon samples under designation *C*. These

TABLE 1.3
Correspondence Between Artifact Number and Provenience for Crater Middens

Artifact number	Provenience
O- 384 - 502	Midden II: Structure 12
O- 503 - 555	Midden II: midden
O- 556A- 683	Midden III: midden
O- 684A- 720	Midden IV: midden
O- 721 - 731	Midden V: midden
O -732 - 769	Midden II: midden
O- 770 - 786	Midden II: surface
O- 787 - 798	Midden III: surface
O- 799 - 806	Midden IV: surface
O- 807	Midden V: surface
O- 808	Off-site: surface
O-1757	Midden II: midden
O-1816 -1819	Off-site: surface
O-1820	Midden I/II: surface
O-1821	Off-site: surface
O-1822A-1861B	Midden I: surface
O-1862 -1908	Midden I: Structure 3
O-1909 -1936	Midden II: surface
O-1937 -2054	Midden II: surface quadrat
O-2055 -2070	Midden II: surface
O-2071 -2080B	Midden II: surface quadrat
O-2081 -2142	Midden II: surface
O-2143 -2163	Midden II: surface quadrat
O-2164 -2216	Midden II: surface
O-2117 -2233	Midden II: surface quadrat
O-2234 -2246	Midden II: surface
O-2247 -2302	Midden II: Structure 7
O-2303 -2309	Midden II: surface
O-2310 -2379	Midden II: Structure 9
O-2380 -2445B	Midden II: Structure 10
O-2446 -3484	Midden II: midden
O-3485 -3518	Midden III: surface
O-3519 -3580	Midden III: surface quadrat
O-3581 -3600	Midden III: surface
O-3601 -3626	Midden III: surface quadrat
O-3627 -3629	Midden III: surface
O-3630 -3647	Midden III: surface quadrat
O-3648 -3658	Midden III: surface
O-3659 -3714	Midden III: surface quadrat
O-3715 -3718	Midden II: surface, Structure 13
O-3719 -4097	Midden III: Structure 16
O-4098A-4581	Midden III: midden
O-4582 -4745	Midden IV: surface
O-4746A-4952	Midden IV: midden
O-4953 -4965	Midden V: surface
O-4966 -4983	Midden V: midden
O-4984	Midden II: surface
O-4985 -4987	Midden III: surface

materials are now included in the collections of the American Museum of Natural History, New York, and are presently housed at the Department of Anthropology, University of California, Davis. As an aid in using the text and figures, tables 1.1, 1.2, and 1.3 indicate provenience for blocks of artifact numbers at each of the three sites treated here.

A further word of note is in order before proceeding. In the following discussion, radiocarbon dates are corrected for secular variation and reported as a 95 percent confidence interval expressed in calendar years (cf. Klein et al., 1982). Accompanying these calendar dates are the ages of the samples in radiocarbon years B.P. and the sample number. Obsidian hydration dates are similarly reported in calendar dates. All hydration rim (i.e., rind or band) measurements are for specimens of Fish Springs obsidian for which the tentatively proposed rate of hydration is: $Y = 800.3X - 831.2$, where X is the hydration measurement in microns (μ) and Y is the age of the sample in years B.P. (1950). Accompanying each hydration date is the corresponding rim measurement in microns and the University of California, Davis, Hydration Laboratory specimen number (OHL).

CHAPTER 2. PINYON HOUSE: NATURAL SETTING, ARCHAEOLOGICAL PROCEDURES, AND FEATURES

Rising abruptly from adjacent lowlands, the Inyo-White Mountains present a steep, wall-like front that looms over the eastern side of Owens Valley. The White Mountains, which constitute the northern half of this chain, achieve elevations in excess of 4270 m and are exceptionally rugged. To the south, the Inyo Mountains are lower and more gentle in topography, but still present a formidable barrier that is in places impassible.

Westgaard Pass, a narrow faulted gap used as an aboriginal travel route between Owens Valley and Deep Springs Valley to the east, marks the arbitrary division between the two mountain groups. The archaeological site of Pinyon House (fig. 2.1) is located on the south side of the pass, on a narrow, west-trending ridge that juts out midway down the face of a steep, west-facing slope.

The site consists of structural remains—two still standing, the others marked only by depressions or stone foundations, bedrock milling facilities, and an extensive scatter of chipped stone tools and waste, ceramics, groundstone, and lesser quantities of wooden implements and historic metal containers. These are spread over an area about 135 × 120 m, but chiefly concentrated in a shallow, troughlike depression between the main ridge on the site and a small promontory immediately to its south (fig. 2.2). This trough parallels the ridge, but instead of draining west with the strike of the ridge, drains east, deepens, and turns to the south as it passes between the small promontory and the steep mountain slope behind the site. A ditchlike trail passes through the northernmost portion of the site before dropping into the canyon of Westgaard Pass. It is evidently the route used by an historic wood cutter to skid pinyon logs to kilns that supplied local mine smelters with charcoal.

Two nearby archaeological localities are sufficiently close to the main Pinyon House site to suggest they might have been functionally related to it. One of these is Pinyon House South, located about 200 m downhill to the southwest. It consists of several features and a surface artifact scatter located within a narrow saddle on a ridge that is an extension of the small, hill-like promontory on the southern flank of the main Pinyon House site. Pinyon House South and its features are described separately in greater detail at the end of this chapter.

Also close enough to Pinyon House to raise the possibility of some connection is a sparse scatter of artifacts on a gentle west-facing slope located about 100 m north of the main site. The slope on which this scatter is situated is bounded on the north by a deep, steep-sided canyon on the rim of which, not far from the scatter, is a single petroglyph panel. A game

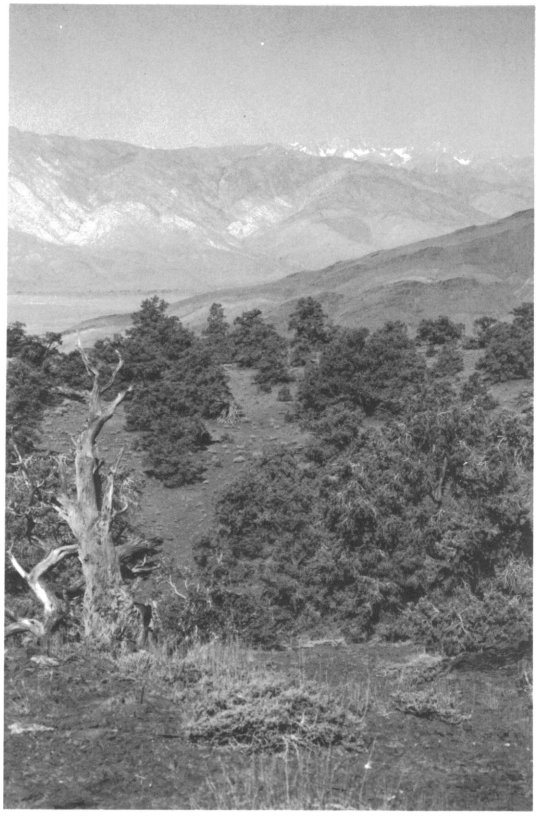

Fig. 2.1. View of Pinyon House from the east. The floor of Owens Valley is visible at the foot of the Sierra Nevada, which dominate background and skyline. Structure 14, a standing lodge, appears just left of the center of photograph.

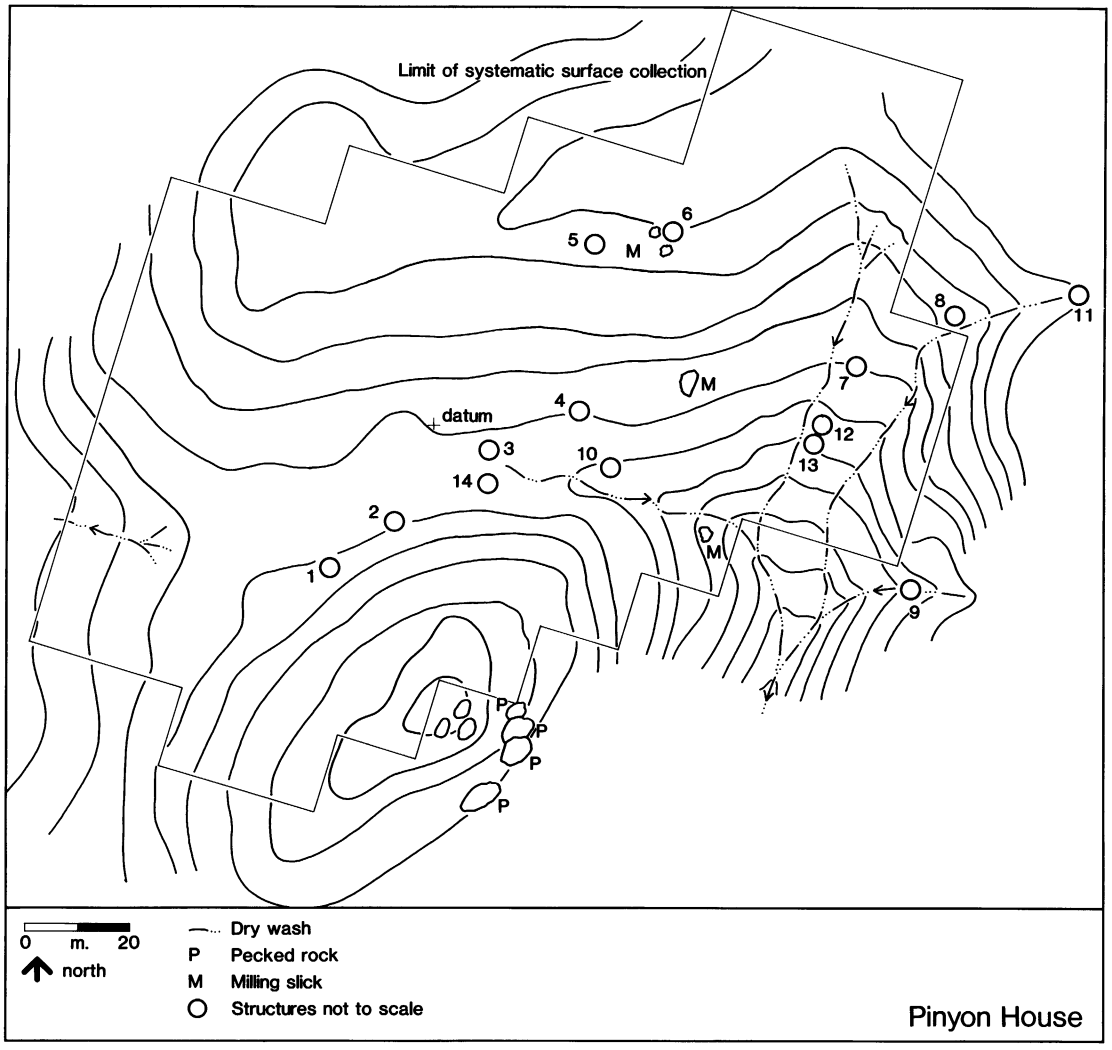

Fig. 2.2. Contour map of Pinyon House locating major features.

trail that apparently originates somewhere in the vicinity of the main Pinyon House site passes through the artifact scatter and into the canyon just east of the petroglyph panel. A description of the petroglyph and a sample of artifacts collected from this scatter are included here.

At an elevation of 2195 m, Pinyon House lies at the lower edge of the Pinyon Woodland community, expressed here as an overstory of pinyon (*Pinus monophylla*), with an understory of cliff rose (*Cowania mexicana*), mountain mahogany (*Cercocarpus intricatus*), mormon tea (*Ephedra viridis*), big sagebrush (*Artemisia tridentata*), bunchgrasses including needle grass (*Stipa speciosa*), squirrel tail (*Sitanion hystrix*), giant wild rye (*Elymus condensatus*), and an occasional cactus (*Opuntia* sp.). The upper edge of the desert scrub community is found only 200 m downslope from the site. It is sparsely vegetated, the major species being mormon tea (*Ephedra nevadensis*), menodora (*Menodora spinescens*), big sagebrush, and scattered bunchgrasses.

During the years we spent working at Pinyon House relatively few animals were sighted, among them deer (*Odocoileus hemi-*

onus), cottontail (*Sylvilagus* sp.), black tailed jackrabbit (*Lepus californicus*), and antelope ground squirrel (*Ammospermophilus leucurus*). In a more detailed survey of wildlife in the Inyo and White Mountains, Brosius et al. (n.d.) report the presence within the Pinyon Woodland of mice (*Peromyscus crinitus, P. maniculatus, P. truei*), woodrats (*Neotoma lepida*), pocket gophers (*Thomomys monticola*), chipmunks (*Eutamias* spp.), and golden mantled ground squirrels (*Spermophilus lateralis*). Numerous species of birds were also noted including dove (*Fenaidura macrourai*), mountain quail (*Oreortyx pictus*), and raven (*Corvus corax*). Undoubtedly, the faunal population would be richer in numbers and species were this site closer to water.

Despite its elevation, the site of Pinyon House, along with the entire Inyo-White Mountain range, receives very little annual precipitation, between 20 and 25 cm annually. Most of this falls as winter snow, but some is brought by convectional summer thunderstorms. Temperatures are moderately warm in the summer when the daytime maxima average near 27°C (July) and cold in the winter when daytime maxima average near 4°C (February).

In keeping with the aridity of this desert range, there are no water sources at Pinyon House, and to the southeast within the Inyo uplands proper none are to be found for another 30 km, although there is a reliable spring about 6 km to the southwest at the foot of the range. To the north, Batchelder or Toll House spring lies only 1.7 km away, but the trip to it requires a vertical descent of 427 m, which would be inconvenient were the spring to serve as the primary water source for the site during an extended occupation.

Marked topographic relief presents barriers to travel on virtually every side of Pinyon House. If it is assumed that pedestrian hunter-gatherers confine the bulk of their daily subsistence activities to an exploitation area the radius of which is defined by a 2-hour walk from their current base settlement (Vita-Finzi and Higgs, 1970; Lee, 1969; Steward, 1938a; Gould, 1969), and are capable of traveling about 5 km an hour in flat, unbroken terrain, and half that rate in steep or rough terrain, then the outer margins of the Pinyon House catchment would lie no more than 5 km from the site in every direction except northeast, where, owing to gentler slopes, it would be slightly more than 5 km. Overall, these spatial limits describe a catchment of some 70 km^2, of which approximately 50 percent is Pinyon Woodland and 50 percent Shadscale-Sagebrush desert scrubland.

ARCHAEOLOGICAL PROCEDURES

Pinyon House was located in 1972 during our probabilistic surface survey of Owens Valley. Two additional visits to the site were made that year and another in 1973. Based on these limited inspections, a preliminary report on the site, devoted primarily to a description of its standing lodge, appeared in 1975 (Bettinger, 1975b). In 1977, the author and Philip J. Wilke again traveled to the site, this time to collect tree ring samples that might help establish the age of the lodge. During the course of this visit, several previously unrecognized features were noted, one of them (cf. Structure 2) with associated projectile points dating between A.D. 600 and 1300, the period during which pinyon exploitation and, hence, the use of pinyon camps, was thought to have first begun in central Owens Valley (Bettinger, 1976). The apparent age of the site, in combination with its extensive archaeological assemblage, which encompassed virtually every artifact and feature category known to occur at pinyon camps in eastern California, made it the logical candidate for excavation when we designed a research program to test the model of Owens Valley human ecology developed from surface data.

SURFACE COLLECTION: As is the case for many Great Basin sites, the bulk of the cultural materials found at Pinyon House were surficial. Much of this had been disturbed during the 1600 years the site is now thought to have been occupied, but some material had clearly remained where it had been discarded, cached, or lost. This material was a major source of information regarding location and nature of aboriginal activities at the site, especially since the remoteness of Pinyon House had protected it from collection by amateurs. The problem was to design a surface collection that would yield basic data about spatial distribution of the surface as-

semblage, yet not be so time consuming as to curtail excavation. The requisite spatial control was provided by a grid system of 15 × 15 m squares, or quadrats, anchored at a central datum and oriented to magnetic cardinal compass points. This grid system was subdivided into four quadrants, NE, SE, SW, NW, defined by the cardinal compass points (fig. 2.3). Within each quadrant, the 15 × 15 m squares (quadrats) were individually numbered, 1 to *N*, beginning at the square closest the datum and proceeding in successive east–west rows.

In all there were 67 of these quadrats, 29 in the northeast quadrant, 10 in the southeast quadrant, 18 in the southwest quadrant, and 10 in the northwest quadrant. All artifactual material was collected from each numbered quadrat, except millingstones, which were only counted owing to difficulty of transport from the site.

Less elaborate methods of surface collection were used in four cases where circumstances seemed to justify them. First, a small pile of artifacts adjacent to Structure 14, apparently discarded by a recent relic seeker or hunter, was collected as a unit and not included as a part of the surface assemblage of the quadrat in which it was located. Second, a scatter of historic metal containers found near Structure 9 was located as a single group in 1977, prior to the establishment of the collection grid. As mapped at that time, they lay outside the grid system later established. Given the record of their provenience, the grid system could have been extended to include the area in which they were found, but as no other artifacts occurred there and the association of these containers with each other and with Structure 9 was clear, there was nothing to be gained by doing so. Third, the surface assemblage of Pinyon House South was collected without spatial divisions because the saddle on which it occurred was believed too small to be subdivided into units that would be meaningful analytically. Fourth, and finally, only formal tools and tool fragments were retrieved from the surface scatter north of the main site as it was felt that more intensive artifact recovery would not repay the effort involved.

EXCAVATION: There being no true midden in evidence, excavation was entirely confined to a sample of 7 of the 14 structural features present. In general, the same basic procedures were followed for all of them but adjustments were made when necessary to accommodate structural or depositional irregularities. In the main, these steps were also followed in excavating structures at Two Eagles and Crater Middens.

Initially, brush was removed by cutting within and around the feature and a center line was staked. This was made to run either magnetic north–south or east–west and bisect the feature, one end serving as its datum point; a separate datum stake was occasionally established. A second line was added, perpendicular to the first, intersecting it at the apparent center of the structure. The feature was then mapped and elevations relative to the datum point recorded.

Excavation began in a quadrant free of root or rodent disturbance and containing few protruding rocks—that is, an open quadrant where stratigraphic distinctions would most likely be preserved and most easily recognized. With one edge of the quadrant selected as a working face, trowel and whisk broom were used to peel the deposit down and back from this edge until a stratigraphic break was encountered. The excavated material was passed through ⅛-in. mesh screen from which all cultural materials and floral and faunal remains were retrieved and bagged separately by quadrant and level. Beyond this, considerable variation in procedure was needed to expose intact living surfaces to fullest advantage. Generally, if the first stratigraphic contact was poorly defined or appeared natural, as opposed to cultural, excavation might continue in the same quadrant until a second stratigraphic break was encountered, the material from the second unit being kept separate from the first. This cycle might be repeated until sterile, subsurface deposit was reached. More commonly, if the first stratigraphic break in one quadrant was unpromising, excavation would turn to one of the other quadrants with the idea that an identifiable surface might be found. This was also done to determine whether a potential living surface encountered in the first extended into any of the remaining three. If no suitable sur-

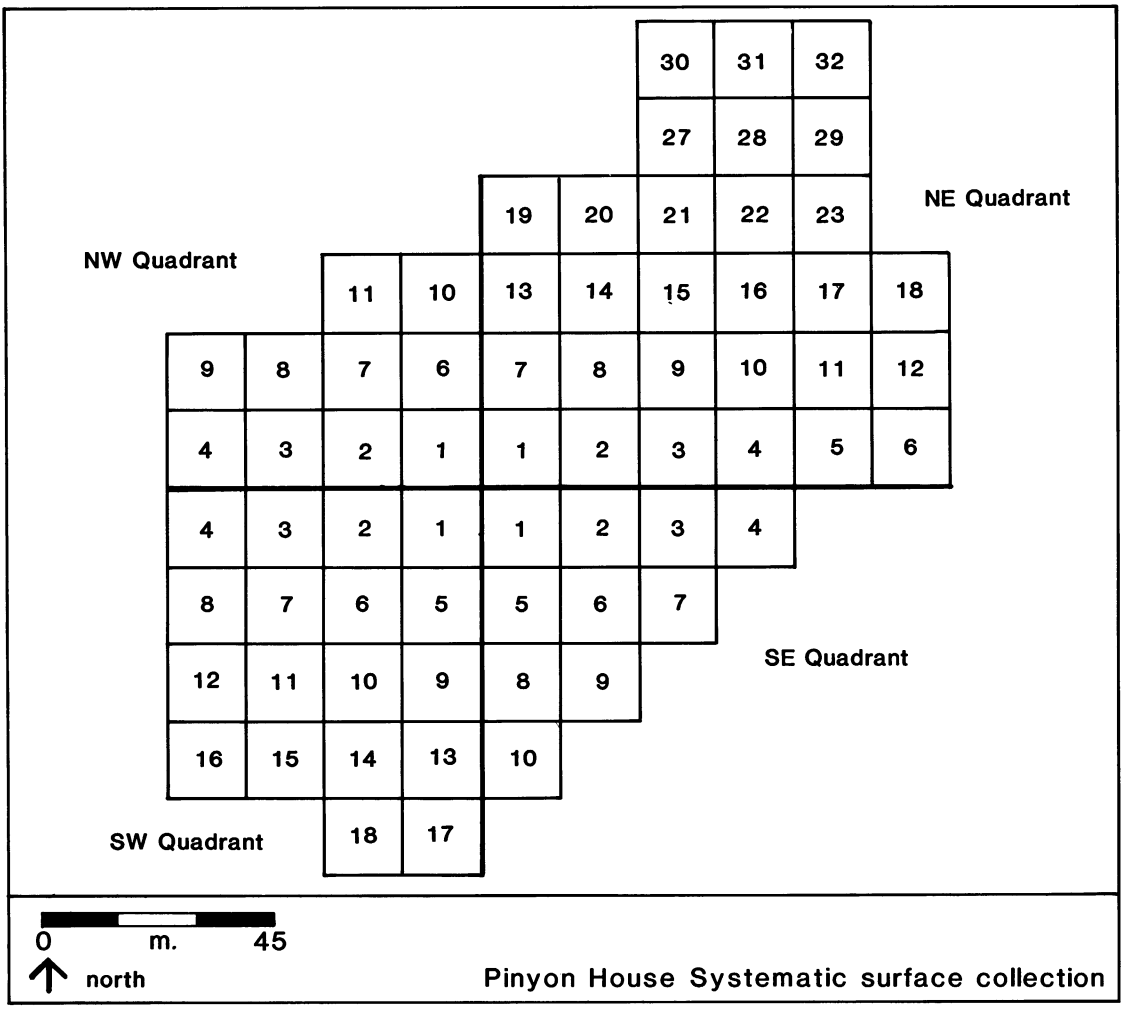

Fig. 2.3. Surface collection grid system used at Pinyon House.

faces were found in the first two quadrants, excavation might either proceed further in these areas until sterile deposits were reached or begin in one of the remaining quadrants.

At Pinyon House—and this is essentially true of Two Eagles and Crater Middens—no discrete floors were encountered in any of the excavated structures. Recognizable stratigraphic breaks and well-defined features such as hearths and beams extending into two or more quadrants, however, were relatively common. The reasons for this are explored in the discussion pertaining to Structure 14.

SURFACE FEATURES

Surface features at Pinyon House are of three kinds, petroglyphs, bedrock milling facilities, and structural remains.

PETROGLYPHS: A single petroglyph panel, 70 × 70 cm, comprising abraded, pecked, and scratched elements is located about 150 m northeast of the site on a cliff overlooking a steep canyon (fig. 2.4). Five abraded glyphs executed in the Great Basin Rectilinear abstract style (Heizer and Baumhoff, 1962) dominate the panel. Two are sets of paired

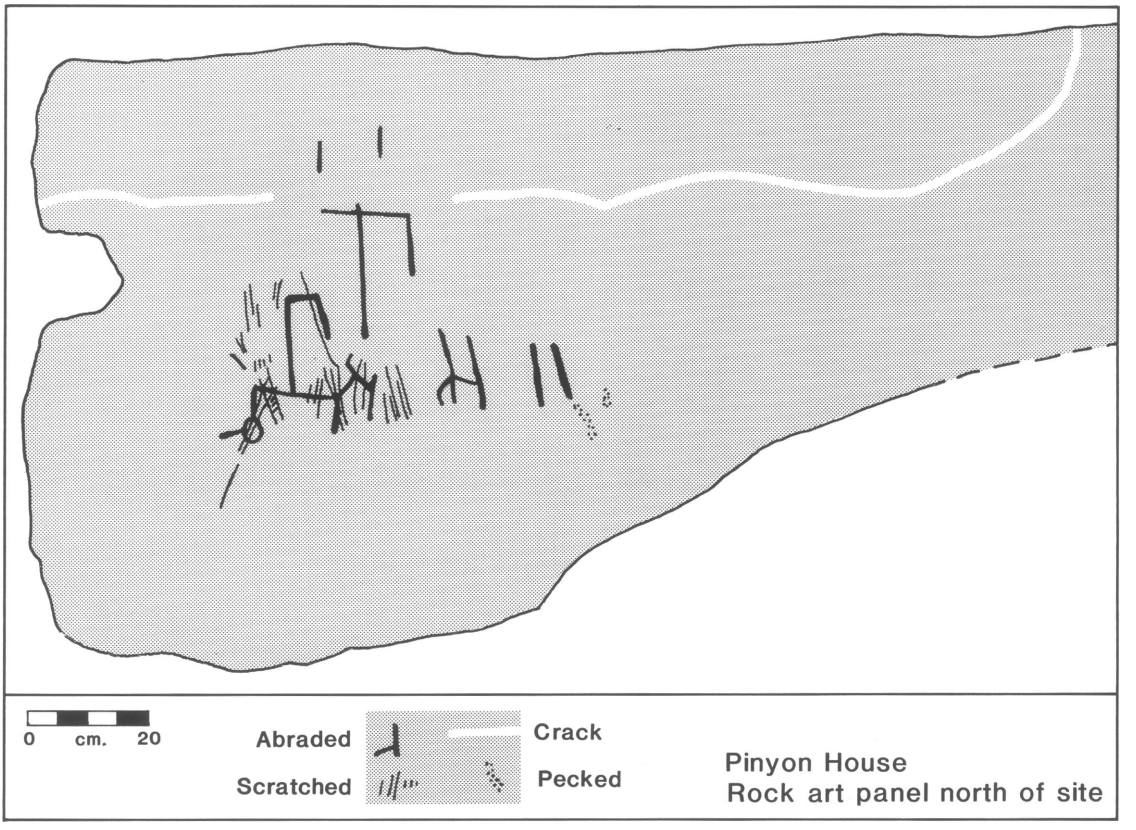

Fig. 2.4. Rock art panel associated with small artifact scatter north of the main site of Pinyon House.

straight lines, and three are more complex designs. Pecking is confined to a short, lightly pecked line extending down from the base of one of the paired line elements and a small, pecked area directly adjacent to this. Scratching takes the form of numerous light parallel lines superimposed over the largest of the three complex rectilinear elements, apparently to obliterate it. Von Werlhof (1965) has recorded many rectilinear and curvilinear petroglyphs with superimposed scratched elements in Owens Valley (cf. von Werlhof, 1965: figs. 1k, 11l, 20b, 26i). Closer by, Bettinger (1975a: 143–144) has described a similar petroglyph panel in the Inyo Mountains about 19 km south of Pinyon House. It consisted of a single Great Basin Curvilinear element with a superimposed scratched grid.

Great Basin rock art continues to defy precise dating, but as rough estimates Heizer and Baumhoff (1962) have placed the Great Basin Curvilinear style between 1000 B.C. and A.D. 1500, the Great Basin Rectilinear style between 0 B.C. and A.D. 1500, and the Great Basin Scratched style between A.D. 1000 and very late prehistoric times.

The Pinyon House rock art probably predates use of the site as a pinyon camp, however, Heizer and Baumhoff have also argued that Great Basin rock art is a form of hunting magic executed in locations favorable for the procurement of game and therefore generally some distance from contemporaneous occupation sites. The location of this panel on a cliff face near a game trail passing through Pinyon House and into the canyon north of it is consistent with this interpretation. Hunting in this spot, however, would be out of the question when Pinyon House was occupied during the fall pinyon harvest, the season in

which the trail is most heavily traveled by game. Because Pinyon House was used as a pinyon camp more or less continuously after A.D. 300, the location must have been used as a hunting stand prior to that, its function shifting sometime thereafter to pinyon procurement. If this argument rings true, then the rectilinear rock art at Pinyon House probably dates before A.D. 300, when the site was apparently first used as a pinyon camp. With regard to the scratched elements, it is relevant that Bettinger and Baumhoff (1982) interpret the Great Basin Scratched style as Numic ritual magic designed to cleanse or vandalize Prenumic hunting sites and petroglyph panels. This might explain its apparently intentional superpositioning over earlier elements at Pinyon House. The same possibility applies to the Inyo Mountains rock art site previously reported by Bettinger (1975a), which also occurred in an area where pinyon exploitation replaced earlier hunting activity. It is not clear whether the scratched elements at Pinyon House are associated with earlier use of the site for hunting, which would indicate the presence of Numic—more precisely, protowestern Numic—hunting parties before A.D. 300, these same peoples later using the site for pinyon procurement. The alternative is that the scratched elements are later than A.D. 300, which would suggest that the function of the site shifted from hunting camp to pinyon camp prior to or, what seems more likely, with the appearance of protowestern Numic folk, who, when they made first use of the site, for some reason felt compelled to disfigure the rock art, which stemmed from an older occupation.

BEDROCK MILLING FEATURES: As is true of portable milling equipment at the site, identifiable bedrock milling features are rare at Pinyon House. Only four examples were noted, all lightly ground slicks. Three of these are associated with Structure 6, of which one is an oval grinding area measuring 40 × 25 cm on a low slab south of the feature; the other two are slightly smaller grinding slicks, one 25 × 25 cm, the other 25 × 15 cm, on a shale slab west of the feature. The fourth grinding slick measures 50 × 40 cm and is located on a bedrock outcrop in quadrat NE9. The roughness and natural cracks of all these bedrock features would make them unsuitable for small seed processing, but they would serve well for pinecone pounding, pine nut cracking and hulling, berry pulping, and berry pit cracking.

PROBLEMATIC BEDROCK FEATURES: In addition to reliably identified milling surfaces, there are numerous other bedrock features that may also have been used for this purpose. These include a single feature in quadrat SE4 and a large complex of features roughly 30 m southeast of the limit of the site as defined by its chipping scatter.

The feature in quadrat SE4 is a lightly ground surface, 40 × 20 cm, which bears evidence of both pecking and scratching. The pecking is concentrated in only a few areas, in one spot piercing the partly exfoliated shale slab that caps this outcrop. The slab is cracked and shows evidence of spalling in several other places but it is not clear whether this is the result of pecking or weathering. The surface is somewhat eroded but the scratching appears to be more or less distributed haphazardly over most of the slab surface as zigzags, parallel lines, or seemingly random marks. In some cases it appears that the grinding is superimposed over the scratched designs but this is uncertain. Were it not for the scratching, there would be no difficulty in identifying this feature as a milling surface of some kind, perhaps for threshing pinecones. Given their presence, however, some alternative possibilities should be mentioned. For one, it may be that the grinding and pecking were attempts to deface what was once a Great Basin Scratched rock art panel; were this the case, the defacement would probably have been more complete. Alternatively, the grinding and scratching may have been in some way related to plant processing performed here and the pecking an attempt to detach the working surface for use elsewhere. Two similar scratched and ground slab fragments interpreted as millingstones recovered elsewhere on the site—one in square NE3 (O-1207), the other in Structure 1 (O-135)—lend some support to this interpretation. The specific nature of the activity represented by these objects is uncertain but it may be that both the bedrock and portable examples were milling slabs periodically scratched to rejuvenate the grinding surface; rejuvenation of millingstones is well documented in the Great

Basin, but was ordinarily accomplished by pecking. The patterned scratching may have been an esthetic elaboration of this task.

The large complex of bedrock features south of the site consists of 35 individual pecked surfaces distributed between 10 separate bedrock slabs and boulders. As a group the outcrops overlook the steep canyon that is the downstream part of the dry channel that runs through the center of the site. Some of the pecked surfaces were located atop boulders that can be scaled only with difficulty. A total of 15 of these are relatively small, averaging about 6 cm in diameter, and roughly circular in outline; the remainder are without obvious shape and range in size from about 5 to 10 cm. This pecking may mark locations where pinecones were threshed or pine nuts cracked and shelled, but their placement well away from the site and the presence of two on horizontal boulder faces militate against such an interpretation. Neither would it appear that they are a form of rock art; the execution is casual at best, although they bear some resemblance to the Pit and Groove style (von Werlhof, 1965). The possibility remains that these features are related to animal procurement that occurred at the site. It may be that large ungulates, deer, and mountain sheep were driven up the canyon along which these outcrops are situated and into a corral or line of waiting hunters situated at the head of the canyon near the east end of the site. If so, then perhaps individuals acting as hazers were stationed at these outcrops to turn escaping animals back into the drive line by shouting and pounding rocks on the outcrops.

STRUCTURES

The assemblage of structural features at Pinyon House is both large and diverse, the 14 structures present falling into three broad categories: standing structures (two examples), rock rings (five examples), and structural depressions (seven examples). The category of standing structures is further divided into lodges and windbreaks, each represented by a single example, and the category of rock structures into rings, of which there are four, and dams, of which there is only one. Structures were numbered from 1 to 14, without regard to category. Their location is shown in figure 2.2.

Standing Structures

Lodge (Structure 14): The Pinyon House lodge has been previously described in a preliminary report (Bettinger, 1975b). It stands roughly 2 m high, is approximately conical in shape, and generally circular in ground plan, though the eastern side is distinctly flattened, possibly to facilitate entry along that wall through an opening 35 cm wide on the north side of the structure (fig. 2.5). The interior diameter is 3.0 m east–west, 2.5 m north–south, the area enclosed being 6.6 m^2. It is constructed entirely of pinyon limbs, more than 90 in all, varying from ½ to 2 m in length. Many of these limbs have been axe trimmed at the base or along the stem by the removal of secondary limbs, particularly those that would have projected inside the structure. Principal structural support is provided by two large forked beams, a longer one on the north side, its base resting partly on a flat rock possibly provided for support, and a shorter one on the south side. Both forked beams lean inward and are bridged by a single log that tilts 45° from horizontal as it runs from the crotch of the short beam to the crotch of the long one. Numerous other beams lean inward from around the perimeter of the structure to provide support for the longer forked beam and the ridge beam. This basic framework was supplemented by the addition of other limbs placed to fill the larger gaps in the exterior of the structure. The forked beams, perimeter supports, and covering beams all appear to rest on the natural ground surface rather than being set into a dug trench or individual holes.

Prior to excavation, the floor inside the structure was thickly matted with pine needles and cone debris. Excavation consisted of little more than removing this duff layer to expose a loosely compacted dirt surface interpreted as the structure floor. Cramped quarters inside the structure precluded accurate measurement of elevation, but the surface is gently saucer shaped in contour, apparently the result of natural accumulation of debris at the base of the perimeter beams rather than intentional excavation of the in-

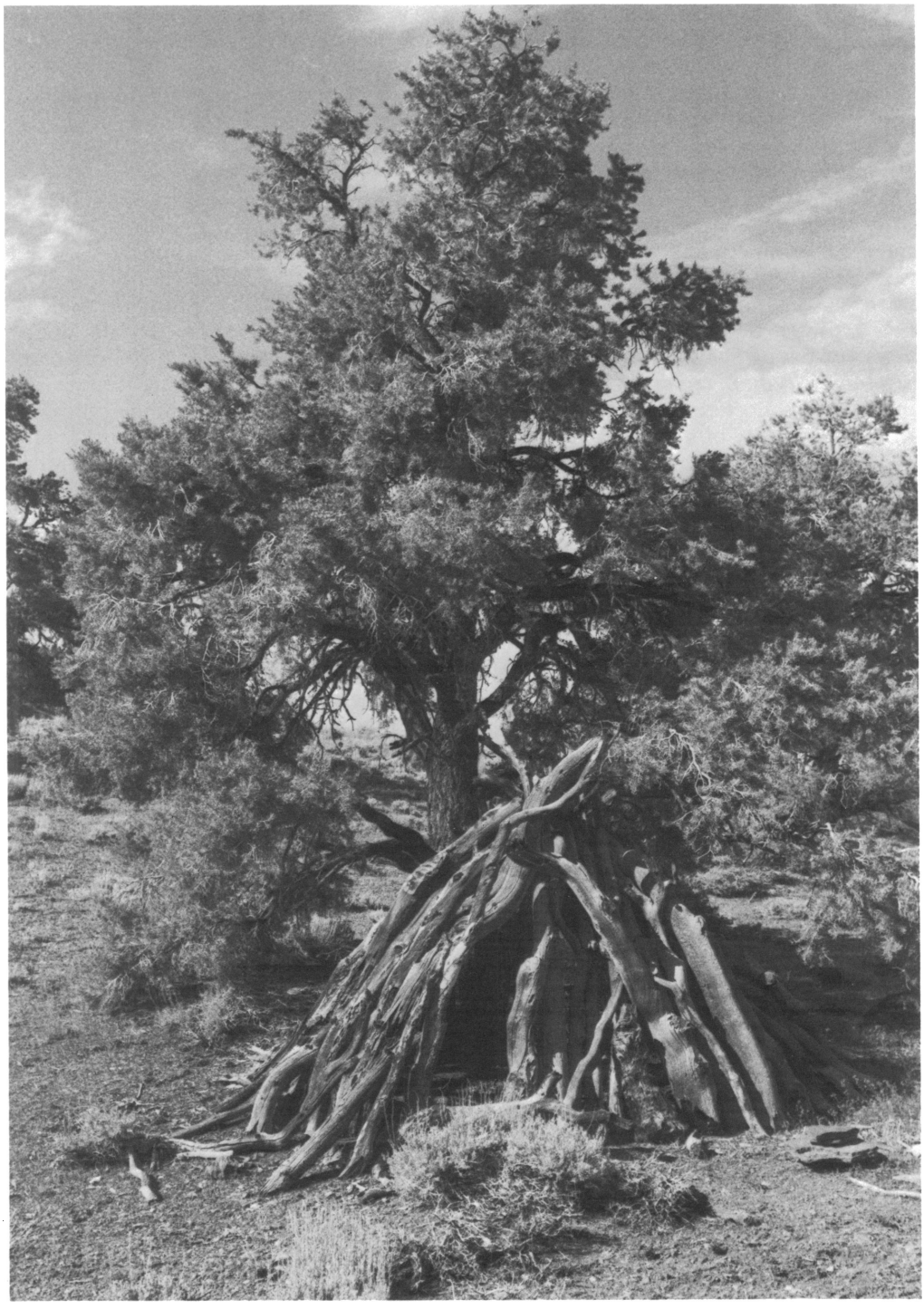

Fig. 2.5. Structure 14 (standing lodge) at Pinyon House. Note doorway visible in the center of the structure and possible millingstone cache to the right at the base of the structure. View is to south. Photograph courtesy of J. Stuart and Journal of California and Great Basin Anthropology.

terior. Although this surface lacks the compaction that might be expected of a floor in a domestic structure, two features associated with it, a grass bed and a large hearth, leave little doubt that it is a living floor.

The grass bed occupies the outer margin of the southwest quadrant, extending between 40 and 60 cm inward from the base of the perimeter beams. It consists of two distinct mats, the lower confined entirely to the southwest quadrant, the upper entirely overlapping the lower and extending beyond it into the northwest quadrant of the feature. Both mats consist of tightly packed bunches of squirrel tail (*Sitanion* sp. probably *S. hystrix*) apparently collected, roots and all, by hand from the vicinity of the site. The lower mat is considerably more compacted and worn in appearance than the upper, which was evidently added when the lower bed had lost its loft. This might have been done during a single extended occupation, for example a winter-long stay, or when it was reoccupied after a period of disuse, for example after a summer spent in the lowlands (fig. 2.7).

The hearth is located immediately to the west (right when entering) inside the inferred doorway, which may have acted as a smokehole for the structure as there is no opening suitable for this purpose in the roof. When in use, the hearth would have obstructed direct access to the center of the structure and, as suggested earlier, entry was probably along the eastern wall, the linear configuration of which appears intentionally designed to permit passage around the hearth when passing into the structure. The hearth itself is bowl-shaped, measuring 70 cm in diameter and 12 cm in depth, and filled with gray-white ash intermixed with occasional lumps of charcoal. The surrounding soil matrix has been oxidized to a deep brick red, or terra cotta, color. When subjected to water separation, a flotation sample (F-7) of the hearth fill yielded charred shells of pinyon pine nuts.

Very few artifacts were found in the structure. These included small fragments of cotton cloth, a piece of willow that may represent a basketry element, a biface, two roughouts, a point blank, two unifaces, a bit of worked bone, and a few scraps of chippage that may well have been deposited on the site surface prior to the construction of the structure.

Hydration rim measurements on two obsidian flakes recovered from the structure fill indicate calendar dates compatible with the recency of the structure implied by its state of preservation, by its axe-cut limbs, and by the historic items found within it: A.D. 1740 (1.3 μ; OHL 857) and A.D. 1661 (1.4 μ; OHL 858).

In its use of forked beams to support a ridge pole, this standing structure resembles the gabled winter mountain house described by Steward (1933: 263) for the historic Owens Valley Paiute; it lacks, however, the eastern doorway, central roof smokehole, and interior forked support placement that together distinguish the gabled house. It more closely approximates the ethnographic conical lodge, the short forked support and steeply pitched ridge pole working in effect as a composite perimeter beam and the long forked support acting to lock the main perimeter beams together. It does, however, lack the central roof smokehole that is typical of the conical house form (Steward, 1941: 283), but the location and size of the hearth are approximately the same. Both the gabled house and the conical lodge are recorded as having been thatched with either pine sod or pine boughs; the pine duff covering the floor of the lodge may represent the remnants of such a roof. The grass bed at the rear of the lodge is undoubtedly a seating and sleeping area, grass or brush being used for these purposes in all ethnographic house types (Steward, 1941: 284). The location of the bed opposite the doorway is likewise consistent with ethnographic accounts, which designate this spot as a position of honor, being the least subject to drafts and smoke (Steward, 1933: 263).

The above description is based on observations made in 1978 and it is worth noting that between 1973 and 1976 an unknown party made several alterations in the structure; a central interior support beam was removed and a collapsed portion of the southern wall was repaired. Close comparison of photographs taken in 1973 and 1976 also revealed the addition of several limbs to the structure exterior. Aside from the removal of the interior support, an element more typical of the ethnographic gabled house than the conical lodge, these alterations do not appear to have changed the basic design of the structure.

During the same period a stack of three

shale slabs intermixed with fragments of a glass bottle were also tampered with by the addition of several bottle fragments, probably collected from the surrounding area, and by the repositioning of the shale slabs. Together, the three slabs were interpreted as a millingstone cache in 1973, but their disturbance between 1973 and 1976 raises the possibility that this small rock feature is of very recent (postaboriginal) origin, perhaps a hunters table, and that the light wear on two of them is not due to grinding use but to their having been occasionally piled and used in this manner.

Despite its recent disturbance,the lodge is certainly aboriginal. The floor plan, structural design, and interior furniture are consistent with ethnographic accounts and the thick pine duff layer covering the living floor demonstrates at least minimal antiquity. The available evidence points to its use for sleeping and possibly eating and cooking, probably by a family-size group since its interior is not spacious. The interior hearth and relatively elaborate structural design suggest extended occupation in the winter or fall and winter, as more transitory residence or use in summer would not require these accommodations.

Two additional characteristics of this archaeological feature are instructive for the interpretation of other less well-preserved features. First, the living floor of this structure is not well marked except by its contact with the overlying pine duff; had it been covered instead by slopewash it is unlikely that we would have recognized it as easily. This stratigraphic invisibility is probably due to the use of a grass floor covering, possibly in combination with plaited mats. The general use of such floor coverings in prehistoric times may account for our regular failure to expose discrete floors in the structural features at any of the three Owens Valley sites that were excavated.

A second point regards the absence of artifactual remains associated with the feature. If we take this lodge as representative of aboriginal structures in seasonal disuse or recently abandoned, then it would follow that much of the material found within the remnants of such features is debris that accumulated there long after they were in use and, except where there is obvious evidence of association, not items used, lost, or stored there.

WINDBREAK (STRUCTURE 7): A standing framework of four large upright pinyon limbs propped against the large horizontal limb of a live pinyon pine, apparently the remnants of a windbreak or lean-to, is located in quadrat NE17. The tree trunk and four limbs form a rude fence that runs 2.7 m north–south and leans to the west, providing a simple shelter that opens toward the main part of the site (fig. 2.6). The original outline of the associated living floor is marked by a thick mat of pine duff measuring 7.0 m north–south and 5.0 m east–west, covering an area of 29.9 m^2, which is entirely sheltered under the boughs of the large pine that supports the structure. Decayed brush concentrated near the edge of the mat evidently represents the remains of a low brush wall intended to provide shelter or privacy. The framework of limbs is set toward the eastern portion of the duff bed, leaving a larger area to the west, where most activities would have been performed. No evidence of a hearth was observed within the structure, which was not excavated.

All six artifacts found in association with the structure are of categories employed in pinyon procurement and processing (fig. 2.7). Three, however, are grinding implements—two slab millingstones, each used on both sides, and a bifacial mano—that may have been used to process foods other than pine nuts. The remaining three pieces are wooden implements used exclusively for cone collecting and threshing. Two are parts of two different composite pinyon hooks and one is a crudely shaped paddle, probably a cone beater.

Although the windbreak is sheltered by tree boughs overhead, it was probably intended for a purpose different from that served by roofed lodges at the site, perhaps a temporary residence or as a specialized activity area, possibly for pinecone processing. Steward (1941, 1943) and Stewart (1941, 1942) documented the use of roofless brush windbreaks and roofed shades left open on one or more sides at temporary camps and summer settlements by nearly all Numic groups, including the Owens Valley Paiute; they record no structure type that closely resembles this lean-to, however. A variety of standing open sided structures, roofed and unroofed, have been

Fig. 2.6. Structure 7 (standing windbreak) at Pinyon House. Note remnants of sagebrush wall and four standing limbs that, in addition to the main tree trunk, compose the windbreak. Millingstones are visible behind and directly in front of the standing limbs. View is to east.

located during archaeological surveys in western Nevada (Fenenga, 1975) and eastern California (Wallace and Taylor, 1955: 359); no two of these are exactly alike and none duplicates the one at Pinyon House. It would appear that the construction of temporary structures followed no fixed pattern but was improvised according to the materials available, the nature of the local terrain and vegetation, and the needs of the builder. The same observation probably applies to aboriginal construction of roofed structures, though in lesser degree.

Structural Depressions (7 Examples; 5 Excavated)

There were seven structural depressions: Structures 1, 2, 3, 4, 10, 12, and 13. Because subsurface testing quickly made it clear that these, and not rock rings, represented house remains at the site, all but two were excavated. The five excavated examples varied in size, shape, and floor plan, but each one exhibited a well-defined hearth containing pinyon charcoal, usually surrounded by heavily oxidized soil, and a red-brown or brown floor stain probably resulting from the gradual incorporation of ash, charcoal, decayed grass bedding, and other debris into the underlying soil during occupation. All five excavated structural depressions are interpreted as the remains of either conical lodges or gabled houses. In addition to floor stains and hearths, Structures 1, 2, and 10 contained concentrations of charred sagebrush and pinecone debris. Superficially resembling hearths, these lenses are shallower and burned at temperatures too low to oxidize the surrounding earth. They are interpreted as pinecone roasting hearths placed in these depressions after the structures that originally occupied them had been abandoned.

Structure 1: Structure 1 was a circular surface depression 5 m in diameter and 10 cm in depth. Located on the boundary between quadrats SW5 and SW9, it is the westernmost structure on the side. Only the

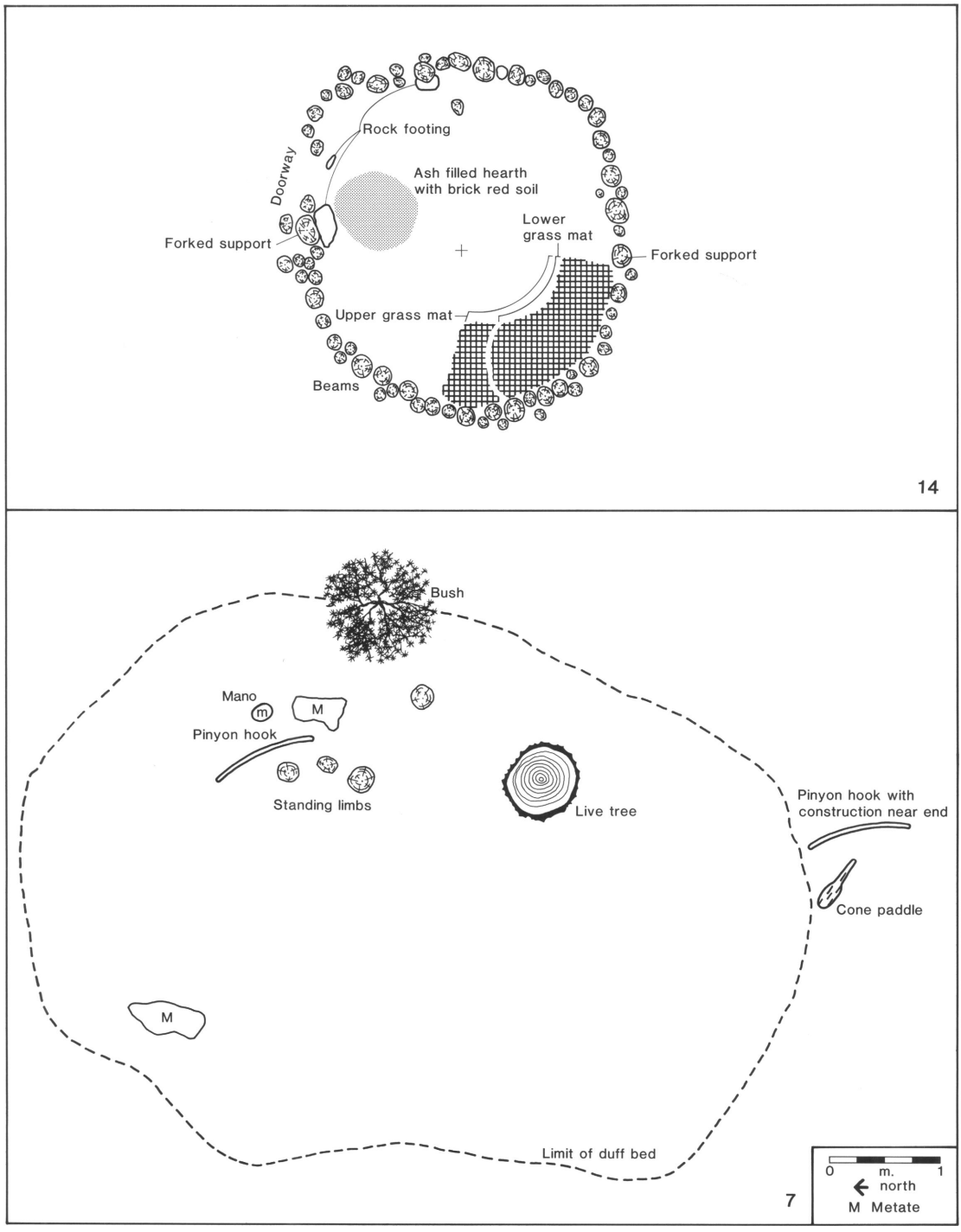

Fig. 2.7. Floor maps of Structures 14 (standing lodge) and 7 (standing windbreak) at Pinyon House.

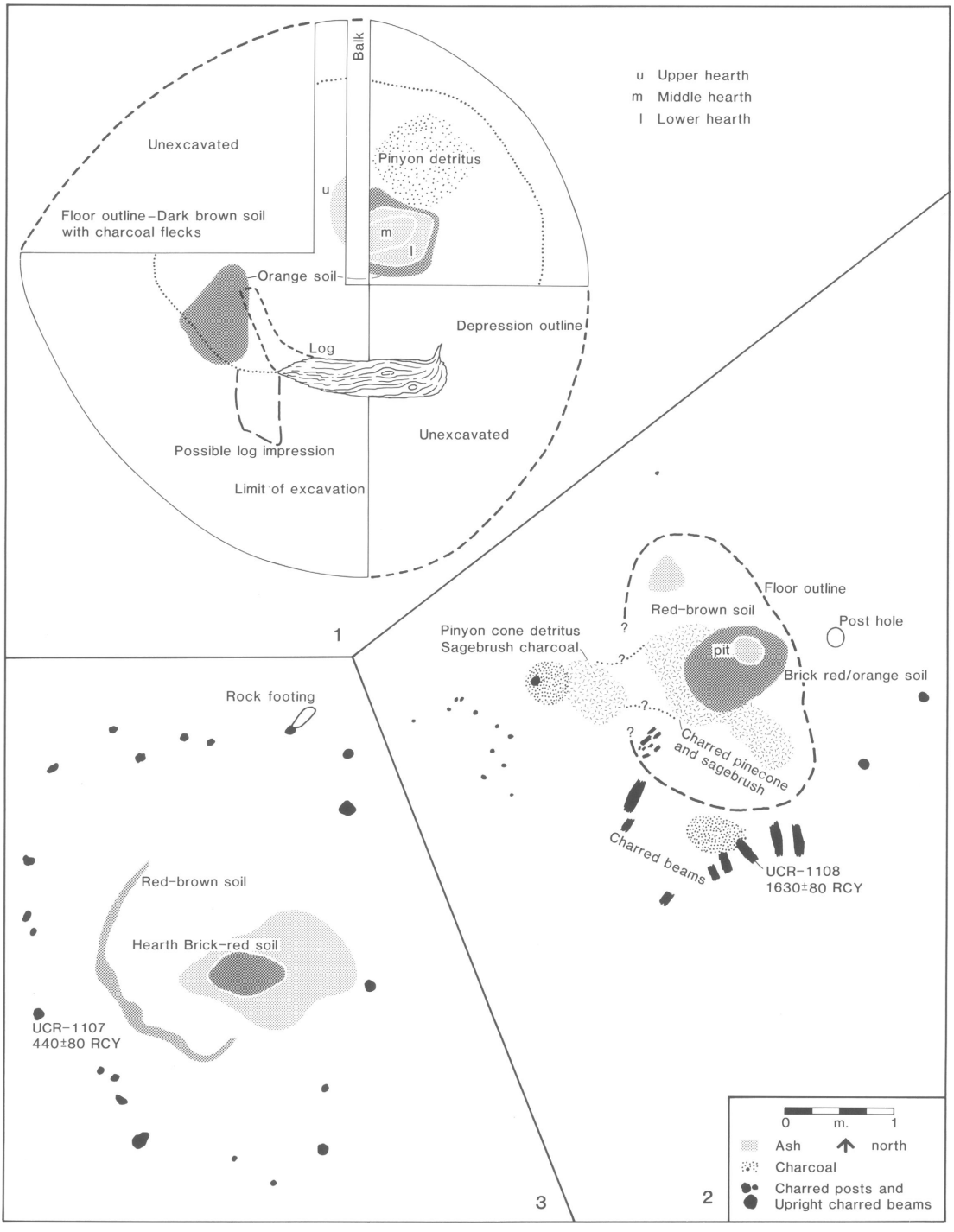

Fig. 2.8. Floor maps of Structures 1, 2, and 3 (structural depressions) at Pinyon House.

northeast and southwest quadrants of the structure were fully excavated. The southeast quadrant was left entirely intact and exposure of the northwest quadrant was limited to two trenches, each 30 cm in width, one placed adjacent to a balk between the northwest and northeast quadrants (fig. 2.8). These limited excavations proved sufficient to disclose the basic nature of this complex feature.

The main depositional unit in Structure 1 is a dark, charcoal-flecked, brown soil that, except for a thin layer of loose surface debris, fills the depression from its modern surface to sterile subsoil. This is thought to mark the limits of the living floor associated with the structure and to have accumulated during its occupation. This unit was recognized in the northeast, northwest, and southwest quadrants, and no doubt extends into the unexcavated southeast quadrant as well. The unit is displaced slightly north and east within the depression it occupies and measures 2.5 m north–south and 3.5 m east–west, covering an area of 7.6 m^2. It thickens gradually from less than 4 cm at the southern margin to 21 cm near the northern margin, where the unit rises abruptly along the side of what is apparently an excavated housepit. This steep-faced excavation is confined to the northern quarter of the structure. Elsewhere, the fill unit is saucer shaped in contour, pinching without obvious break between sterile soil and loose surface debris.

In the northeast quadrant, the fill unit is interrupted by two features. One is a set of three superimposed ash lenses—designated *upper, middle,* and *lower*—subtended by a zone of oxidized orange soil. Together these cover an area 115 cm in maximum diameter near the center of the fill unit. The multiple ash lenses and the area of oxidized soil upon which they rest extend completely through the central portion of the fill unit, interdigitating with it, and probably represent a hearth in use during the interval in which the fill unit accumulated. A flotation sample (F-8) recovered from this ashy deposit yielded a charred pinecone scale and a few small, unidentifiable seeds. A charred fruit or berry (O-182) found in the lowest part of the fill unit in the northeast quadrant of Structure 1 may also derive from the hearth.

The second feature is a shallow pit, about 1 m in diameter and roughly circular in plan, filled with sagebrush charcoal and located just outside the hearth previously described. This pit is intrusive into the fill unit and is interpreted as a pinyon roasting feature emplaced subsequent to the use of the depression as a structure location. A charred pine nut (O-157A) and several fragments of nut shells (O-157B) found in the vicinity of the pit are probably residue from the roasting process. Two other charred pine nuts (O-195A, 209A), charred pinecone scales, and nut shells found at the same stratigraphic level but well outside this roasting feature may represent material that strayed from it or material from routine subsistence activities that took place in the structure that originally occupied this depression.

In the southwest quadrant an area of oxidized orange soil without associated ash or charcoal appeared at the base of the fill unit near its southwest margin. Its relationship to the other features in this depression is uncertain; possibly it marks the location of an older hearth not associated with the depression.

A large pinyon log rests partly on the ground surface in the southwest and southeast quadrants, its rotting remnants extending into the fill unit in the southwest quadrant directly adjacent to the problematic zone of orange soil. This may be a beam incorporated in a roofed structure or an associated windbreak. A soft depression just west of this log may mark the position of a second structural beam in a more advanced state of decay.

In addition to bone and stone tools and debris, Structure 1 yielded two Rose Spring Corner-notched points, a Rose Spring Contracting Stem point, a Cottonwood Triangular point, two *Tivella* thin disk beads, and a variety of historic items including numerous metal fixtures from a pair of Levi-Straus overalls, possibly discarded after having become excessively coated with pitch during the pinyon harvest. Pine nuts and nut hulls were also found throughout the fill unit. All the points were found on the surface of the structure or in the uppermost deposit, which limits their utility as chronological indicators, there being the possibility of fortuitous

association. The historic items were concentrated in the pinecone roasting pit, clearly dating this secondary feature to early historic times. The deepest portion of the fill unit, on the other hand, lacked any historic material, and produced two *Tivella* beads of a type regarded tentatively as Klondike phase markers in central Owens Valley. This suggests that the structure itself was first occupied prior to contact. This interpretation is supported by obsidian hydration rim measurements on two flakes from the lowest part of the fill unit. One of these suggests an apparent age of either 1300 B.C. or A.D. 1181 (5.1, 2.0 μ; OHL 859), that is, the piece was broken or reworked so that its two faces display hydration rims of different thicknesses. The other piece indicates a calendar date of A.D. 941 (2.3 μ; OHL 860). There is the possibility, however, that these are refuse from earlier occupations that became accidentally incorporated in the fill unit during or after the use of the structure. A handful of historic items found in the upper fill unit appear to have strayed from the roasting pit or been trampled into the deposit in historic times.

Although the data are limited, Structure 1 is probably either a roofed lodge or gabled house built over an excavated housepit and furnished with an interior hearth. The historic Owens Valley Paiute evidently did not use excavated housepits in conjunction with winter mountain houses (Steward, 1933: 263, 1941: 283), employing them only for winter valley houses and sweathouses (Steward, 1933: 264–265, 1941: 285). The winter mountain house of many other Great Basin groups, however, incorporates this attribute, so its presence is not surprising (Steward, 1941: 283). Alternatively, what little aboriginal excavation was noted may not represent a true housepit but merely an attempt to achieve more secure footing for the north wall segment. There is no evidence that the structure was destroyed by fire. It may have simply collapsed and had most of its beams scavenged for other structures. In any case, it was evidently built and abandoned in precontact times, after which the depression marking its former location was used as a pinecone roasting pit subsequent to European contact.

STRUCTURE 2: Structure 2 is a roughly circular surface depression slightly more than 4 m in diameter, reaching a maximum depth of 15 cm, 1 m north of center (fig. 2.8). Excavation revealed an oval floor stain 2.75 m long and 1.6 m wide, occupying an area of 3.5 m^2, its long axis oriented north–south. Its size and shape suggest a gabled house rather than a conical lodge. A large hearth preserved as an oval of oxidized red-orange soil more than a meter in maximum diameter is located slightly east of center within the floor stain. A small ash-filled pit 10 cm in depth in the eastern half of this hearth likely represents the fireplace last used within this structure. A flotation sample (F-10) from this small pit yielded a few seeds of *Atriplex lentiformis*.

A total of 12 charred pinyon beams and one posthole that together ring the south half of the floor stain are all that remains of a log superstructure destroyed by fire—either accidentally or intentionally, perhaps upon the death of an occupant. A radiocarbon assay on one of these beams indicated a date for which the corresponding 95 percent confidence interval in calendar years is A.D. 340 $\pm$ 255 (1630 $\pm$ 80 B.P.; UCR-1108). Evidently these structural remains were preserved by colluvial deposits washed from the hillside south and above the structure. Remains of the north half of the structure, on the other hand, were not similarly covered and therefore not preserved. In most cases, the orientation of the beams can be determined: the two beams along the east wall are upright, the five along the south wall run due north, and the four along the west wall (three so perfectly aligned that they are probably parts of the same beam) run northeast. The orientation of a single charred post set well west of the structure could not be determined.

If, as seems likely from the shape of the floor stain and the presence of a central hearth, these beams were once part of a gabled house, the five pieces along the south wall would have composed the end, or short wall, nearest the southern gable support. Assuming this is so, the position in which they were found is the one we would expect had the structure collapsed inward, falling to the north. The northeast orientation of the beams along the west wall fits with this interpretation as these structural elements were located near the southwest corner of the house where the original roofing beams would have run northeast

rather than due east as those beams in the middle of the south wall. The upright beams east of the structure and the beam of uncertain orientation west of the structure are equivocal with regard to the shape of this structure and the nature of its collapse. It is unclear whether the depression in which the beams are located was intentionally excavated, but this seems likely.

As was the case at Structure 1, the depression associated with Structure 2 was the location of much aboriginal activity subsequent to the destruction of the building that once stood there. There are two concentrations of charred sagebrush and pinecone debris, the smaller about 60 cm in diameter and located on the west edge of the depression, the larger bilobed in plan, 1.7 cm in length, and located squarely in its center. Both concentrations yielded intact charred pine nuts (O-1589, 1625, 1647, 1665), several of which were still embedded in a cone fragment (O-1675).

These two concentrations occur at essentially the same stratigraphic level and may represent a single large cone roasting hearth, the smaller concentration and the smaller lobe of the larger one being the remains of cones and debris raked from the large pile during cone processing.

In addition to the pinecone roasting feature, a small concentration of ash was noted superimposed on the north end of the floor stain. This may represent the remains of a grass bed consumed by the fire that destroyed the structure.

Nine typable projectile points were recovered during the excavation of Structure 2; one was Cottonwood Leaf, five Desert were Side-notched, two were Rose Spring, and one was Elko Eared. The Desert Side-notched points were concentrated in the vicinity of the smaller sagebrush and pinecone concentration, dating it between A.D. 1300 and historic times, the floruit for this type. The Elko Eared point was recovered well outside the floor stain and so provides no help in assessing the age of the structure. The Cottonwood Triangular points, which date between A.D. 1300 and historic times, and the Rose Spring points, which date between A.D. 600 and 1300, were stratigraphically mixed within the depression deposit and cannot be reliably associated with either the roofed structure or more recent pinecone roasting feature. The same is true of two shell beads, a Split-Punched *Olivella* (class D1) and a *Tivella* cylinder, both regarded tentatively as Baker phase markers in central Owens Valley, also recovered in this mixed deposit. The Rose Spring points and the beads, however, imply a maximum age of A.D. 600 for the structure, which is broadly consistent with the radiocarbon assay obtained from one of its beams. An obsidian hydration rim measurement on a flake recovered from the hearth area corresponds to a calendar date of A.D. 1501 (1.60 μ; OHL 872), which would suggest the structure was occupied at least this late in time, presuming, of course, that it is not unrelated refuse fortuitously incorporated in the deposit. A second flake (OHL 871) showed no visible hydration rim, possibly because of its exposure to fire.

STRUCTURE 3: The location of Structure 3 was denoted by an elliptical depression measuring 4.4 m north–south, 3.1 m east–west, and between 5 and 7 cm in depth, covering an area of 9.2 m^2 in all, situated on the common boundary between surface quadrats NE1 and SE1. Within this depression, buried beneath a shallow layer of loose surface debris nowhere more than 7 cm thick and pocketed with concentrations of ash and charcoal, were the remains of a large roofed structure, probably a gabled house (fig. 2.8). Despite its proximity to the ground surface, this proved the least disturbed and best preserved structure excavated at Pinyon House. The outline of the house is marked by 21 charred pinyon stubs set 5 to 7 cm into the ground, all but one oriented to the east; apparently these are the remnants of burned beams (fig. 2.9). The north and east walls composed by these beams are straight and perpendicular to each other so that the northeast corner of the structure is nearly square. The north wall beam nearest this square corner rests just inside a large rock possibly put there as a footing. On the opposite side of the structure, the west and south walls are curved, their beams together forming a more or less continuous arc from the northwest corner to the southeast corner of the structure. One of the west wall beams yielded an apparent radiocarbon age the 95 percent confidence interval for which is in

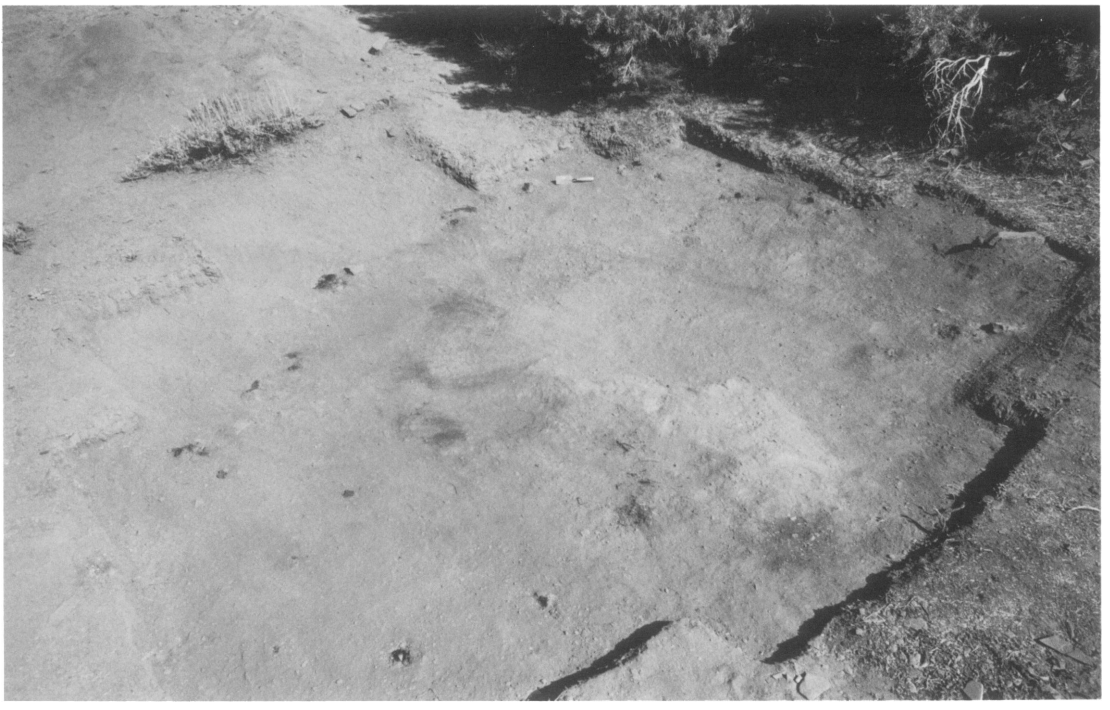

Fig. 2.9. Exposed floor of Structure 3 (structural depression). Note charred posts, curvilinear stain possibly marking charred edge of grass bed, and ash concentration marking hearth location near doorway. View is to northwest.

calendar years A.D. 1490 ± 150 (440 ± 80 years B.P.; UCR-1107).

A 1.5 m break in the east wall is probably the doorway. Just inside and south of this opening is a hearth area marked by a thick lens of gray-white ash, 160 cm long and 110 cm wide, within which there is a firepit, 70 cm long, 44 cm wide, and 35 cm deep, filled with ash and charcoal and surrounded by red oxidized soil. Water separation of a sample of the firepit fill (F-5) yielded about 20 seeds of *Eriogonum* sp. To the west of the hearth, further inside the structure, is a curvilinear red-brown floor stain that partly encircles the hearth area and opens toward the doorway in the east wall. This evidently marks either the singed edge of grass bedding placed at the base of the south and west walls or the margin of a heavily used portion of the structure interior.

A broad range of artifacts, primarily chipped stone, was recovered from within the depression. The bulk of these occurred in the loose surface debris, however, and probably represent refuse naturally or culturally deposited sometime after the house was destroyed by fire. The few historic artifacts recovered in the structure, a glass button and several fragments of glass, were confined to this unit of loose surface debris entirely. Charred pine nut shells and pinecone scales were also recovered from this unit although there was no evidence of cone roasting pits similar to those noted within the depressions of Structures 1 and 2. Artifacts were much more scarce on the floor itself, the most notable items being a few scraps of worked bone, two beads—one *Olivella* (class H1b), the other steatite—and two Cottonwood Triangular projectile points found in the hearth. Pine nuts were conspicuously absent from both the floor and the hearth.

The floor plan and arrangement of structural beams around the perimeter of the depression clearly identify Structure 3 as a gabled house built over a shallow housepit. From the condition and near-uniform orientation of the beams it is also clear that the

house burned to the ground, by accident or design, the whole of the superstructure collapsing to the east, that is, toward the door. No ridge pole or interior forked supports were identified. They may have burned beyond recognition or been removed from the house ruins and used for firewood or beams in other structures at the site.

The radiocarbon assay on one of the west wall beams securely dates the construction of this feature around A.D. 1500, which is consistent with the two Cottonwood Triangular projectile points recovered from the hearth.

Two obsidian hydration rim measurements on small flakes also obtained from the hearth zone suggest calendar dates of A.D. 1021 (2.2 μ; OHL 861) and A.D. 1581 (1.5 μ; OHL 862). The younger of these is wholly consistent with the dating of the structure implied by the beads found on the floor and the projectile points found in the hearth and the radiocarbon dated wall beam; the older hydration date is anomalous and the flake from which it is taken is probably older refuse that somehow became incorporated in the structure deposit.

The date of the destruction of the structure is poorly documented. However, the fact that late prehistoric time markers including Desert Side-notched and Cottonwood Triangular projectile points, beads of shell and stone, and Owens Valley Brown Ware sherds were relatively common within the fill overlying the housefloor, while historic materials were relatively scarce, would tend to place the event in precontact times.

STRUCTURE 4: A shallow pit cut into a hillside, evidently to provide a level housefloor, marked the location of Structure 4. The resulting depression is essentially U-shaped, opening to the south and measuring 3 m north–south, 2 m east–west, and 15 cm in maximum depth (fig. 2.10). Very little debris had accumulated in the depression subsequent to its use as a housepit and excavation consisted of little more than light brushing and troweling to remove a thin layer of colluvium. This revealed a circular reddish-brown floor stain slightly more than 2 m in diameter and occupying an area of 3.7 m^2. At the south edge of the stain, near the open side of the housepit, was a hearth area marked by a nearly circular concentration of pinyon charcoal about 70 cm in diameter and beneath it a zone of oxidized red soil. A flotation sample (F-11) of its matrix yielded a single charred pine nut, several charred pine nut shells, and several unidentified small charred seeds.

Several large rocks were noted resting on the same surface as the floor stain, concentrated chiefly outside its northern perimeter and near the hearth. These may be structural elements, i.e., beam footings and hearth furniture, or refuse tossed into the depression at a later time.

Two charred pinyon log sections, both oriented toward the center of the depression and resting on the present ground surface slightly west of the stain, are thought to be remnants of beams incorporated in the structure that once covered the depression.

A large zone of reddish soil, possibly burned, that was exposed south of the depression appears unrelated to the structure but may be the result of other activities that occurred at the site.

The lack of preserved structural beams other than the two outside the depression precludes a definitive statement regarding construction of the structure. The circular floor stain suggests a conical lodge, but Steward (1941: 233) indicates this floor plan occasionally characterized gabled houses as well. Too, the floor stain in Structure 3, almost certainly a gabled house, is more circular than elongate, so the stain in Structure 4 need not imply circular beam placement.

Little more than this can be said except to note that the structure was built over a housepit and that the two charred beams suggest the structure was destroyed by fire.

The dating of the feature is equally ambiguous. The bulk of the sparse artifactual assemblage including a few scraps of worked stone, used and unused chipping waste, and bone fragments were of little use in establishing its age. Together, the three chronologically sensitive pieces recovered from the depression, a Rose Spring point, a Desert Side-notched point, and a burned glass button, represented virtually the entire span of aboriginal occupation at Pinyon House. Any one or all of these, however, might have washed or been thrown into the depression when it was no longer occupied by a house

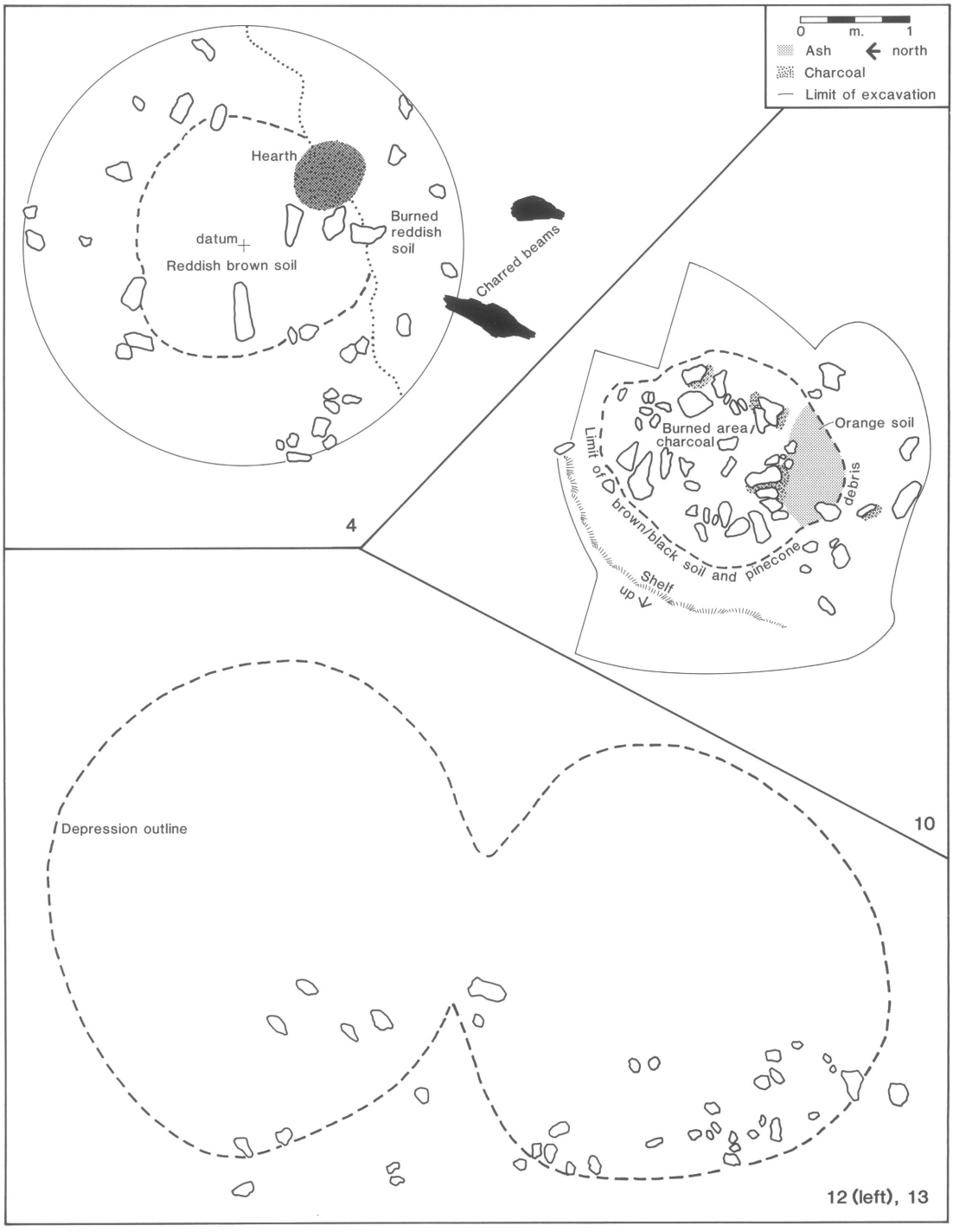

Fig. 2.10. Floor maps of Structures 4, 10, 12, and 13 (structural depressions) at Pinyon House.

and thus might represent earlier or later occupations. Similar ambiguity is observed in obsidian hydration rim measurements on two flakes recovered during excavation of the structure. One of these suggests calendar dates of either 3061 B.C. or A.D. 941 (7.3 μ, 2.3 μ; OHL 863), two distinct hydration rims being present. The earlier of these is almost certainly anomalous and probably relates to earlier occupation of the site; the later is in agreement with the Rose Spring point recovered from the deposit. A second flake indicated an apparent calendar date of A.D. 1821 (1.2 μ; OHL 866), which, allowing for the inherent error in hydration rim measurement, is compatible with the historic glass button found in the structure. One additional clue lies in the observation that the glass button was burned, possibly during the destruction of the house. If so, then the most recent use of the depression as a housefloor would have been in historic times. Since the structure does not appear to have been in use over a long period, it seems safest to conclude that it is very recent, probably historic, which would account for the recent obsidian hydration date (OHL 866), the burned glass button, and possibly the Desert Side-notched projectile point; the Rose Spring projectile point and the flake yielding the older hydration dates (OHL 863) would by this view be extraneous refuse inadvertently mixed into the shallow cultural deposit either during or after the time the structure was occupied. Much of this, however, is conjecture.

STRUCTURE 10: Structure 10 is similar to Structure 4 in terms of size, housepit configuration, and internal floor plan. Structure 10, however, is stratigraphically more complex because the depression in which it was built was later used as a pinecone roasting feature.

The depression itself was cut into a hillside forming a shallow basin, opening to the south and sloping downward in that direction along its major axis (fig. 2.10). The limits of the depression are nowhere well defined but insofar as can be determined it is about 2.5 m long, 2.0 m wide, and 10 cm in maximum depth. A shelflike cut one-half meter outside the northwestern third of this depression may be an area from which soil was removed inadvertently as charcoal was mounded during pinyon processing.

Lining the floor of the depression, directly above sterile soil, was a large brownish-black stain, 2.5 m long, 1.75 m wide, and oval in plan, occupying an area of 3.2 m^2, at the south end of which was a large firepit, 1.0 m long, 0.5 m wide, and 20 cm in depth, filled with gray-white ash and surrounded by orange oxidized soil. Analysis of a flotation sample (F-6) extracted from this ash and treated by water separation yielded charred seeds of pinyon pine, pinecone scales, pine nut shells, and several small seeds of *Phacelia* sp.

A unit of loose soil mixed with charcoal and pinecone debris about 5–10 cm in thickness lay directly above the stain, following its horizontal distribution in the main but slightly overlapping the hearth zone. Several charred pine nuts, charred pine nut shells, and charred pine bark (O-381) were found in this unit, which is undoubtedly residue from pinecone roasting. This unit is in turn covered by a discontinuous layer of large fire cracked rocks the horizontal distribution of which matches that of the basal stain and charred pinecone residue. Patches of ash and charcoal concentrated beneath and around the burned rocks that compose this last layer indicate they were placed in the depression while the pinecone residue, at least its upper part, was still afire. They may have been put there to slow or extinguish the fire—to prevent severe charring of pinecones on an especially windy day, for example. The burned rock layer represents the last active use of the depression of Structure 10, after which a thin layer of colluvium accumulated.

It is unclear whether the brown/black basal stain is a housefloor or fine residue leaching down from the charred pinecone layer directly above. If it is indeed a floor stain, as seems likely, then aside from its later use for pinecone roasting and the lack of evidence for destruction by fire—which may have been obscured by the pinecone roasting feature—Structure 10 would differ in no appreciable way from Structure 4. Simply put, it is a gabled house or conical lodge, built over a shallow housepit and furnished with an interior hearth, probably set toward the door, and therefore opening to the south.

Only two time-sensitive artifacts, an Owens Valley Brown Ware sherd and a Cottonwood Triangular projectile point, were re-

covered from Structure 10. The remaining assemblage included a millingstone fragment, several pieces of worked stone and bone, used and unused flakes, and several scraps of bone, presumably food residue.

The two time-markers would indicate a date of between A.D. 1300 and historic times. A somewhat longer span of occupancy is indicated by hydration rim measurements on two obsidian flakes obtained from the structure fill. One of these indicates an apparent calendar date of A.D. 1901 (1.1 μ; OHL 864), which is in agreement with the dating implied by the time-sensitive artifacts found in the structure. The other produced a hydration rim measurement corresponding to a calendar date of A.D. 1021 (2.2 μ; OHL 865), which, if accepted as valid, would suggest the structure is much older, dating to the middle period of occupation at Pinyon House. As has been repeatedly stated, none of these is necessarily a reliable indicator of the age of the structure, given that it was reused and lacks deep compacted deposits that would reduce the probability of fortuitous association. In this particular case, however, the preponderance of evidence suggests use of the structure in late prehistoric times and this chronological placement is regarded as relatively secure.

STRUCTURES 12, 13: Structures 12 and 13 are classified as structural depressions largely for convenience. They share certain characteristics with the other examples of this category, chiefly a round floor plan and the lack of rock architecture, but differ in floor contour, taking the form of leveled platforms rather than dug-out depressions.

Both clearings are about 4 m in diameter and nearly circular in plan (fig. 2.10). Structure 12 occupies an area of 13.6 m^2, Structure 13 occupies 12.3 m^2. They are located together on a low, narrow ridge that separates two small gullies on the eastern edge of the site. The clearings touch to make a bilobed feature, Structure 12 forming the uphill (northern) half, Structure 13 the downhill (southern) half. Aside from a scatter of rocks, which do not appear to be functionally associated with this pair of clearings, nothing was found in or around them that might be interpreted as construction material or cultural debris deriving from the activities they sustained. They may have been housepads for roofed structures or unroofed brush windbreaks, or clearings used for storage or work. Neither was excavated.

ROCK RINGS (4 EXAMPLES; 1 EXCAVATED)

The rock rings at Pinyon House are circular, single course, stone alignments more than 2 m in diameter (figs. 2.11, 2.12). The width of the stone courses, generally several stones deep, cannot be established precisely as it is difficult to distinguish intentionally placed stones from those occurring naturally. Indeed, the distinction may be illusory since the builders probably turned natural alignments to their advantage by building on them. Structure 5 differs from the others in the presence of a small circle of stones, 1.3 × 1.0 m, attached to its northwestern rim, which is treated here as a structural elaboration rather than a separate ring (fig. 2.11).

The salient characteristics of each of the four rock rings at Pinyon House are summarized in table 2.1.

Three bedrock milling slicks, previously described, were associated with Structure 6 and seven shale slabs bearing faint evidence of use as grinding stones were incorporated into the rock alignment of Structure 11. It is not clear whether these latter, only the largest of which may be complete, are items used in activities occurring at the ring or merely cultural refuse used as building material. The absence of millingstones in other rock rings, however, tends to support the former notion. Other than this milling equipment, surface inspection uniformly failed to disclose evidence of additional construction material or obvious refuse of aboriginal activities in clear association with any of the rings. The subsurface deposit of the single excavated ring, Structure 5, proved equally depauperate in these respects, yielding only a small quantity of chipped stone tools and debitage. All of this could have been, and very likely was, washed into the ring or thrown there as trash. Indeed, potential evidence of human activity at Structure 5, other than its rudimentary stone architecture, was limited to a faint red discoloration in its center. As no charcoal or ash was found in association, it is unlikely

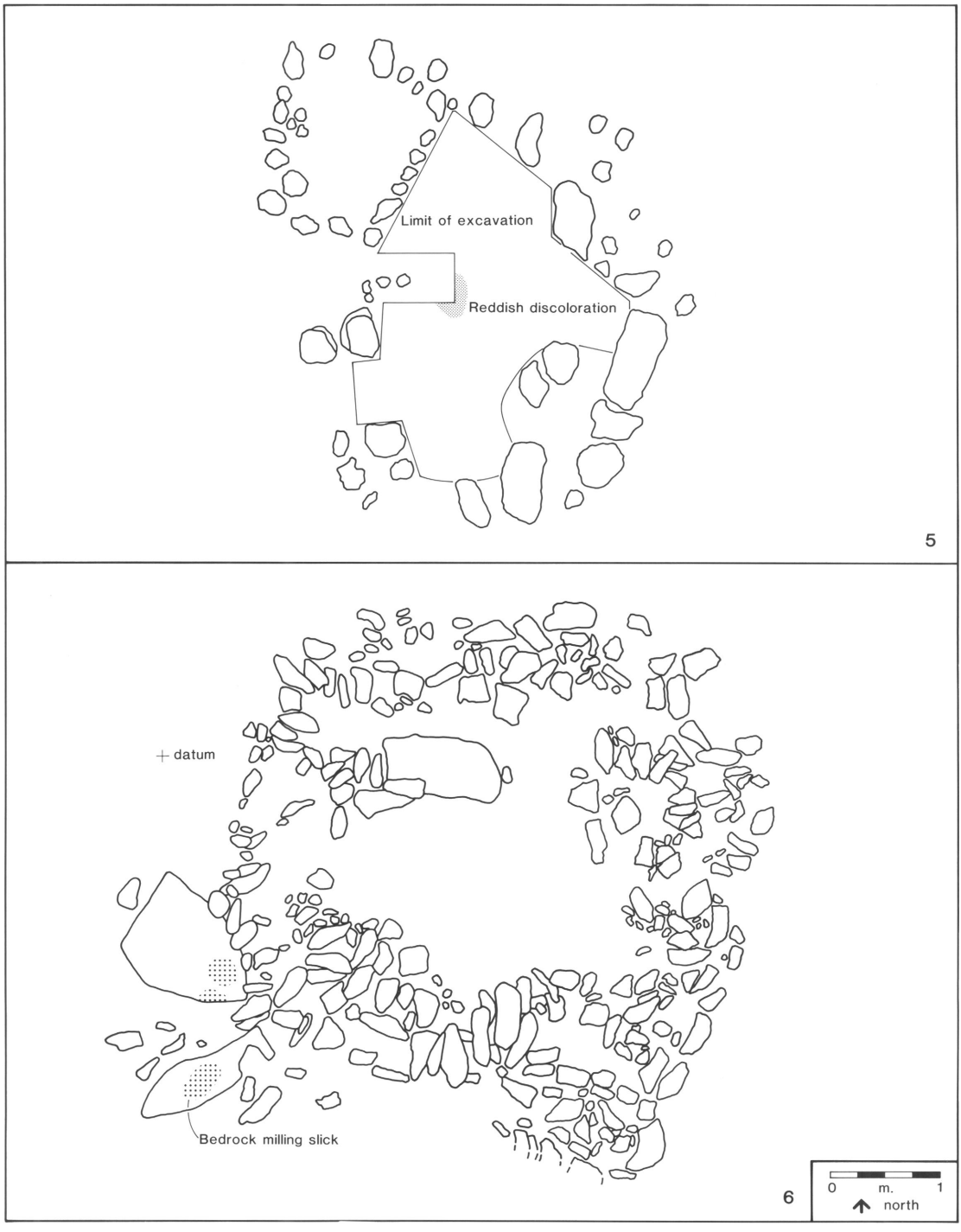

Fig. 2.11. Floor maps of Structures 5 and 6 (rock rings) at Pinyon House.

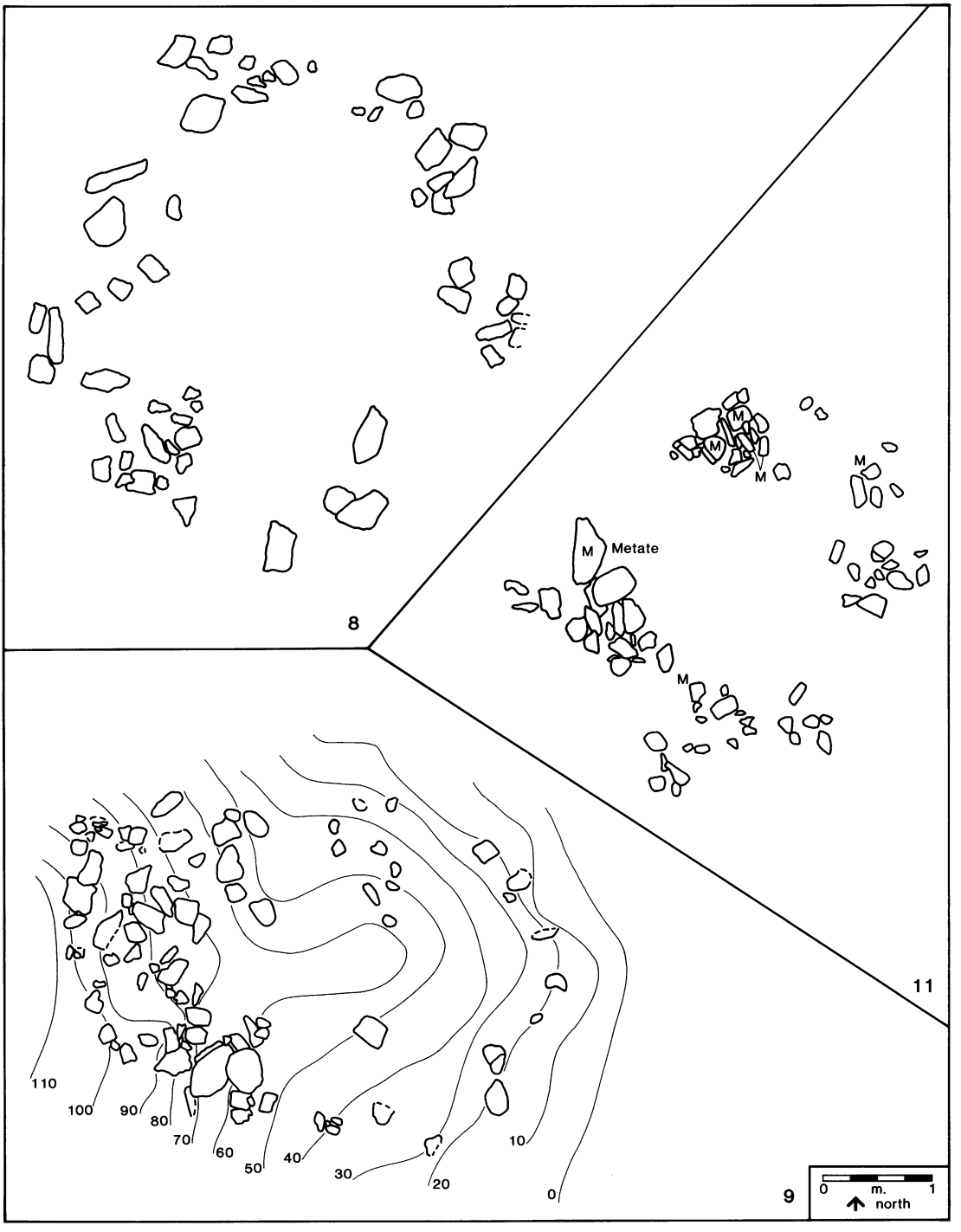

Fig. 2.12. Floor maps of Structures 8 and 11 (rock rings) and Structure 9 (rock dam) at Pinyon House. Contour interval for Structure 9 is 10 cm.

TABLE 2.1
Characteristics of Rock Rings at Pinyon House

	Dimensions (m)	Area (m^2)	Orientation	Number of stones	Associated artifacts
Structure 5	3.2 × 2.1	4.8	N–S	39	
Attachment	1.3 × 1.0	1.3	NE–SW	17	
Structure 6	2.9 × 2.6	4.5	N–S	230+	3 bedrock milling slicks
Structure 8	3.8 × 2.5	8.0	N–S	50	
Structure 11	2.2 × 2.0	4.0	N–S	83	7 millingstones and fragments

that this represents a fire of any size, certainly not a formal hearth, and it is altogether possible that it is natural.

Archaeological investigations of rock rings at pinyon camps elsewhere in central eastern California have produced results similar to those obtained at Pinyon House. These studies have almost invariably failed to disclose construction material, interior furniture, or cultural debris in excavated rock rings (e.g., Cowan and Wallof, 1974), which almost certainly eliminates them from consideration as dwellings. The frequency with which these structures occur at archaeological sites within the pinyon woodland suggests they were closely linked to pinyon procurement and their size and configuration would indicate use as caches. These are reported for nearly every Great Basin group (Stewart, 1942; Steward, 1941), including the Owens Valley Paiute (Steward, 1933: 242), although the form specifically mentioned consisted of a pit, lined with rocks and padded with grass, which was filled with cones or seeds, then covered with pine duff and boughs and finally rocks. The pit is lacking in the examples at Pinyon House and other localities in eastern California (cf. Cowan and Wallof, 1974: appendix 2, fig. 3), so these caches would have been above ground not subterranean. In terms of construction materials, however, they were probably similar to those described ethnographically. The stone rings observed archaeologically in all probability represent the final stage in the use of these features, that is, after they had been opened and their contents removed. If this is so, then the milling equipment found in association with these features was probably used in cone threshing, to remove pine nuts from cones prior to storage or from dried cones taken from the cache, or in the processing of stored pine nuts withdrawn from the cache.

Rock Dam

Structure 9 is a low rock dam, 2.5 m long, 1.0 m wide, and 10 cm high, thrown across a fairly narrow but deep gully on the west-facing hillside behind, or east of, the main site (fig. 2.12). It encloses a U-shaped basin 2.5 m long, 1.5 m wide, and 2.6 m^2 in total area, the eastern, or upstream, end of which appears to have been enlarged by excavating into the hillside. Six metal containers including an enamelware pot and basin, a pie tin, or plate and two tin cans, one with a matching lid, were found strewn about the face of the dam and in the gully below. There was no evidence of fire either within or around the dam or basin.

This feature appears too small to be a dwelling. Possibly it is a pinyon cache, but its construction is considerably different from the others at the site. More likely this structure was used to store snow for use as drinking water, a notion supported by its location in a well-shaded recess where snow would be likely to linger, a circumstance that would certainly discourage use of the spot for a house or food cache. The associated metal containers may have been used to melt the stored snow as it was needed for water.

Similar features interpreted as *snow basins* have been previously reported for the Inyo Mountains (Bettinger, 1975a: 157–158), one not far from the site of Pinyon House. They are not known elsewhere in the Great Basin, nor are they mentioned in Great Basin ethnographic accounts. Steward (1933: 263) notes in passing, however, that the Owens Valley Paiute often relied on snow for water

when wintering in the Inyo and White Mountains and some sort of storage facility would likely have been necessary to make this effective. Given the lack of free water sources at Pinyon House and numerous other pinyon camps in eastern California and the rest of the Great Basin, it is logical that snow would have been critical to prolonged occupation in the vicinity of pine nut caches and, because of this, to the economical use of pine nuts as a winter staple. This is not conclusive evidence, of course, that Structure 9 was used in this way, but it makes this interpretation more likely. It is likely, further, that similar features exist elsewhere in the Great Basin and future investigators should be alert to this possibility.

The dating of Structure 9 cannot be established precisely, although it was certainly in use during historic times as shown by the presence of metal containers.

PINYON HOUSE SOUTH

Pinyon House South is a small archaeological locality situated astride a short, narrow saddle on a ridge about 200 m southwest of the site of Pinyon House. This ridge is a continuation of the promontory that bounds the southern margin of the Pinyon House site and the two localities are within easy access of each other. Indeed, the decision to treat the two localities separately is partly arbitrary. Occasional bits of chippage are to be found in the area between them so they might on this basis, and on the basis that they appear contemporaneous and represent the same range of activities, be considered the same site, divided only by peculiarities of landform and the limitation of locations suitable for dwellings and subsistence activities.

Pinyon House South consists of a lithic scatter distributed across a saddle, covering an area perhaps 40 m in diameter and roughly circular in plan, within the limits of which are three structural features: a structural depression (Structure 1), a rock ring (Structure 2), and a rock dam (Structure 3). The depression is located squarely in the center of the saddle. Structure 2, a circular alignment of stones, one course high, measuring 2.4 m north–south and 2.5 m east–west, is situated 26 m away from Structure 1, upslope to the northeast. Structure 3, an east–west oriented rock dam 2.4 m long and 1.2 m wide blocking a north draining wash, was 18 m due north of Structure 1 and downhill from it. A Rose Spring point was recovered from the basin behind the rock dam, which is probably part of a snow basin similar to the one described from Pinyon House proper.

The results of the excavation of Structure 1 are summarized in detail below. Individual artifact descriptions and discussion of artifact distribution for Pinyon House South are included with those for Pinyon House proper.

STRUCTURE 1: Prior to excavation, Structure 1 at Pinyon House South was a shallow, saucer shaped depression about 4.5 m in diameter, 10 cm in depth, and nearly circular in plan. A discontinuous skirt of angular cobbles, less formal than the stone alignments that distinguish the rock rings at Pinyon House, was deployed around the edge of the depression. Several charred sections of pinyon logs or branches, evidently the remnants of structural beams, were noted both inside and outside the depression, chiefly concentrated near its perimeter. A mixture of red oxidized soil and gray ash produced pink soil discolorations in two areas, the larger a band extending from the center of the depression to its southwestern margin, the smaller a thin arc running along the western edge of the depression. Frost heaving had raised small hummocks of loose soil at several points within the depression.

The living floor lay very close to the ground surface and the major task of excavation was removal of the loose, frost heaved surface material from the more compacted deposit below (fig. 2.13). This exposed a red-brown floor stain 5 m long, 3.5 m wide, covering an area of 8.0 m^2, oriented northeast–southwest, and largely confined within the rock skirt surrounding the depression. When cleared, the contour of the floor depression differed from that observed prior to excavation being roughly oval in plan, 3 m long, 2.5 m wide, 10 cm deep, and oriented northeast–southwest. The floor stain occupies the whole of this depression but extends about 1 m beyond it in a broad apron to the east and a narrow meter-long lobe to the southwest.

Several large fragments of charcoal, many surrounded by ash, were found in roughly the

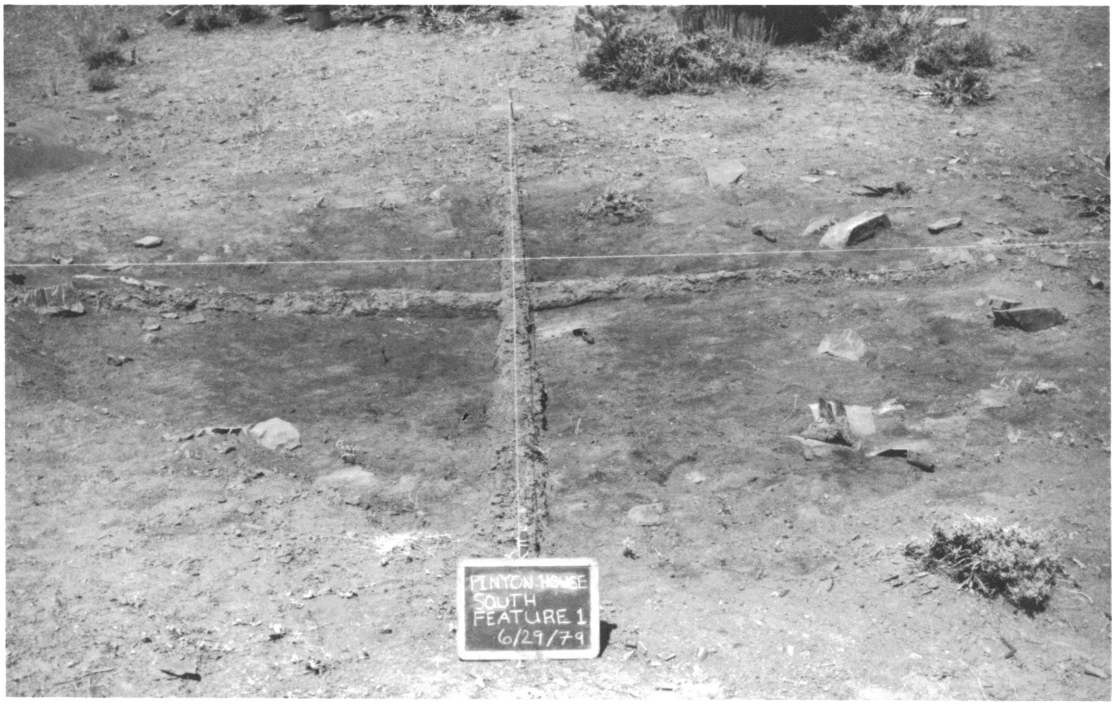

Fig. 2.13. Exposed floor of Structure 1 (structural depression) at Pinyon House South. Note ash concentration marking hearth location in center of the structure and charred post resting on rock footings. View is to northeast.

same alignment as the perimeter rocks (fig. 2.14). Most of these charcoal fragments, which are clearly the remains of structural beams, were located along the southern edge of the structure. That the rocks were provided as beam footings is demonstrated by one example near the southwestern edge of the structure where a large fragment of wood, subtended by charcoal and ash, was found wedged between two large stones.

The central earth was denoted by a large ashy area, irregular in outline and 70 cm in diameter at its widest. Beneath this was a zone of red oxidized soil of about the same width as the ash but about 1.3 m long, extending further east and west. Most likely, the ash marks the final hearth location within the structure, the oxidized soil its previous positions. There was no evidence of a depression. A flotation sample (F-12) extracted from the ashy hearth deposit yielded charred pine nut shells and several small seeds.

The artifact assemblage recovered during the excavation of the structure was quite limited. It included a single Cottonwood Triangular projectile point, a few chipped stone tools, a small quantity of chipping waste, two rolls of fired clay, and a steel awl. Bone fragments were relatively abundant by comparison. Charred and partially charred pine nut shells, pinecone fragments (O-1715, 1722, 1726, 1732), and a single uncharred or partially charred pine nut (O-1715) were found scattered throughout the structure fill. In addition, a small mass of seedlike pellets was located in close association with one of the charred beams along the southeast wall of the structure. These may represent the eggs or fecal pellets of a wood-boring insect.

The lack of abundant occupational debris at Pinyon House South makes it likely that the Cottonwood point and steel awl found in the structure stem from its use rather than from slopewash or the discard of refuse. If so, they date the house to early historic times. This time placement is well supported by hydration rim measurements on obsidian flakes obtained from the structure fill. Both of these

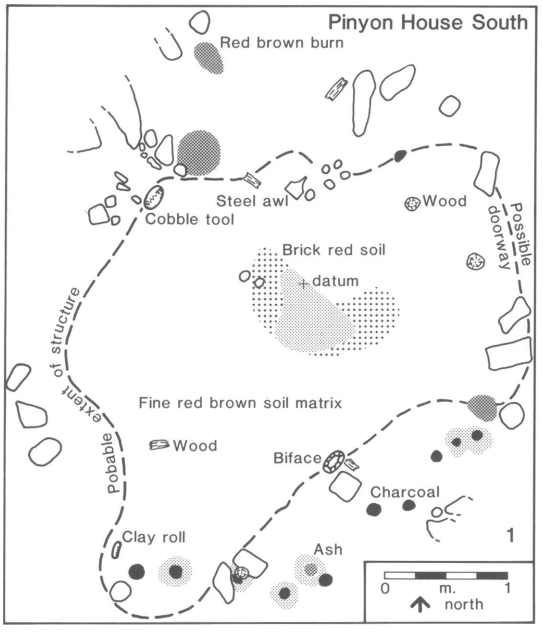

Fig. 2.14. Floor map of Structure 1 (structural depression) at Pinyon House South.

indicated apparent calendar dates of A.D. 1821 (1.2 μ; OHL 875 and 1.2 μ; OHL 876). This does not preclude use in earlier times, the possibility of which is raised by the Rose Spring point found near the structure.

Although the construction of Structure 1 cannot be determined with certainty, if the floor stain and surrounding beams and rock footings mark its outline, a gabled house seems likely. The floor area defined by these features is too large for a conical lodge given the length of pinyon logs that would be needed to bridge the floor and still provide ample interior headspace. If a gabled house is indeed represented, it differs from those excavated at Pinyon House proper in that the housepit over which it was constructed was confined to the western part of the structure, leaving a wide apron to the east, possibly the entryway, and a shelflike area just inside the wall beams along virtually the whole of the structure interior. Too, in this instance the hearth is set well out from the surrounding walls, which implies the presence of a central smokehole, there being no door nearby. As is the case with nearly all the structures, gabled and ungabled, at Pinyon House, Structure 1 at Pinyon House South was obviously destroyed by fire.

CHAPTER 3. PINYON HOUSE: ARTIFACT ASSEMBLAGE

As discussed in chapter 1, the following description of the Pinyon House artifact assemblage is organized by broad classes of artifacts. Within these classes, artifacts are grouped by category (e.g., manos) and by type and subtype within a category (e.g., flat manos). The system employed for the Pinyon House assemblage is subsequently followed in describing the artifact assemblages from Two Eagles and Crater Middens. To simplify matters, each category represented at Pinyon House is discussed in terms of all its constituent types as these are known from all three sites considered in this monograph, whether or not all these types are in fact represented in the Pinyon House collection. Categories not represented at all at Pinyon House, however, are not described here.

MILLING EQUIPMENT

MILLINGSTONES: A total of 42 millingstones was present. Of these, only two, both surface specimens, appear to be complete. The remainder consists principally of small pieces recognizable as artifacts only by the presence of a lightly ground surface.

The category of millingstones is divided into three types based on shape and configuration of working surface. Two basic shapes, *block* and *slab,* are defined. The distinction between the two is maximum thickness, which is less than 10 cm for slab millingstones and greater than or equal to 10 cm for block millingstones. There are also two working surface configurations, *flat* and *basin.* The separation between these is more difficult to define because with extended use all milling surfaces become increasingly concave and thus gradually evolve toward a basinlike form. The intended distinction between basin and flat millingstones is, however, one of function, not curation or duration of use. It would appear that basin millingstones are intentionally shaped or habitually used in such a way as to produce a relatively deep, steep sided working surface that is confined to a relatively small area, usually oval in plan. This usually results in a working surface with a break in contour somewhere between the basin center and the basin sides. Flat millingstones, on the other hand, exhibit working surfaces that vary from slightly convex or flat to moderately concave. In contrast to basin millingstones, the concavity that results from prolonged use in flat millingstones typically extends over a larger area—often the entire face of the millingstone—and is less regular in outline (plan) but more regular in cross section; generally, there are no obvious breaks in the contour of the concavity from side to side or from end to end.

Flat milling surfaces occur on both block and slab millingstones, while in the collections considered in this volume, basin surfaces occur only with millingstones of block form.

In addition to the three millingstone types defined on the basis of shape and working surface configuration, a fourth type, *graters,* is defined that exhibits minimal modification of the working surface—predominantly confined to the higher natural projections of the slab of block face employed as a grinding surface. The wear patterns observed on graters suggest uses distinct from those of millingstones of other types but some may be incipient forms that in time would have developed more regularly worn working surfaces that typify flat block or flat slab millingstones.

All 42 millingstones and millingstone fragments noted at Pinyon House are of the flat slab type.

Flat slab millingstones (42 examples; 7 metasediment, 13 mudstone/siltstone/shale, 3 sandstone, 19 unclassified). As indicated in the earlier discussion of archaeological procedures followed at Pinyon House, surface millingstones, of which there were 29 (table 3.1), were counted but, with a single exception noted below, not collected. Seven of these were incorporated in the wall of Structure 11, which is outside the area gridded for surface collection. Metric data and material were recorded only for the two uncollected surface specimens that were clearly complete. Both were very thin slabs found in association with Structure 7 but are counted as part of the surface assemblage. One of these, N-6A, was made of sandstone. It measures 47 cm in length, 28 cm in width, and about 5 cm in

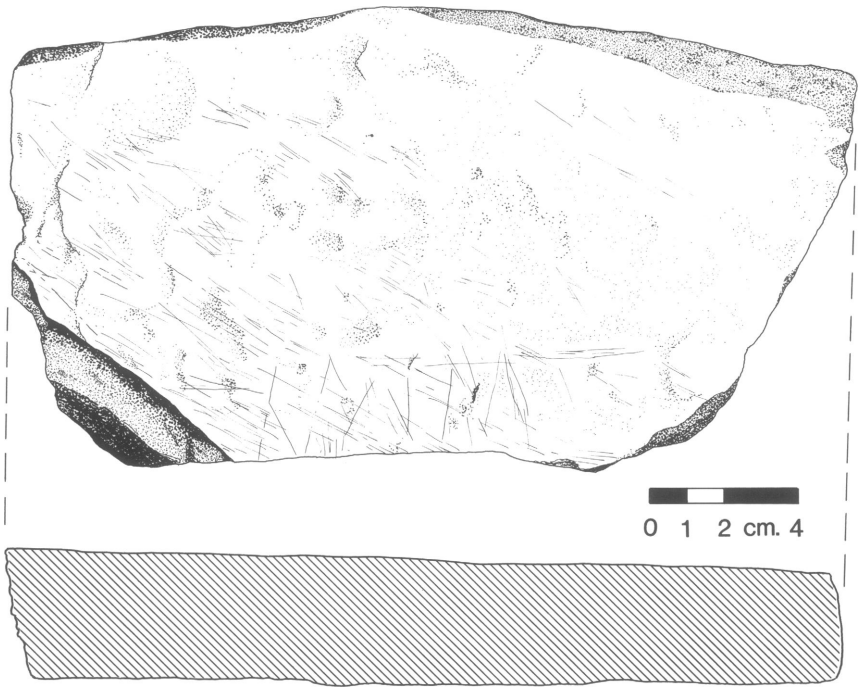

Fig. 3.1. Incised millingstone (O-1207).

thickness, and shows evidence of grinding on both faces. The other (N-6B) was of siltstone, measured 57 cm in length, 28 cm in width, and 6 cm in thickness, and was ground and pecked on both faces. The natural contour of this latter slab was curved so that one face is slightly convex, the other slightly concave. Neither example showed any obvious attempt at shaping other than rough trimming to remove projections along the margins. A lightly used shale slab measuring 60 × 30 cm in association with Structure 11 may also be complete to judge from its size but this is uncertain.

One surface millingstone was collected (O-1207) because it showed evidence of patterned scratching on its surface (fig. 3.1). This appears as a series of zig-zags that appear to have been partly obliterated by subsequent grinding. The purpose of the scratching is unclear but as in the case of the scratching noted on the problematic bedrock feature in quadrat SE4 and a small millingstone fragment excavated in Structure 1 (see below), it may have been a decorative method of rejuvenating the grinding surface.

The remaining 25 unmeasured surface millingstones were all fragments of the flat slab type, all made of locally occurring stone.

The excavated sample of millingstones, that is, those recovered from subsurface contexts within structures, consists of 13 flat slab fragments. Nearly all of these are very small. None shows evidence of intensive wear and on many the grinding is confined to isolated high spots which in a few cases are highly polished. There are no examples with grinding surfaces on both faces, but the largest fragment has been pecked or pounded on the face opposing the ground working surface. One of the fragments (O-135), recovered from Structure 1, shows faint linear scratches oriented along what was apparently the long axis of the grinding face. The single case of conjoining fragments consists of two pieces found in Structure 2. The only meaningful measurement obtainable from the excavated specimens is thickness, which is as follows:

	$\bar{x}$	S	n
Maximum Thickness	2.80 cm	1.40 cm	4

TABLE 3.1
Distribution of Milling Equipment at Pinyon House

		Structures							Pinyon House South		
	Surface	1	2	3	4	5	10	14	Surface	St. 1	Total
Millingstones											
Flat slab	29	1	9	2			1				42
Manos											
Convex	6	2							1		9
Flat	1										1
Unclassified	1										1
Pestle	1										1
Pitted stone									1		1

MANOS: A total of 11 artifacts was identified as manos (table 3.1). Only one of these is complete. Among the 10 fragmentary examples, there are two instances of pairs that fit together; the others obviously derive from different artifacts. In all, therefore, the collection represents only nine different manos.

The classification of manos is based primarily on the character of working surfaces, which may be either flat or convex. The difference between the two is believed to represent distinct kinds of motions, the flat type being designed for or resulting from a circular motion, the convex type from a reciprocal or "back and forth" motion. The two are distinguished not by the configuration of the center of the grinding face, which can be quite flat in some manos employed with a reciprocal motion, but by the configuration of the contact between the grinding surface and the nonworking sides of the implement. In specimens used with a circular motion, the working surface is sharply distinct from the adjacent unused sides throughout its circumference, the angle between the two often approaching 90°. Specimens used with a reciprocal motion, those with convex surfaces, exhibit an asymmetrical contact between the working and nonworking surfaces around the perimeter. The working surface extends well up onto, and gradually grades into, the nonworking surface on the sides of the piece that are in line with the motion of work but is sharply set off from the nonworking surface on the sides that occur on the perpendicular to the line of reciprocal motion. Loud and Harrington (1924), who were among the first to recognize this morphological distinction in manos, identified the flat form as a huller used to crack and loosen seed and nut coats prior to actual milling, for which the convex form was used. This interpretation is consistent with ethnographic accounts (e.g., Wheat, 1967: 26, 33) and is accepted here.

On the basis of the above distinction in working surface form, three mano types are defined: *flat manos* are those in which the surfaces are only of the flat form; *convex manos* are those in which the surfaces are only of the convex form; and *plano-convex manos* are those with one side of the flat form, the other of the convex form. To these three mano types is added a fourth, *rude manos,* distinguished from the other three by the lack of advanced wear on the working surface, the greater part of which remains unground, its contour being determined by the natural shape of the cobble used. Some of these lightly worn manos are, no doubt, simply newly made tools that with time would have sustained enough wear to be classified with one of the other three mano types. Many, however, differ from manos of the other three types in both size and shape, which suggests they were used for an altogether different purpose. In a sense, the distinction between rude manos and manos of other types is equivalent to the distinction between graters and millingstones: graters show little evidence of modification through wear but broadly resemble millingstones in size and shape.

Only flat manos and convex manos are represented in the Pinyon House collection. Of

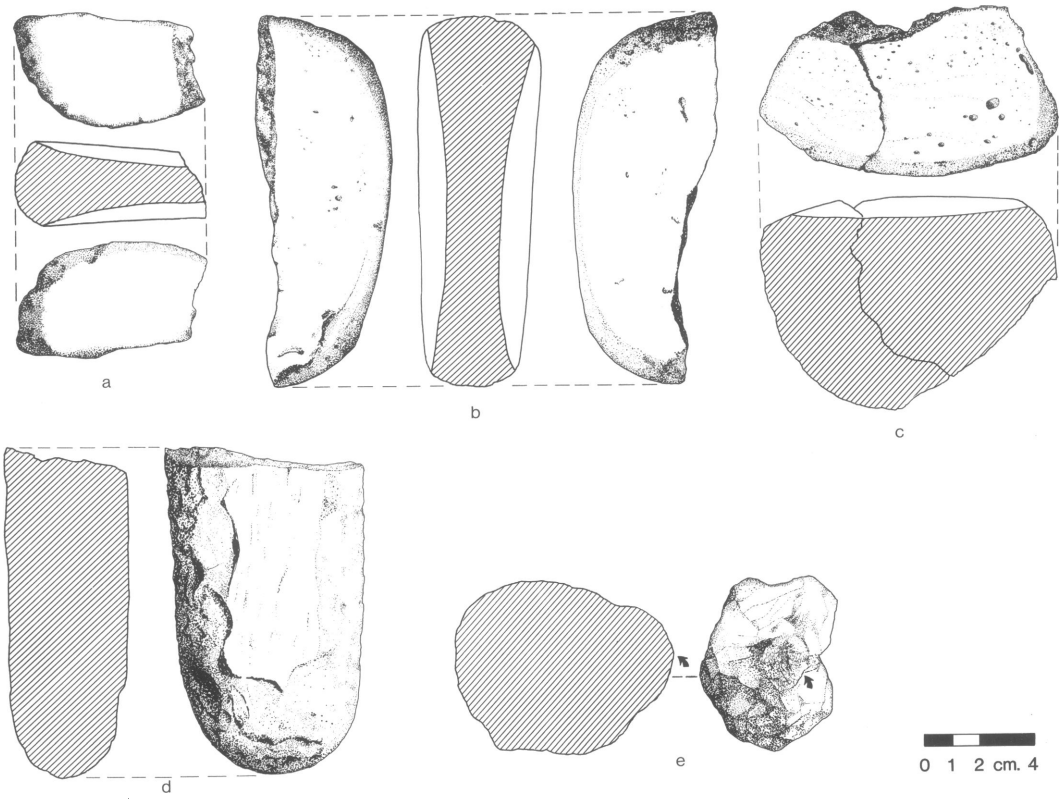

Fig. 3.2. **Manos, pestle, and hammerstone from Pinyon House. a. flat mano; b, c. convex manos; d. pestle; e. hammerstone.** a. O-1217; b. O-1341; c. O-1453/O-1521; d. O-1245; e. O-1234.

the 11 specimens identified as manos, one, made of vesicular basalt, was too small to be assigned confidently to either type. The remainder are described as follows.

Convex manos (9 specimens; 4 vesicular basalt, 2 metagranitics, 2 sandstone, 1 granitic). Four of these, including the one complete mano in the Pinyon House collection (O-1271), exhibit convex grinding surfaces on opposing faces and appear to have been shaped by pecking. The complete example, which measures 10.7 cm long, 8.2 cm wide, and 6.4 cm thick, is subtriangular in plan, wedge-shaped in long and short cross sections, and shows some evidence of battering on the ends. The most complete of the three bifacial fragments (O-1341) is 13.0 cm long, wedge-shaped in long section, and was evidently subrectangular in plan when complete although its fragmentary state makes this uncertain and precludes inferences as to its other dimensions (fig. 3.2b, c). The remaining two bifacial fragments both appear to be quarter-sections of well-shaped manos that were subrectangular in both long and short cross section. One (O-137) is 3.4 cm thick, the other (O-187) 4.7 cm thick.

Four of the five unifacial fragments are from two different manos made of vesicular basalt, each one represented by two fitting pieces that together constitute most but not all of the original tool. The grinding surface of both refitted specimens is highly polished and in places the nonworking surfaces of both show a very smooth, but uneven, polish or gloss that resembles the finish or wear imparted by silica-rich plants, for example grasses, but which evidently is the result of being grasped by the hand during use. Both are rather thick, one (O-74/O-1242) 6.6 cm in this dimension, the other (O-1453/O-1521) 7.4 cm (fig. 3.2c).

The remaining specimen (O-1678) is evi-

TABLE 3.2
Distribution of Ceramic Artifacts at Pinyon House

		Structures							Pinyon House South		
	Surface	1	2	3	4	5	10	14	Surface	St. 1	Total
Owens Valley Brown Ware											
Body sherds	42[a]		3	7			1		8		61
Rim sherds	2			1							3
Clay roll										1	1
Clay rim										1	1

[a] Eight recovered in artifact scatter north of main site.

dently a section from the long side of a subrectangular or oval mano.

Flat manos (1 specimen; granitic). This specimen (O-1217) exhibits highly polished grinding surfaces on both faces and is wedge-shaped in both long and short cross sections (fig. 3.2a). The maximum thickness of the piece is 2.9 cm but given its expanding cross section, the complete specimen had a maximum thickness greater than this.

PESTLE: The only pestle (O-1245) in the collection from Pinyon House was recovered from the surface. It is a transversely broken distal fragment 11.5 cm long, 7.0 cm wide, and 4.2 cm thick and is subrectangular in plan in both long and short cross section (fig. 3.2d). The original piece was manufactured from a tabular slab of locally occurring metasedimentary stone carefully shaped by pecking. The working end has been smoothed, rather than battered, by use in such a way that jagged contours left by pecking during manufacture have been softened but nowhere obliterated. Such wear is consistent with the notion that this pestle was used in conjunction with a wooden, rather than stone, mortar. None of either kind was found at the site, however.

PITTED STONE: A large block of metamorphic stone 39 cm long, 21 cm wide, and 13 cm thick found on the surface of Pinyon House South exhibited a single small pit or cupule that is conical in cross section and measures 2.5 cm in diameter and 0.5 cm in depth. In the eastern or midwestern U.S., this object would be identified as a nutting stone (e.g., Winters, 1969: pl. 29c) used to crack the hulls of large seeded nuts. Pine nuts could certainly have been shelled in this manner, though the huller and flat metate were used for this purpose universally in the Great Basin in ethnographic times (Steward, 1941, 1943; Stewart, 1941, 1942). Conceivably, such other large seeds as *Prunus* spp. or hard fleshy fruits as *Rosa* might have been processed using this tool; here again, however, there is no ethnographic record of this practice. The only other obvious interpretation is that this pitted stone is a portable example of Pit-and-Groove rock art, which is common in Owens Valley (von Werlhof, 1965: 119–120). Of all these possibilities, the use of this object for shelling pine nuts seems the most likely.

CERAMICS

There are 66 ceramic artifacts in the Pinyon House collection of which 64 can confidently be identified as vessel fragments (table 3.2). All of these are classified as Owens Valley Brown Ware, a ceramic type that constitutes the vast majority of pottery found at archaeological sites in Owens Valley including the three sites considered in this volume. This ware was originally described by Riddell (1951). He defined it as a simple brown ware made of residual clays containing quartz and mica inclusions, shaped by coiling and scraping, and fired in an uncontrolled, oxidizing atmosphere. Vessel forms were said to include bowls and jars with flat or rounded bottoms. Decoration was limited to rare examples with thumbnail punctations near the rim.

Subsequent research in Owens Valley (e.g., Bettinger, 1975a) has shown that a great deal of variability in paste, thickness, and surface

finish exists within collections of sherds traditionally identified as Owens Valley Brown Ware. To date no comprehensive treatment of this variability has been undertaken. There are similar shortcomings in the published descriptions of late prehistoric ceramics from adjacent parts of the western Great Basin and eastern California. Because of this, it is presently unclear whether sherds that have been previously identified as Owens Valley Brown Ware—chiefly on the basis of geographical location—differ in any significant way from late prehistoric ceramics that have been found in adjacent parts of central eastern California and the western Great Basin.

For the moment the simplest and most effective way to describe Owens Valley Brown Ware (and other Great Basin plainwares) is to quantify (rather than merely list as present) the frequency with which modes of surface treatment occur individually on sherd interiors and exteriors and jointly on the interior and exterior of the same sherd. These data can be put in matrix form as is done below with the exterior modes as columns and the interior modes as rows. Thus, each body sherd tallies one count for the exterior mode it displays, one count for the interior mode it displays, and one count for its specific combination of exterior and interior modes.

Examination of the ceramic assemblages from the three sites considered here and those collected from surface sites in Owens Valley (Bettinger, 1975a) and review of published descriptions of late prehistoric ceramics from the Great Basin indicate that the vast majority of brown ware sherd interiors and exteriors can be adequately described in terms of five more or less discrete modes of surface treatment: *smooth, rough, random brushed, parallel brushed,* and *tooled.* The meanings of these terms seem relatively clear, but the tendency for different treatments to intergrade makes it useful to provide at least a brief definition of each one. *Smooth* interiors and exteriors have been finished by wiping, presumably with moistened hand, to remove surface irregularities. The surface may be uneven in the sense of showing gentle undulations, but never to the point that it feels rough to the touch. *Rough* surfaces, by contrast, both feel and look rough. Minor imperfections including cavities, partially unobliterated coil joints, spatters, scrapes, and lumps characterize these surfaces. *Random brushed* surfaces are matted by brush marks that intersect each other and show no obvious direction of orientation. *Parallel brushed* surfaces, on the other hand, are covered by brush marks that in the main conform to a single line of orientation. Among all the vessel sherds examined from the three sites considered here, in nearly all cases where the orientation of a parallel brushed sherd was clear (generally from a coil break) the interior parallel brushing was horizontal, running with the coils, and exterior parallel brushing was vertical, running across the coils. Thus, when both the interior and exterior of a sherd are parallel brushed, the orientation of the brushing on one surface is generally perpendicular to the orientation of brushing on the opposite surface. *Tooled* surfaces are those in which a stick or very fine hard brush has left relatively deep gouge marks. Most commonly these occur as a series of parallel channels but in some cases the pattern is essentially random. Tooled surfaces are relatively rare in our collections and are found only on vessel interiors.

Notice that the classification of body sherds by interior and exterior surface treatment does not imply that the vessel from which each originated is uniformly characterized by the same attributes. Indeed, in our collections many of the larger sherds and vessel fragments formed by conjoining sherds exhibit two or more modes of treatment on the same surface; for the purpose of this analysis such sherds were classified according to the treatment characterizing the majority or plurality of the surface in question. The mixture of different treatments on the same vessel surface complicates analysis, but the frequency with which specific modes appear on sherd interiors and exteriors and co-occur in specific combinations on opposing sides of the same sherd provides perhaps the most concrete basis upon which ceramic assemblages can be compared.

The lack of independence between individual sherds, many of which will usually derive from the same vessels, precludes statistical tests routinely used to ascertain the probability of the pattern observed (cf. Spaulding, 1953) within a single ceramic assemblage. Two different assemblages, how-

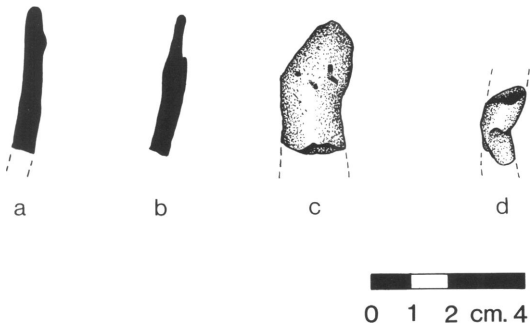

Fig. 3.3. Ceramic artifacts from Pinyon House. **a, b.** rim sherds; **c.** clay roll; **d.** crude clay rim. a. O-213A; b. O-66A/B; c. O-1727; d. O-1710.

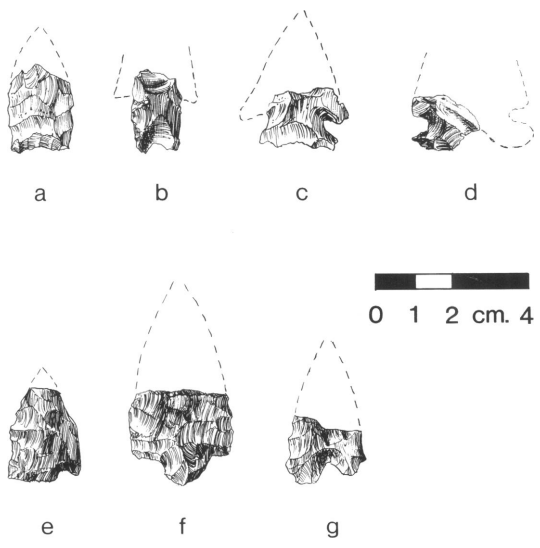

Fig. 3.4. Humboldt, Little Lake, Elko series, and Untyped projectile points from Pinyon House. **a.** Humboldt; **b.** Little Lake; **c, d.** Elko Eared; **e.** Elko Corner-notched; **f.** Elko Contracting Stem; **g.** Untyped point. a. O-57; b. O-1458; c. O-1294; d. O-1583; e. O-238; f. O-1290; g. O-59.

ever, can be meaningfully compared by use of Robinson's index of agreement (Robinson, 1951), *IA*, though this statistic does not avoid the lack of independence inherent in data of this kind. This simple statistic is used here to quantify separately for exterior mode of surface treatment, interior mode of surface treatment, and joint combinations of exterior and interior modes of the same sherd the degree of similarity between two ceramic assemblages. The index is easily calculated as:

$$IA_{jk} = 200 - \left(\sum_{i=1}^{m} |X_{ij} - X_{ik}| \right),$$

where IA_{jk} is the index of agreement between assemblages j and k, and X_{ij} is the proportion of i—a particular mode (exterior or interior) or combination of exterior and interior modes, depending on the case—in assemblage j, and X_{ik} is the proportion of the same mode or combination of modes in assemblage k. Put in plain words, in the case for which it is being calculated, say, exterior modes, the index of agreement is obtained by finding for each exterior mode represented in at least one of the two sites being compared the difference in the percentage of sherds with that mode at one site and the percentage with the same mode at the second site. The sum of these differences, all taken as positive or absolute values, is subtracted from 200. Thus, should two sites show exactly the same percentages for every mode present, there would be no differences at all and the index of agreement would be: $IA = 200 - 0 = 200$. On the other hand should two assemblages share no modes in common—as for example when one site shows only one mode and a second site shows only a different mode—the sum of the differences would be 200 (100 for the percentage of the mode at the first site and 100 for the percentage of the mode at the second site) and the index of agreement would be: $IA = 200 - 200 = 0$. The same procedure would be successively used for calculations based on interior modes or joint exterior–interior combinations.

In the following analysis of the ceramics from Pinyon House, and subsequently in the analyses of ceramics from Two Eagles and Crater Middens, indices of agreement are presented comparing each ceramic assemblage to those of the other two sites in terms of the frequency with which exterior modes, interior modes, and joint combinations of exterior–interior modes of surface treatment are represented.

Owens Valley Brown Ware (64 specimens; 3 rim sherds, 61 body sherds): In keeping with their identification as Owens Valley Brown Ware, all of the sherds in the Pinyon

TABLE 3.3
Characteristics of Owens Valley Brown Ware Sherds from Pinyon House

Interior surface treatment	Exterior surface treatment				
	Smooth	Rough	Random brushed	Parallel brushed	Total
Smooth	1	6			7 (12%)
Rough		10		2	12 (21%)
Random brushed		5	3		8 (14%)
Parallel brushed		14[a]	12	4[a]	30 (52%)
Tooled		1			1 (2%)
Total	1 (2%)	36 (62%)	15 (26%)	6 (10%)	58

[a] Category contains one rimsherd.

House collection appear to represent vessels manufactured of residual clays shaped by coiling and scraping. Color varies between 10YR and 2.5YR, though the vast majority of cores, interiors, and exteriors are 10YR.

Wall thickness is also variable:

Wall Thickness (cm)	$\bar{x}$	S	Max.	Min.	n
	0.61	0.16	0.9	0.3	64

The thicker sherds appear to belong to smaller vessels, but owing to the fragmentary nature of the sample this might just as easily be the result of the intentional thickening of vessel bases. The three rim sherds, two of which fit (O-66A, O-66B), are direct and were constructed by merely rounding and smoothing the upper edge of a final vessel coil (fig. 3.3a, b). The single bottom sherd in the collection is round and might belong to either a conical or globular vessel.

As is characteristic of this ware, aplastic inclusions grade in size from coarse to fine and in quantity from abundant to rare and there are no obvious discontinuities in these graduations. Hollow interstices left by plant parts, including seeds, are common. It is not clear whether these were intentionally added, inadvertently mixed into the clay while it was being processed, or were part of the natural clay matrix.

None of the sherds is decorated and none exhibits exterior soot coating or interior residues; weathering may have removed traces of soot and food remains, however, as most of the sherds were recovered from the site surface. The surface luster of most specimens is dull or matte, regardless of surface treatment, but a few show a faint shine; possibly the latter is the result of a vegetable surface coating applied to green vessels before they were fired (Steward, 1933: 266–267).

In the Pinyon House collection Owens Valley Brown Ware sherds large enough to be reliably classified exhibited the composition shown in table 3.3 with respect to surface treatment.

It is clear by inspection that rough exteriors, parallel brushed interiors, rough and random brushed exteriors in combination with parallel brushed interiors, and rough exteriors in combination with rough interiors dominate this assemblage.

The indices of agreement provided in table 3.4 compare the body sherds from Pinyon House to those of Two Eagles and Crater Middens in terms of the distribution of exterior, interior, and joint exterior–interior modes of surface treatment.

In comparison to both, Pinyon House shows the greatest resemblances in exterior surface treatment and the least resemblances in joint exterior–interior surface treatment. The strongest similarity is that between Pinyon House and Two Eagles in exterior surface treatment, the two being virtually identical in this respect. The similarity between Pinyon House and Crater Middens in exterior surface treatment is somewhat lower but still quite strong. On the other hand, in interior surface treatment and joint exterior–interior surface treatment Pinyon House is substantially more similar to Crater Middens

than Two Eagles, although these values, especially for joint exterior–interior surface treatment, are uniformly lower than those noted for exterior surface treatment.

MISCELLANEOUS FIRED CLAY: Two odd ceramic pieces were recovered during excavation of Structure 1 at Pinyon House South. One (O-1727) is a fragment of fired clay that was rolled and smoothed into a crooked cylinder slightly pinched and rounded to a blunt taper on one end. The piece, which is about 2.0 cm in diameter and 3.8 cm long, was part of a larger object, either a longer clay roll or, more likely, an appendage for a footed vessel or figurine (fig. 3.3c). Neither footed nor lugged containers nor baked clay figurines are common in Owens Valley, though the latter have been reported occasionally in eastern California (Hunt, 1960: fig. 58).

The other problematic clay object (O-1710) resembles most closely a very crooked, pinched, rim sherd that cracked during firing or in the course of construction—perhaps because the clay from which it was made had become too dry (fig. 3.3d). The chief objection to classifying this small piece as a vessel fragment is its construction, which is far more crude than that observed on any other sherd in the Pinyon House collection. The only other possibility would seem to be that it is part of a toy, perhaps a vessel made as a child's plaything, or a figurine, though it does not lend itself to any obvious figurine form.

PROJECTILE POINTS

A total of 78 artifacts was identified as projectile points (table 3.5). Of these, 12 are too fragmentary to be typed. With only one exception, the remaining 66 specimens are readily identified as examples of well-known projectile point series found throughout the Great Basin and known to distinguish specific time periods in the western part of the area (Lanning, 1963; Hester, 1973; Bettinger and Taylor, 1974; Thomas and Bettinger, 1976; Heizer and Hester, 1978; Thomas, 1981). The typological criteria and nomenclature employed in the classification of these artifacts are the same as those used in previous analyses of projectile points in Owens Valley and eastern California (Bettinger, 1975a; Bettinger and Taylor, 1974).

TABLE 3.4
Robinson's Indices of Agreement Between Owens Valley Brown Ware Sherds from Pinyon House and from Two Eagles and Crater Middens

	Pinyon House/Two Eagles	Pinyon House/ Crater Middens
Exterior surface treatment	194	175
Interior surface treatment	146	169
Exterior-interior surface treatment	117	150

For the most part, this typological system is similar to the one recently described in more formal terms by Thomas (1981). His system, however, eliminates certain taxa that appear to be important in the Inyo-Mono region and relies on attributes that yield ambiguous results for others (cf. Bettinger, n.d.). These problems are not insurmountable and the differences between the taxonomy used by Thomas and the one used here are systematic rather than random; they highlight variation that may reflect important prehistoric cultural differences between the Inyo-Mono region and the rest of the Great Basin. Given the demonstrated utility of the system employed here is past work in the Inyo-Mono region, there is little to be gained but confusion by shifting now to the more elegant system proposed by Thomas (1981). Future research, however, might very well eventually demonstrate the need to do so. The more salient differences between the present classification system and the one set forth by Thomas are indicated where relevant in discussion of specific projectile point series and types below.

In simplest terms, the classification system employed here organizes projectile points into *series* on the basis of shape and size as measured by weight. In turn, each series is subdivided into types on the basis of finer distinctions in shape and, occasionally, weight. As a rule, it is the series, rather than the type, that is considered temporally sensitive; and thus, generally, the temporal limits of the series apply to all its constituent types. Not all series, however, are time-sensitive.

As Lanning (1963) long ago recognized,

TABLE 3.5
Distribution of Projectile Points at Pinyon House

	Surface	Structures 1	2	3	4	5	10	14	Pinyon House South Surface	St. 1	Total
Humboldt series	1										1
Little Lake series	1										1
Elko series											
Eared	1[a]		1								2
Corner-notched				1							1
Contracting Stem	1[a]										1
Rose Spring series											
Corner-notched	8[a]	2	2	1	1				2		16
Contracting Stem	2	1									3
Cottonwood series											
Triangular	5	1		6			1		1	1	15
Leaf			1								1
Desert Side-notched											
Sierra	8		1								9
General	3		1	1							5
Delta	2			1							3
Redding	1[a]										1
Unclassified	1		3		1				1		6
Untyped Point	1										1
Untypable Fragments											
Large	3			1							4
Small	4[a]		2	2							8

[a] In each of the categories noted one specimen was recovered from artifact scatter north of main site.

weight is perhaps the most diagnostic attribute of Inyo-Mono projectile points because there appear to be two distinct size classes that evidently correspond to a basic dichotomy of function (cf. Fenenga, 1953): large points, weighing more than 3.0 g, are thought to be dart points used in conjunction with the atlatl; small points, weighing less than 3.0 g, are thought to be arrow points used in conjunction with the bow. On this basis most series can be initially characterized as either large or small. In turn, the temporal limits established for large and small point series provide a reasonable date for the replacement of the atlatl and dart by the bow and arrow, this being about A.D. 600 throughout the Great Basin, including the Inyo-Mono region (Bettinger and Taylor, 1974). Conversely, if the size distinction is accepted as functionally significant in terms of weapon type and the date is accepted as marking the transition in weapon types, then any projectile point fragment for which weight can be reliably determined can be provisionally identified as either a dart point or an arrow point and thus roughly dated as falling before or after A.D. 600, whether or not the piece can be confidently placed in a specific series with more precise temporal implications.

Shape is more difficult to define and apply meaningfully. Thomas (1981) solves this problem by means of precise measurement of specific variables. This tactic is not followed here but the results are virtually identical. The reader is referred to Thomas's work for operational definitions essentially equivalent to those set forth in more loose terms below.

In all, seven well-defined and readily recognized projectile point series of common occurrence in the Inyo-Mono region and adjoining parts of the Great Basin are represented in the collections considered in this volume: Humboldt, Little Lake, Elko, Rose Spring, Eastgate, Desert Side-notched, and Cottonwood. Six of these series were found at Pinyon House.

HUMBOLDT SERIES (1 specimen; green

chert): The Humboldt Series is less well understood than any other commonly found in the Great Basin, in terms of of both morphology and chronology. In general, Humboldt points are unshouldered and lanceolate or leaf-shaped in outline with the maximum width occurring somewhere above the base, which is slightly to deeply concave. Originally, three Humboldt types were defined (Heizer and Clewlow, 1968): *Humboldt Concave Base A,* a large form thought to date between about 2500 and 1200 B.C.; *Humboldt Concave Base B,* a small form thought to date after A.D. 600; and *Humboldt Basal-notched,* a large, deeply concave based form of unclear age but presumed to be earlier than A.D. 600. Subsequent research suggests that the Humboldt Basal-notched type is probably a knife form (biface) dating after A.D. 1 (Bettinger, 1978b; see Bifaces) and that Humboldt Concave Bases A and B are both temporally persistent throughout much of the Medithermal and therefore useless as time-markers. During earlier surveys of Owens Valley and Long Valley (Bettinger, 1975a, 1977b; Cowan and Wallof, 1974) it was noted that Humboldt Concave Bases A and B projectile points displayed a peculiar distribution, occurring only sporadically at large occupation sites but in large numbers at some smaller locations. It was thought that this resulted from their specialized use in communal hunting situations, an idea expressed independently by Thomas (1981). Such specialized use would seem to explain the paucity of Humboldt points in all of the collections considered in this volume, including that of Pinyon House.

The Humboldt Series point in the Pinyon House collection is a basal fragment that fits the original definition of Humboldt Concave Base A. It measures 1.7 cm wide and 0.5 cm thick (fig. 3.4a).

LITTLE LAKE SERIES (1 specimen; obsidian): The type site for this series is Stahl near Little Lake, just below Owens Valley, where points of this kind were termed *Pinto* by Harrington (1957: 51–53) on the basis of presumed temporal and cultural equivalence with points recovered at the Pinto Basin site in southern California (Campbell and Campbell, 1935). Lanning (1963) was the first to use the term *Little Lake series,* in reference to points, including wide and narrow leaf-shaped forms, from the Rose Spring site, Iny-372, that resembled those recovered by Harrington at Stahl. Lanning, however, explicitly distinguished the Little Lake series from the Pinto Basin Pinto points, although he suggested that there might be connections between the two forms in time (Lanning, 1963: 251). Bettinger and Taylor (1974), following the lead of Lanning, distinguished *Little Lake series* points—which they equated to points termed *Pinto* throughout the Great Basin, including the Inyo-Mono region, and *Pinto Basin series* points—which they equated to points termed *Pinto* throughout the eastern Mohave Desert and Colorado Desert, possibly extending as far east as western Arizona.

Elsewhere in the Great Basin, specimens typologically similar to Little Lake points have been termed Bare Creek Eared (O'Connell and Ambro, 1968) and Silent Snake (Layton, 1970). More recently Thomas (1981) has included points essentially identical to those of the Little Lake series in his Gatecliff series under the typological designation Gatecliff Split Stem. Also included in the Gatecliff series of Thomas is Gatecliff Contracting Stem, a type that includes forms that are termed here Elko Contracting Stem as part of the Elko series, which has temporal implications quite different from the Gatecliff series (see below).

Little Lake points are large and shouldered with parallel-sided stems and notched or concave bases. The differences between the Little Lake series points defined in this manner and Gatecliff Split Stem points (Thomas, 1981) are few but significant: Gatecliff Split Stem points may be as small as 1.0 g and their stems may expand slightly (at an angle of less than 20°).

Harrington (1957) originally defined five subtypes of Pinto (Little Lake) points based on shoulder configuration: shoulderless, sloping shoulders, square shoulders, barbed, and one-shoulder. Lanning (1963) persisted in this practice at Rose Spring, where he found only shoulderless and sloping shouldered forms in addition to the wide and narrow leaf-shaped points that he also included in his Little Lake series.

Neither the Little Lake series as defined here, nor the Gatecliff series as defined by Thomas (1981), distinguishes between these

shoulder forms, nor does either series include wide or narrow leaf-shaped forms.

Other than gross morphology, two particularly distinguishing characteristics of the Little Lake series are a high frequency of serrated blade edges (cf. Harrington, 1957: 49)—a trait shared with Pinto Basin series points from the Pinto Basin (Campbell and Campbell, 1935)—and evidence of extensive resharpening, often down to a stub—an attribute not shared with Pinto Basin series points (Harrington, 1957: 49–50).

On the basis of radiocarbon dates from sites in the Great Basin, Bettinger and Taylor (1974) assigned the Little Lake series to their Little Lake Period which dates between 4000 and 1200 B.C. Although not directly dated, Pinto Basin series points were also identified as time-markers for this period. Bettinger (1975a) later revised slightly the dates for the Little Lake series to between 3500 and 1200 B.C. in central Owens Valley, where it is a type fossil of the *Clyde phase.* Thomas (1981) proposes a time span for the Gatecliff series that is essentially the same as this revised dating of the Little Lake series.

Meighan (1981) has recently produced a series of obsidian hydration dates for a mixture of projectile points, including those of the Little Lake series, from the Stahl site that is compatible with the dating of the series accepted here. It should be noted, however, that Warren (1980; Jenkins and Warren, 1984) would favor a somewhat earlier dating for the Little Lake series, roughly between 5000 and 2000 B.C.

The single Little Lake series point in the Pinyon House collection (fig. 3.4b) is a small stub consisting of the stem and a very small part of the blade of a resharpened point. The *stem* is 1.3 cm wide and 0.5 cm thick. The material is Fish Springs obsidian.

ELKO SERIES: The Elko series, as first defined by Heizer and Baumhoff (1961: 128), consisted of three types separated on the basis of basal configuration: Eared, Corner-notched, and Contracting Stem. Elko Side-notched was later added to the first three (Heizer et al., 1968).

On the basis of work by Lanning (1963), O'Connell (1967), and evidence provided by relevant radiocarbon dates from the Great Basin, Bettinger and Taylor (1974) defined the Elko series as markers for their *Newberry period* in the southern Great Basin, which dated between 1200 B.C. and A.D. 600. In doing so, they noted the typological equivalence between Gypsum Cave points and Elko Contracting Stem points (cf. Thomas, 1970; Clewlow, 1967). Bettinger (1975a) later dropped the designation Gypsum Cave (point) altogether in favor of Elko Contracting Stem which, along with the rest of the Elko series, was employed as a time-marker for the Cowhorn phase in central Owens Valley. Like the Newberry period, the Cowhorn phase spans the interval between 1200 B.C. and A.D. 600, the dating accepted here for the Elko series.

Thomas (1981) proposes a similar temporal floruit for the Elko series, but excludes from the series two types previously included: Contracting Stem and Side-notched. Elko Side-notched is placed in a residual category of *Large Side-notched points,* which is without clear temporal implications but thought to date earlier than A.D. 1300. Elko Contracting Stem is renamed Gatecliff Contracting Stem by Thomas and included, along with Gatecliff Split Stem (the morphological equivalent of Little Lake) in the Gatecliff series, which is essentially coeval with the Little Lake series. This revision is not adopted here. Evidence from the Inyo-Mono region and the Mohave Desert strongly suggests that, as originally argued by Lanning (1963) and later by Bettinger and Taylor (1974), Elko Contracting Stem points in this area fall well within the temporal limits of the Elko series (see Davis and Smith, 1981). The case regarding Elko Side-notched is less certain because the type tends to intergrade both with Elko Corner-notched and Northern Side-notched, an earlier type dating roughly between 7000 and 3500 B.P. which is confined primarily to the northern Great Basin. As Northern Side-notched does not occur in any frequency in Owens Valley or adjacent areas, morphological similarity between it and Elko Side-notched is unlikely to be a problem. The gradation between Elko Corner-notched and Elko Side-notched, on the other hand, is clear and may give rise to typological inconsistencies between investigators. Nevertheless,

present evidence suggests that in the southern Great Basin, points of the Elko series are occasionally side-notched (cf. Rogers, 1939; Hunt, 1960: fig. 30a; E. Davis, 1964, cf. Type 2B1, 2B2) and on this basis it seems worthwhile to maintain the Elko Side-notched designation.

Elko series points are large. In the Inyo-Mono region they average substantially more than 3.0 g. All of the types are stemmed and shouldered but they differ in basal configuration, evidently reflecting different methods of hafting or at least different degrees of security with which the point was bound to the shaft (foreshaft) and protection afforded the binding material. The types within the Elko series are defined as follows.

Elko Corner-notched points are triangular in outline with expanding stems the basal width of which is less than the maximum width of the point. The stem base varies from slightly concave to moderately convex. The notches display a great deal of variability in the angle of opening, but generally extend diagonally upward from the corners. Heizer and Baumhoff (1961: 128) defined Elko Corner-notched points as triangular with sloping shoulders and expanding stems or as triangular points with deep parabolic notches.

Elko Eared points differ from the Corner-notched type primarily by the presence of stems that are basally notched or sufficiently concave to produce the appearance of ears. At one extreme, they may be said to be notched on the sides and base, taking the appearance of triangular points with two nubs or ears extending diagonally outward from the base. At the other extreme, they are simply triangular, corner-notched points with deeply concave bases (Heizer and Baumhoff, 1961: 128).

Elko Side-notched points are typically leaf-shaped with wide, deep notches set low on the sides, extending diagonally upward and inward. As defined here, the term side-notched refers to any notched point the stem of which is equal to the maximum width of the point or which is not narrowed by its notches, i.e., the stem width is the same before and after notching. Thomas (1981) defines large side-notched points (weighing more than 1.5 g) as those with proximal shoulder (the lower part of the notch) angles greater than 150° and small side-notched points as those with proximal shoulder angles greater than 130°.

Elko Contracting Stem points are defined exclusively on the basis of the stem, the sides of which vary from parallel to steeply convergent (contracting) and the base of which varies from straight to rounded in the parallel-sided form. In many instances, the stem is merely a small but thick rounded or pointed nub protruding a short distance below the blade. The shoulders are variable. Many points typed as Gypsum Cave (cf. Bettinger and Taylor, 1974; Davis and Smith, 1981) (a designation eschewed here in favor of Elko Contracting Stem, but probably legitimate in southern California and the extreme southern Great Basin where the type site is located) are sloping shouldered to the extent that the basic shape is that of a diamond or lozenge, the basal portion of which is slightly waisted or merely converges more steeply than the distal portion of the blade. At the other extreme, particularly in the Inyo-Mono region, the shoulders are drawn back to form barbs.

Thomas (1981) defines contracting stem forms that would here be typed Elko Contracting Stem as having proximal shoulder angles less than 100° (that is, the stem expands at an angle less than 20°) or a notch opening greater than 60°.

Four points in the Pinyon House collection fall into the Elko series (fig. 3.4c–f).

Elko Eared (2 specimens; both obsidian). Two small point fragments were identified as Elko Eared. One of these (O-1583), is the ear and lower blade corner from a point of the side- and basal notched form. Too fragmentary to permit any meaningful measurements, it was recovered from the basal deposit of Structure 2, which is old enough (A.D. 85–595) to suggest the two are associated with the same occupation; given the fragmentary state of this piece and the more abundant younger point types found in this structure, it seems more likely that the association is fortuitous, resulting from the inadvertent incorporation of older debris into the structure or from the reworking of a point from an older site occupation.

The other fragment (O-1294) consists of

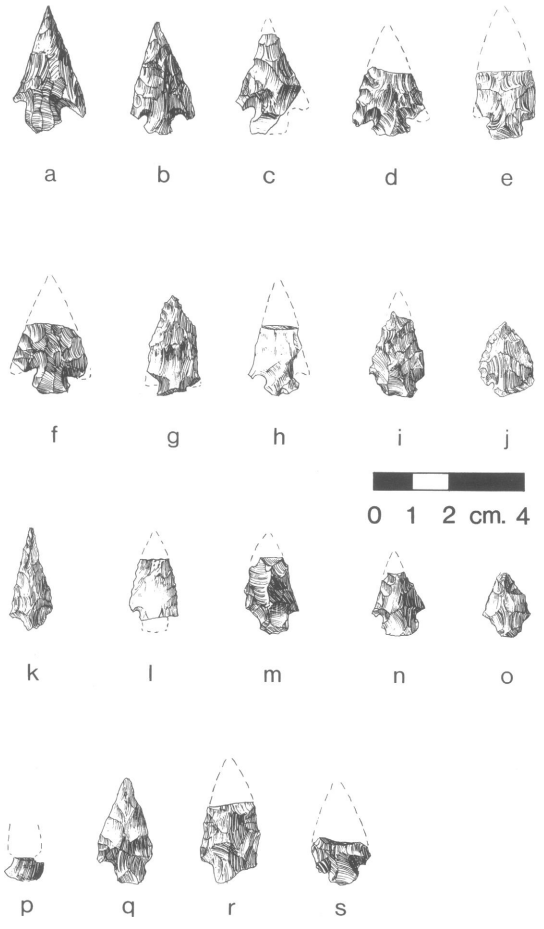

Fig. 3.5. Rose Spring Corner-notched and Contracting Stem projectile points from Pinyon House. **a–p.** Rose Spring Corner-notched; **q–s.** Rose Spring Contracting Stem. a. O-1582; b. O-1613; c. O-143; d. O-1292; e. O-1684; f. O-1252; g. O-1457; h. O-1681; i. O-1394; j. O-62; k. O-42; l. O-240; m. O-335; n. O-63; o. O-160; p. O-1352; q. O-132; r. O-40; s. O-1331.

most of the base and one shoulder from a point of the corner-notched and concave based form. It was found within the light artifact scatter adjacent to the canyon north of the site which, on the basis of time-sensitive artifacts found there, including this piece, appears to be predominantly of Cowhorn age, although there is evidence of later occupation, principally in the form of ceramics.

Elko Corner-notched (1 specimen; obsidian). The single Elko Corner-notched point (O-238) found at Pinyon House is more or less complete but appears to have been reworked, possibly resharpened, along one side, removing the shoulder. A small part of the tip is missing, which may be the reason it was reworked. In its present state, the piece is 2.5 cm long, 1.9 cm wide, 0.7 cm thick, and weighs 2.6 g—which is slightly below the accepted weight threshold for Elko points, discounted here owing to the reworking that is evident. It was recovered in Structure 3, where it is clearly out of place in terms of time, this structure having been radiocarbon dated between A.D. 1335 and 1640 on the basis of a charcoal sample extracted from one of its structural beams.

Elko Contracting Stem (1 specimen; obsidian). This specimen (O-1290) is the base and lower blade of a larger, well-made point with square shoulders and convex blade edges. It is 2.8 cm wide and 0.7 cm thick and was recovered in the artifact scatter north of the site, where it is taken, along with other evidence, as indicating use in the Cowhorn phase.

ROSE SPRING SERIES: As first described by Heizer and Baumhoff (1961) and later by Lanning (1963) in more detail on the basis of a larger collection from the type site, the Rose Spring series comprises a suite of small, stemmed point types. In form, though not in size, these types, along with the Eastgate series, duplicate those of the Elko series, leading both Heizer and Baumhoff (1961: 128) and Lanning (1963: 249, 252) to infer that their appearance marked the introduction of the bow and arrow, which required a lighter projectile point. Most subsequent investigations accept this interpretation (e.g., Bettinger and Taylor, 1974). It is worthy of note in this regard that the Rose Spring series appears to be much more variable in the Inyo-Mono region than elsewhere in the Great Basin (Bettinger, n.d.). Data provided by Thomas (n.d.) show that for most sites in the Great Basin, Rose Spring points are clearly separated from Elko series points in terms of both stem width (less than 1.0 cm) and weight (less than 3.0 g). In the Inyo-Mono region however, stem width and weight, at least at the critical thresholds of 1.0 cm and 3.0 g, do not appear to vary jointly. A great many points weighing less than 3.0 g exhibit stem widths in excess

of 1.0 cm. Bettinger (n.d.) suggests that this might reflect the initial introduction of the bow and arrow in the Inyo-Mono region. He reasons that a reduction in point size would almost certainly accompany early efforts in bow and arrow technology, but that shaft diameters and hafting technology might have lagged behind, perhaps being nothing more than slightly modified dart shafts. This would explain the apparent reduction in point size prior to reduction in stem width and, thus, the presence of points weighing less than 3.0 g with stem widths greater than 1.0 cm. By contrast, in the remainder of the Great Basin, both reduction in shaft size (as measured by stem width) and reduction in point size appear to have occurred in unison. This suggests bow and arrow technology reached that area as a well-developed complex. Whatever the case, for reasons outlined above, to use the 1.0-cm stem width threshold to separate Rose Spring and Elko points in the Inyo-Mono region, as Thomas (1981) has proposed for the entire Great Basin, would cause some light (arrow) points to be classified with heavy (dart) points. This would obscure the distinction between the Elko series and Rose Spring series that was originally intended. The possibility, however, that large-stemmed Rose Spring points in the Inyo-Mono region are older than Rose Spring points found elsewhere in the Great Basin and date earlier than A.D. 600 seems reasonable and should be explored in the future.

Bettinger and Taylor (1974) define points of the Rose Spring and Eastgate series as time-markers for the Haiwee period in the southern Great Basin, which dates between A.D. 600 and 1300. Bettinger (1975a) similarly employs Rose Spring and Eastgate series points to distinguish the Baker phase, A.D. 600–1300, in Owens Valley. Virtually all the data presently in hand support these dates for the Rose Spring series. The three types constituting the Rose Spring series are Corner-notched, Contracting Stem, and Side-notched.

Rose Spring Corner-notched points are best described simply as small triangular points with expanding stems the bases of which vary from straight to moderately convex. The notch opening is usually wide and projects inward diagonally from the corner. The degree of finish and symmetry is variable. Some pieces are extremely long and narrow, but this is exceptional.

As Thomas (1981) notes, Rose Spring Corner-notched points intergrade with those of the Eastgate series, with which they are coeval in time. Both are time-markers for the Haiwee period in the southern Great Basin (Bettinger and Taylor, 1974) and the Baker phase (Bettinger, 1975a) in Owens Valley proper. To eliminate potential confusion, Thomas combines Rose Spring Corner-notched and Eastgate series points in a single Rosegate series. Recognizing the possibility of such confusion, his lead is not followed here, as there appear to be culturally meaningful spatial differences in the occurrence of Rose Spring and Eastgate points in eastern California. Eastgate points are not represented in the Pinyon House collection but a description of the series is given here to clarify what distinguishes these points from those of the Rose Spring series.

As Rose Spring Corner-notched points, Eastgate series points are triangular in outline, and stemmed. The blade sides range from moderately convex to moderately concave. The chief distinctions between Rose Spring and Eastgate points lie in workmanship, the ratio of width to thickness, and, most important, the configuration of the notches. Eastgate points are finely worked and thin with respect to width. It is common that one blade face retains an unworked portion of the flake from which the piece was made. The notch opening is usually deep and narrow and the notches are executed in such a way that the overall outline of the point is not interrupted by them. For example, in the case of a point that is triangular with a straight base, the notches extend from the base leaving square barbs roughly in line with the stem, except where the latter is modified by a notch. The same principle applies in the case where the base is either convex or concave, except the barbs will be either rounded or hollowed, though still following, along with the stem, the contour of the original base of the piece. As Lanning (1963: 253) noted, Eastgate points are not common in Owens Valley. They are not, however, as rare as he believed and occur in increasing numbers in the valleys east of the Inyo and White Mountains.

Rose Spring Contracting Stem points are

TABLE 3.6
Metrical Data for Rose Spring Projectile Points from Pinyon House

	Length (cm)	Width (cm)	Thickness (cm)	Weight (g)
Rose Spring Corner-notched				
$\bar{x}$	2.67	1.51	0.41	1.50
S	0.78	0.25	0.07	0.70
n	3	9	15	3
Range	3.3–1.8	2.0–1.2	0.6–0.3	2.3–1.0
Rose Spring Contracting Stem				
$\bar{x}$	2.7	1.5	0.6	2.0
S		0.00	0.14	
n	1	2	2	1
Range			0.7–0.5	

essentially diminutive versions of Elko Contracting Stem points. Shoulders range from sloping to barbed and stems range from parallel sided with straight or convex bases to steeply contracting. Thomas (1981) dispenses with the Rose Spring Contracting Stem type, including the larger ones, weighing more than 1.0 g, in the Gatecliff Contracting Stem type. The type is maintained here as Rose Spring Contracting Stem points are relatively common at Rose Spring, where they are clearly coeval with the Rose Spring series (Lanning, 1963: 250, 254, pl. 7e).

Rose Spring Side-notched points are typically leaf-shaped with round notches low on the sides and convex bases or stem bases. In a few instances the stem base is straight. They differ from Desert Side-notched points (see below), which they occasionally resemble (especially where the stem base is straight), in being somewhat thicker and more leaf-shaped than Desert Side-notched points, which are typically triangular with straight blade sides. By definition, Rose Spring Side-notched points never exhibit the concave or notched bases commonly found on Desert Side-notched points.

Thomas (1981) combines the Rose Spring Side-notched type, along with Eastgate and Rose Spring Corner-notched, in his Rosegate series, justifiably noting that the specimens illustrated by Lanning (1963: pl. 7a) closely resemble Rose Spring Corner-notched points illustrated in the same plate. Nevertheless, there are in surface collections from Owens Valley (Bettinger, 1975a) and in the collections considered in this volume, though not at Pinyon House, side-notched points that are similar to other Rose Spring types in size and are clearly not Desert Side-notched; these are defined as Rose Spring Side-notched. As throughout this classification, side-notched refers to points the stems of which are equal in width to the maximum width of the piece or in which the width of the stem base is unaffected (i.e., not made more narrow) by notching.

It is perhaps significant that Rose Spring Side-notched-like points are scarce elsewhere in the Great Basin and that throughout this area Desert Side-notched points are clearly distinct from those of the Rose Spring series. In the Owens Valley area, on the other hand, Rose Spring Side-notched points are reasonably common and show resemblance to Desert Side-notched points. The data in hand, however, are far too scanty to make anything of this.

Only two of the three Rose Spring types were found at Pinyon House: Corner-notched and Contracting Stem (fig. 3.5).

Rose Spring Corner-notched (16 specimens; 14 obsidian, 1 chert, 1 chalcedony). These 16 specimens display a great deal of variation in size (fig. 3.5a–p; table 3.6) and workmanship. The largest (O-1582) weighs 2.3 g, the smallest (O-62) 1.0 g. One example (O-1352) is merely the stem of a point that broke across the notches; such stem fragments are quite common in collections of Rose Spring points from other sites in Owens Valley and the White and Inyo Mountains. At Crater Middens they make up more than a third of the total for this series. No other point type of any series approaches this propensity to break across the notches. In view of the earlier discussion regarding the introduction of the bow and arrow and the consequent development and refinement of point shape, it is interesting to speculate whether the stem breakage that so clearly characterizes Rose Spring Corner-notched points might not reflect a faulty design that incorrectly matched blade size and stem width in an early attempt to devise a light arrow point that could be properly hafted. This and other alternative possibilities are more thoroughly

explored with reference to the Rose Spring Corner-notched points from Crater Middens.

Rose Spring Contracting Stem (3 specimens; all obsidian). Of these three pieces (fig. 3.5q–s), only one (O-132) is complete. The more complete of the two fragments (O-40) is missing the distal third of the blade. The remaining example (O-1331) is a small basal fragment.

COTTONWOOD SERIES: The Cottonwood series was first defined by Heizer and Baumhoff (1961) and later described in greater detail by Lanning (1963). The series is named for the Cottonwood site, Iny-2 (Riddell, 1951), where it is abundant. Although they vary in outline, the criterion upon which types within the series are defined, Cottonwood points are uniformly small and unshouldered. They tend to weigh less than 1.0 g and never more than 2.0 g. Bettinger and Taylor (1974) defined Cottonwood series points, along with those of the Desert Side-notched group (see below), as time-markers of the Marana period in the southern Great Basin, which dates between A.D. 1300 and historic times. Bettinger (1975a) similarly employs Cottonwood and Desert Side-notched points as type fossils of the Klondike phase in Owens Valley which, as the Marana period, spans the interval between A.D. 1300 and historic times. Data from throughout the remainder of the Great Basin support this dating for both the Cottonwood and Desert Side-notched series. On the other hand, at the Oro Grande side (Rector et al., 1981) in the Mojave Desert, well to the south of Owens Valley, Cottonwood points—but not Desert Side-notched points—are relatively abundant in a component that appears to date about A.D. 1000. Thus it seems that in the Mojave Desert, Cottonwood points predate A.D. 1300 and precede Desert Side-notched points.

The Cottonwood series is divided into two types on the basis of outline or shape.

Cottonwood Triangular points, as the name implies, are basically triangular in outline. The blade edges vary from moderately concave to moderately convex. The bases are likewise variable, ranging from moderately convex to deeply concave or notched. When present, the basal concavity is occasionally V-shaped.

Cottonwood Leaf points are leaf-shaped.

TABLE 3.7
Metrical Data for Cottonwood Series and Desert Side-Notched Projectile Points from Pinyon House

	Length (cm)	Width (cm)	Thickness (cm)	Weight (g)
Cottonwood series Triangular				
$\bar{x}$	2.15	1.38	0.37	0.80
S	0.36	0.25	0.05	0.24
n	8	13	15	7
Range	2.9–1.8	1.9–0.9	0.4–0.3	1.2–0.5
Leaf				
$\bar{x}$	2.10	1.40	0.40	1.30
S				
n	1	1	1	1
Range				
Desert Side-Notched				
$\bar{x}$	2.01	1.34	0.31	0.77
S	0.36	0.25	0.06	0.50
n	8	10	22	7
Range	2.5–1.5	1.9–1.1	0.4–0.2	1.8–0.5

Both bases and blade edges are typically convex, although examples with straight or pointed bases, i.e., bipoint subtype, are known (cf. Lanning, 1963: 252–253). The type tends to intergrade with Cottonwood Triangular, particularly where the latter exhibits convex sides and rounded corners. As the types are used here, nevertheless, the distinction is between points basically triangular in outline, Cottonwood Triangular, and points basically leaf-shaped in outline, Cottonwood Leaf.

Next to those of the Desert Side-notched type, Cottonwood series points are the most abundant in the collections from the sites considered in this volume.

Cottonwood Triangular (15 specimens; 12 obsidian, 2 chert, 1 chalcedony).

These points display substantial differences in workmanship, but most are well made (fig. 3.6a–o). One (O-55) is serrated. Nine specimens exhibit concave bases, 5 straight bases, and 1 a convex base. The metric data for these points are summarized in table 3.7.

Cottonwood Leaf (1 specimen; obsidian). This (O-1642) is a thick, stubby point, essentially leaf-shaped (fig. 3.6p).

DESERT SIDE-NOTCHED: This type was originally described by Baumhoff and Byrne (1959) and was among the first well-defined

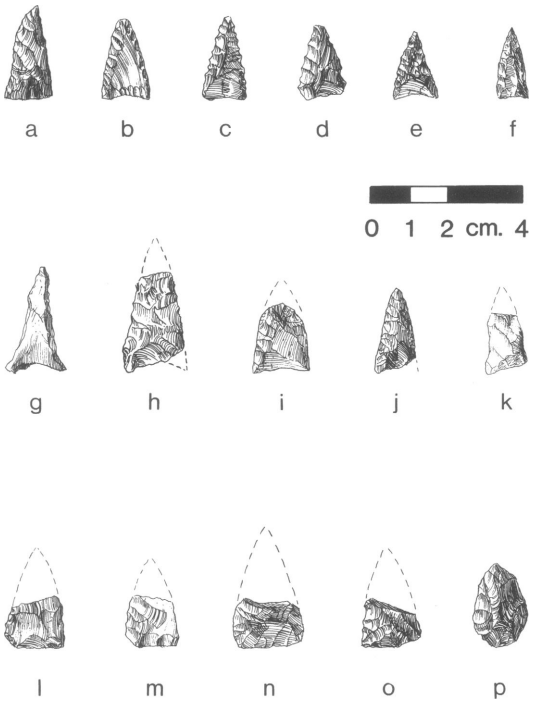

Fig. 3.6. Cottonwood series projectile points from Pinyon House. **a–o.** Cottonwood Triangular; **p.** Cottonwood Leaf. a. O-215; b. O-127; c. O-55; d. O-1717; e. O-315; f. O-314; g. O-267; h. O-1809; i. O-1499; j. O-371; k. O-293; l. O-1325; m. O-1683; n. O-269; o. O-51; p. O-1642.

time-markers recognized in the Great Basin although it occurs over an area much larger than that. From the outset, the dating of the type was known to be late, a view consistently supported by subsequent research. Bettinger and Taylor (1974) define Desert Side-notched points, with Cottonwood series points, as markers for the Marana period, dating between A.D. 1300 and historic times. Bettinger (1975a) likewise uses both the Desert Side-notched and Cottonwood series points as type fossils of the Klondike phase in Owens Valley, which also spans the interval from A.D. 1300 to historic times. Baumhoff and Byrne (1959: 60–61) had much earlier proposed exactly the same dates for the Desert Side-notched series in Owens Valley.

As described by Lanning (1963: 253), Desert Side-notched points are typically small, thin, triangular in outline, with notches placed high on the sides. A few examples in other collections considered in this volume exhibit moderately convex-sided blades, though none of this kind are present in the sample from Pinyon House.

Within the Desert Side-notched type, four subtypes were originally defined (Baumhoff and Byrne, 1959): Sierra, General, Delta, and Redding. The Sierra subtype was distinguished by a central notch in the base, the General subtype by a concave base, the Delta subtype by a V-shaped basal concavity, and the Redding subtype by comma-shaped side-notches and a bell-shaped basal concavity. These distinctions are followed here with only one exception: Desert Side-notched points with straight to slightly convex bases are included in the General subtype which, as noted by Baumhoff and Byrne (1959: 37), is the most variable of the Desert Side-notched type. The inclusion of such specimens in this subtype was considered preferable to the naming of a new one.

Sierra (9 specimens; 7 obsidian, 1 chert, 1 chalcedony). All these points are well made and exhibit a neat notch executed in the center of the base (fig. 3.7a–i).

General (5 specimens; all obsidian). The bases of four of these can be described as concave although there is substantial variation in the depth of the concavity and the care with which it was flaked (fig. 3.7j–n). One specimen (O-45) exhibits a straight to slightly convex base.

Delta (3 specimens; 2 obsidian, 1 chert). Points of this type intergrade with those of the General subtype, but in general at least one edge of the basal concavity is straight in the Delta subtype (fig. 3.7o–q).

Redding (1 specimen; obsidian). The typing of this piece (O-1291) is regarded as provisional because it lacks the bell-shaped basal concavity that distinguishes the Redding subtype. It does, however, display the equally characteristic comma-shaped side-notches of this subtype though one is distorted by breakage (fig. 3.7r). This specimen, which was recovered in the artifact scatter north of the main site, is much larger than any other Desert Side-notched point in the Pinyon House sample (table 3.7), weighing 1.8 g without one part of the tip.

Unclassified Desert Side-notched Fragments (6 specimens; 4 obsidian, 2 chert). All

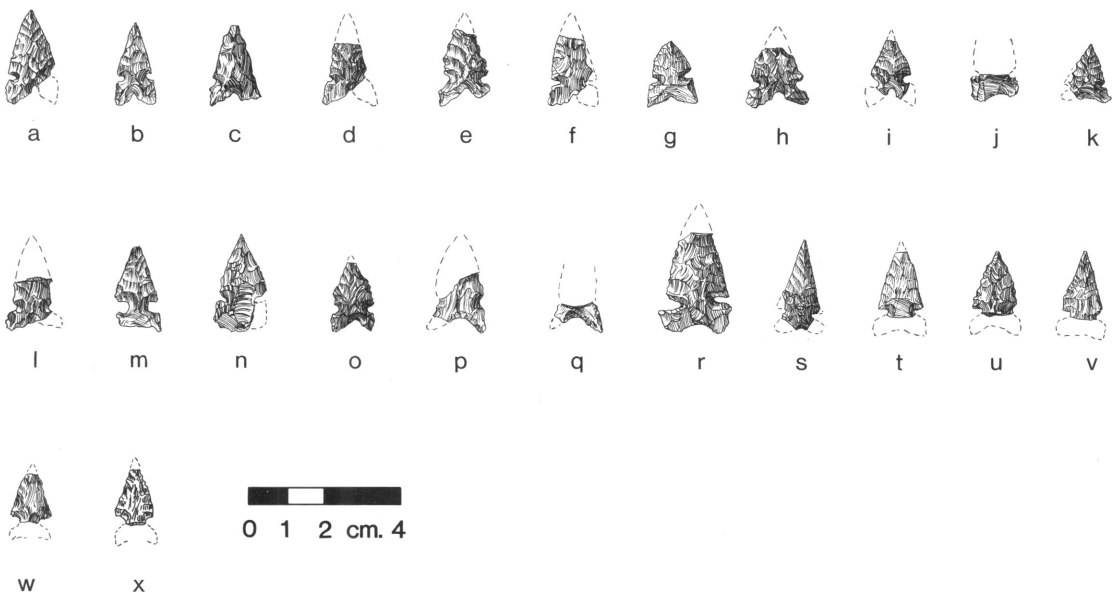

Fig. 3.7. Desert Side-notched projectile points from Pinyon House. **a–i.** Sierra subtype; **j–m.** General subtype with concave base; **n.** General subtype with straight base; **o–q.** Delta subtype; **r.** Redding subtype; **s–x.** unclassified Desert Side-notched fragments. a. O-41; b. O-1407; c. O-1650; d. O-38; e. O-65; f. O-1208; g. O-61; h. O-1456; i. O-1301; j. O-216; k. O-1649; l. O-1315; m. O-64; n. O-45; o. O-54; p. O-56; q. O-239; r. O-1291; s. O-1651; t. O-1685; u. O-1576; v. O-1642; w. O-1495; x. O-330.

of these pieces exhibited the characteristic notching that distinguishes the Desert Side-notched type, but were insufficiently complete to be assigned to any specific subtype (fig. 3.7s–x).

It is perhaps worthy of note in regard to the commonly expressed assumption that Desert Side-notched points are nothing more than notched Cottonwood points or Cottonwoods merely unnotched Desert Side-notched points, that although there is a good deal of overlap between the two (table 3.7), in the Pinyon House sample, as a group Desert Side-notched points tend to be thinner and lighter than Cottonwood points, which suggests they represent two distinct forms.

UNTYPED POINT: A single basal fragment (O-59) made of chalcedony could not be assigned to any known type or series, although it might be an Elko Eared point with diminutive side-notches (shoulders) and a very deep basal notch (fig. 3.4g). When complete it was probably large enough to be classified as a dart point, i.e., it probably weighed more than 3.0 g.

UNTYPABLE FRAGMENTS (12 specimens; all obsidian): The only identifying characteristic of these specimens is the presence of notches, which are here taken to distinguish points from knives. Four are large enough to be tentatively classified as dart points; the others appear to be fragments of arrow points.

Following the phases defined by Bettinger (1975a) the composition of the Pinyon House point collection is summarized in table 3.8 in comparison to the point distributions noted at the 20 pinyon camps located during the surface survey of the Big Pine transect (cf. Bettinger, 1975a, 1976).

Taking into account uncertainty due to sampling, the two collections are remarkably similar in composition.

OTHER CHIPPED STONE ARTIFACTS

BIFACES: Bifaces are working implements with at least one bifacially flaked edge. They are distinguished from roughouts (bifacially flaked artifacts with which they tend to in-

TABLE 3.8
Phase Composition of Projectile Point Assemblages from Pinyon House and 1972 Survey Pinyon Camps

	Clyde Phase	Cowhorn Phase	Baker Phase	Klondike Phase	Total
Pinyon House	1 (2%)	4 (6%)	19 (30%)	40 (63%)	64
1972 Survey Pinyon Camps[a]	0 (0%)	1 (2%)	17 (35%)	30 (63%)	48

[a] Bettinger 1975a.

tergrade) by their working edges, which are suitable for use in cutting or scraping without further modification; roughouts edges are too irregular to be useful in such chores without additional finishing. Bifaces are reliably separated from projectile points only on the basis of basal configuration; those of the former are unnotched, those of the latter are either notched or shouldered or, as in the special case of the Cottonwood series, of diminutive size. The mid and distal portions of bifaces are virtually identical to those of projectile points. In the absence of any dependable method for discriminating between them, all unnotched, unshouldered artifacts with usable bifacially flaked edges were classified as *bifaces*. No doubt some of these are point fragments.

The category of bifaces is subdivided into three types: simple bifaces, Humboldt Basal-notched bifaces, and flake knives (table 3.9).

Simple Bifaces (179 specimens; 158 obsidian, 19 chert, 1 chalcedony, 1 glass). In general, these are bilaterally symmetrical tools the bifacially flaked lateral margins of which form opposing working edges (fig. 3.8a–c). They are typically lenticular in cross section and range from oval or leaf-shaped to triangular. Many of the specimens in the Pinyon House collection are small fragments (table 3.10), possibly the byproducts of attempts to rejuvenate worn bifaces. Many of these fragments take the form of burin spalls made by directing a blow down one side of a biface to remove a bifacial working edge or across the tool to remove a jagged break. These spalls show evidence of battering on both ends, which suggests they were removed with a bipolar technique while held on an anvil.

The working edges of many bifaces have been repeatedly retouched, giving them a steeply angled or rounded configuration. Where it is present, use-wear takes the form of edge crushing, stepping and abrasion. One example (O-287) exhibits silica gloss, possibly as the result of use as a seed knife or thatching sickle.

Of the sections that were large enough to determine the portion of the tool represented, 53 were butt sections, 29 were tip sections, and 29 were midsections. The distinction between tip and butt sections is admittedly ambiguous, however, and some pieces have probably been misattributed.

That so few bifaces are more than small scraps, and that even some of the more complete pieces appear to have been discarded or lost during the process of being reworked, suggests that the activity they represent directly is not that of butchering, sawing, scraping, and light woodworking—the tasks in which simple bifaces are thought to have been employed—but rather the rejuvenation of tools that had become worn from use in these activities. Thus their spatial distribution (table 3.9) is indicative of areas in which stoneworking was carried out while their numbers are indicative of the intensity with which the activities that required the use of implements with bifacial cutting edges were pursued.

No attempt was made to segregate simple bifaces on the basis of basal form, e.g., square butted, round butted, etc.

Humboldt Basal-notched Biface (1 specimen; obsidian). These are lanceolate, unshouldered bifaces with straight to slightly convex sides and lenticular cross sections. The bases exhibit parallel to moderately flared sides and a deep basal notch or concavity (Bettinger, 1978b). They are large, weighing in excess of 3.0 g—occasionally as much as 13.0 g. Initially identified as a point type within the Humboldt series (Heizer and Clewlow, 1968: 61–63), there is growing evi-

dence that they are knives (Bettinger, 1978b; Thomas, 1981). The Humboldt Basal-notched biface type is certainly late in time. Bettinger (1978b) placed it between A.D. 600 and 1300, and thus coeval with the Rose Spring and Eastgate series, which mark the Haiwee period in the southeastern Great Basin and Baker phase in Owens Valley (Bettinger and Taylor, 1974; Bettinger, 1975a). More recent evidence raises the possibility of a slightly earlier date, perhaps between 0 B.C./A.D. and A.D. 900 (Bettinger, n.d.; Thomas, 1981: fig. 5a–c).

The single Humboldt Basal-notched biface (table 3.10) found at Pinyon House is from the surface. It is a deeply notched basal fragment showing evidence of use-wear in the form of crushing along its lateral edges (fig. 3.8f).

Flake Knives (8 specimens; 3 obsidian, 5 chert). These are flakes modified only to the extent that at least one edge has been intentionally worked by delicate pressure retouch to form a sharp cutting edge (fig. 3.8d, e). This retouch is not extensive and seldom impinges much beyond the extreme lateral margins of the flake face. In nearly all cases this retouch is bifacial but in a few instances is merely unifacial. These unifacial examples are, by definition, not bifaces, but it seems clear enough that the purpose of the retouch, whether unifacial or bifacial, was to produce a cutting edge somewhat more regular and steeper, and therefore stronger, than the un-

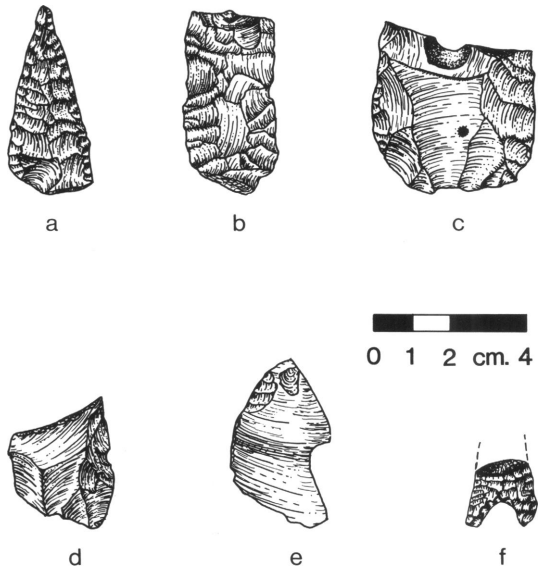

Fig. 3.8. Selected bifaces from Pinyon House. **a–c.** simple bifaces; **d, e.** flake knives; **f.** Humboldt Basal-notched biface. a. O-271; b. O-1728; c. O-1686; d. O-272; e. O-362; f. O-1172.

TABLE 3.9
Distribution of Other Chipped Stone Artifacts at Pinyon House

		Structures							Pinyon House South		
	Surface	1	2	3	4	5	10	14	Surface	St. 1	Total
Bifaces											
Simple Bifaces	113[a]	7	25	20	3	1		1	7	2	179
Humboldt Basal-notched	1										1
Flake Knives	2		2	1			2		1		8
Roughouts	58	4	14	12				2	5	1	96
Point Blanks	2		4	1				1	1		9
Drills											
Flake	1			1							2
Shaped	1[b]										1
Reworked			1								1
Bits	3										3
Unifaces	49[b]	9	13	8	2	2	2	2	8	3	98
Cores	11		2	4			1				18

[a] Three specimens recovered from artifact scatter north of main site.
[b] One specimen in each category noted recovered from artifact scatter north of main site.

TABLE 3.10
Metrical Data for Bifaces from Pinyon House

	Length (cm)	Width (cm)	Thickness (cm)
Simple Bifaces			
$\bar{x}$	4.50	2.23	0.58
S	0.42	0.69	0.18
n	2	47	112
Range	4.8–4.2	4.5–1.3	1.3–0.2
Humboldt Basal-notched			
$\bar{x}$		1.90	0.60
S			
n	1	1	1
Range			
Flake Knives			
$\bar{x}$	3.93	2.80	0.54
S	1.65	1.38	0.26
n	6	6	7
Range	7.0–2.4	5.4–1.4	1.0–0.2

TABLE 3.11
Metrical Data for Roughouts and Point Blanks from Pinyon House

	Length (cm)	Width (cm)	Thickness (cm)	Weight (g)
Roughouts				
$\bar{x}$	3.03	2.19	0.81	
S	1.08	0.67	0.27	
n	23	47	71	
Range	6.6–2.1	4.0–1.2	1.9–0.3	
Point Blanks				
$\bar{x}$	2.14	1.39	0.35	0.86
S	0.46	0.12	0.05	0.28
n	7	7	8	7
Range	2.8–1.6	1.5–1.2	0.4–0.3	1.2–0.5

modified edge. Therefore, to segregate the unifacial examples from bifacial examples, while strictly correct, would be silly.

Although the sample is small, the flakes on which these tools were made are large, oddly shaped, and predominantly chert. It is perhaps significant in this regard that sources of chert and chalcedony are reasonably rare in Owens Valley and that artifacts manufactured from these materials are as a rule more carefully made than those of obsidian. Perhaps this is a reflection of their scarcity or toughness, which conferred a longer and more effective use-life as compared with natural glass. Given this, it may be that these flake knives offered a means for utilizing chert flakes that could not be worked into projectile points or more formal knives but were too valuable to be allowed to go to waste.

None of the pieces exhibits excessive use-wear, the most common form here being an almost imperceptible smoothing of the working edge that does not extend onto the face of the flake on either side. This suggests use in the light cutting of wood, hides, and possibly flesh. That is, as opposed to simple bifaces, which are multipurpose tools employed in sawing, scraping, and cutting, flake knives were probably specialized cutting implements—true knives.

Although in comparison to unworked debitage these flaked tools are large, they exhibit substantial variability in size (table 3.10). The largest (O-1274) is 7.0 cm long, 5.4 cm wide, and 1.0 cm thick; the smallest complete specimen (O-1693) is 3.4 cm long, 2.1 cm wide, and 0.5 cm thick.

As indicated in table 3.9, the distribution of flake knives is strongly biased toward structures.

ROUGHOUTS AND BLANKS: The Pinyon House collection contains 105 chipped stone objects that have been bifacially flaked but without further work would not be useful as points, drills, or bifaces—the finished implements they most closely resemble. It is not possible to determine in all cases why the work was attenuated. Certainly some of these objects are so grotesque in shape that they must have been discarded as unworthy of further attention; others, however, exhibit no obvious flaws and appear eminently suitable for additional flaking. Although the former are readily classified as rejects, the latter as blanks, the two grade without obvious disjunctions into each other and are here regarded without distinction as a single category. Two types are recognized on the basis of size and shape: roughouts and point blanks (table 3.9).

Roughouts (96 specimens; 93 obsidian, 3 chert). These are relatively large, blocky artifacts that have been bifacially flaked along

some part of their margins (table 3.11). It is believed that most of these were originally intended as points or bifaces, which some of the better examples resemble. Quite possibly both forms were fashioned from a generic bifacial preform kept on hand to be used as needed as tools became lost, worn, or broken (fig. 3.9a, b). In any case, despite substantial variability, the shape of these objects is most akin to points and bifaces.

Point Blanks (9 specimens; 8 obsidian, 1 chert). These are small flakes the edges of which have been retouched so that they resemble small triangular projectile points in gross outline but not in the degree of finish or in the shaping of small details (fig. 3.9c–f) although one specimen exhibits rudimentary side-notches. It is clear even from this small sample that the rough shaping of these pieces was achieved by steep unifacial retouch. This created a platform from which broader and shallower flakes impinging on the opposing flake face could be removed. These latter flakes extend beyond the edge of the blank, reaching occasionally well past its midline. In more advanced stages of production additional flakes of the same kind would have removed the original dorsal and ventral surfaces of the flake blank, thus producing the lenticular cross section characteristic of bifacially flaked tools. On these blanks, however, such broad flakes occur sporadically and in no case is the original flake surface entirely obscured by them. In addition to steep unifacial retouch, intentional edge grinding was frequently used to prepare the flake edge platform for the removal of additional flakes. This grinding is present on one-third of the specimens and in each case left a very flat platform oriented perpendicular to the plane of the flake.

There can be little doubt that these are unfinished projectile point blanks. A great deal of care went into shaping them and though they were left unfinished and unused they could have easily been transformed into small projectile points of the Desert Side-notched or Cottonwood series with only a little extra work. They closely resemble no other common artifact type into which similar effort and planning were invested. The only tools with which they might be confused are *used flakes*. On close inspection, however, the two

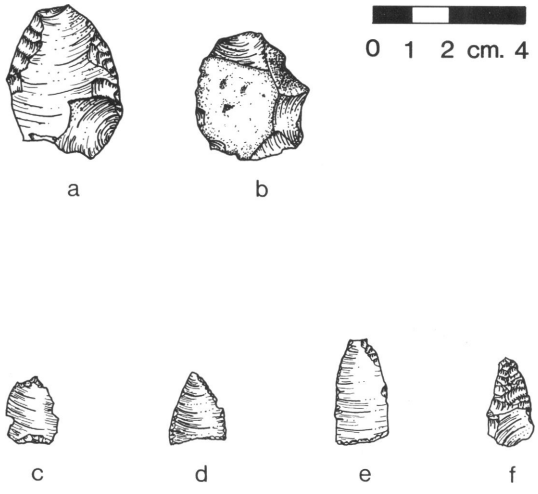

Fig. 3.9. Selected roughouts and point blanks from Pinyon House. **a, b.** roughouts; **c–f.** point blanks. a. O-1395; b. O-1350; c. O-58; d. O-1552; e. O-1682; f. O-268.

are readily distinguished. Used flakes are almost always wedge-shaped in cross section, show no consistent patterning in outline, and exhibit edge modification that approximates the original contour of the conchoidal or prismatic flake selected for use. By contrast, these blanks are nearly tabular, i.e., rectangular, in cross section as the result of having been made on thin, broad flakes that were intentionally singled out for this characteristic and then shaped extensively which removed their thin, featherlike flake margins. The outline of the blanks, likewise, is regular and projectile-pointlike, which would be of no obvious advantage in simple flake tools and therefore seldom occurs in them. There is some possibility that the intentional edge grinding and steep unifacial edge retouch might be mistaken for use-wear, especially in fragmentary specimens. Intentional retouch, however, is typically more irregular and jagged than use retouch, which tends to leave an even edge. Edge grinding can also be distinguished from edge abrasion resulting from use. The former is accomplished with a stone and tends to leave a very flat, planelike surface that is frequently restricted to projecting irregularities along the flake edge and seldom extends onto the flake faces; edge abrasion from use, which

generally results from contact with materials more yielding than stone, is more rounded, and impinges onto the adjacent flake faces and into the hollows between high spots on the flake edges. Had flakes been used to scrape or cut stone, the use-wear would resemble intentional edge preparation, but there is no evidence of this practice in the samples of used flakes that have been examined from Owens Valley.

The metric attributes of these point blanks (table 3.11) are closely comparable to finished projectile points of the Desert Side-notched and Cottonwood series and it is inferred that they are the unfinished counterparts of these point types. The distribution of point blanks is heavily concentrated in structures (table 3.9).

DRILLS (7 specimens; all obsidian): Seven fragmentary artifacts with thick, narrow working bits that vary from steeply subtriangular to diamond-shaped in cross section and exhibit moderate to severe lateral abrasion were identified as drills. There is among these specimens remarkable diversity in shape, size, and degree of finish. Two (O-236, O-1502) are merely flakes one corner of which has been unifacially retouched to form a short, beaklike projection that served as the bit. All five of the remaining pieces were more carefully shaped by bifacial flaking. One (O-1614) has a basally notched expanding stem, which gives it an eared appearance, and may be a reworked Elko Eared point or Humboldt Basal-notched biface (fig. 3.10b). This piece may have been hafted for use but as the stem is large and easily grasped would have worked quite well without being so mounted. It is 2.6 cm wide across the base and 0.7 cm thick; the bit, the distal portion of which is missing, is 1.1 cm wide and 0.6 cm thick.

The only other specimen on which the base is still present (O-1295) is triangular in outline with a convex base and resembles Type 1 drills from the Rose Spring site (Lanning, 1963: 256–257, pl. 9f, g) and drills from Little Lake (Harrington, 1957: fig. 43a, b). It is 2.7 cm long and 0.5 cm wide; one basal corner is missing, which precludes measurement of its width, though this is estimated to be about 1.3 cm (fig. 3.10a). Lanning (1963) designated the Type 1 drill form as a characteristic of Little Lake and Early Rose Spring phase assemblages in the Owens Lake–Little Lake region. This would be contemporaneous with Clyde and Cowhorn phases in Owens Valley, which together span the interval between 3500 B.C. and A.D. 600. This dating is consistent with the recovery of this piece in the surface scatter north of the main site, which on the basis of several lines of evidence, including the occurrence of Elko series projectile points, is thought to be a hunting station of Cowhorn age.

The remaining three drills are bit fragments. Of these two are tips, one (O-1225) measuring 9.0 cm in length, 1.3 cm in width, and 0.8 cm in thickness, the other (O-1911) being too incomplete to provide useful measurements. The third is a midsection that also provides no meaningful measurement.

The uses to which chipped stone drills were put has never been adequately established. The severe wear that is occasionally observed would seem to imply the perforation of wood, bone, stone, and, in recent times, ceramics. Specimens on which use-wear is less pronounced may have been employed to punch hides.

The seven drills in the Pinyon House collection displayed the distribution shown in table 3.9.

UNIFACES (98 specimens; 84 obsidian, 11 chert, 2 chalcedony, 1 quartzite, 1 rhyolitic): Unifaces are formally defined as intentionally modified tools the working edges of which exhibit only unifacial retouch (fig. 3.10c, d). In the Pinyon House collection (table 3.9), these working edges vary from concave to convex in plan and generally exhibit numerous small concavities and protuberances resulting from differential use-wear reduction along their lengths. These irregularities are less pronounced on some specimens and several lack them altogether. A few examples seem to have been intentionally serrated to produce a denticulate working edge, but the work on these is rather casual and does not resemble that which characterizes the more formal denticulate tools that have been reported in Long Valley and the Mono Basin (E. Davis, 1964: 272; Bettinger, 1973: 9, pl. 1k, 1980b: 16–17, 1981c: 33).

Most of these tools are executed on broad flakes with relatively flat ventral surfaces, the retouch extending dorsally. This results in a

tool with a flat, unflaked ventral surface and a sloping dorsal surface of which at least the margins are extensively flaked. This asymmetry between dorsal and ventral faces implies asymmetry in the direction in which force was applied and the tool moved when bringing its working edge in contact with the material being processed—a notion that is supported by examination of use-wear displayed by these implements. Multiple superimposed step fractures and edge abrasion are common on the dorsal side of the working edge and virtually absent on the ventral side except for those occasional examples in which severe abrasion impinges on both ventral and dorsal surfaces; in such cases it is invariably more pronounced on the dorsal surface, however. The abrasion varies from a greasy, silica glosslike polish that extends into hollow flake-scar surfaces to a dull, matte grinding that is confined primarily to projections and ridges between flake scars. Areas where this grinding is severe often exhibit a planar wear surface that is roughly perpendicular to the plane of the dorsal tool surface. These data suggest that unifaces were used with a single unidirectional stroke or repeated series of strokes and held so that the working edge was perpendicular to the stroke direction with the ventral surface of the tool facing forward, that is, toward the direction of work. The bulk of tool resharpening consisted of removing additional flakes from the dorsal face of the implement, the flat ventral surface serving as the platform. There are one or two examples in which rejuvenation flakes were struck in the opposite direction, that is, using the worn dorsal face as a platform from which broad, thin flakes were removed from the ventral face. Frison (1968), commenting on the presence of such ventral rejuvenation flakes at a buffalo butchering and processing site in Wyoming, suggests that this practice may have served to lengthen tool lifespan since it does not reduce the length of the implement even though it results in a fresh working edge.

Unifaces are suitable for use in a variety of activities, but morphology and edge-wear suggest that heavy and light woodworking, the preparation of withe and weft elements for baskets, hideworking, and perhaps fiber processing were among the more common of these.

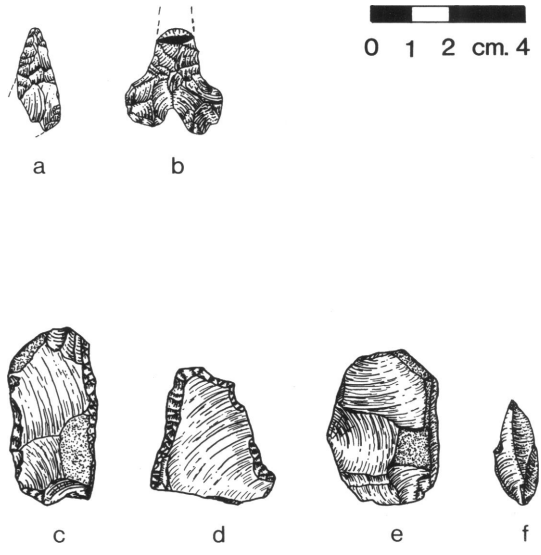

Fig. 3.10. Selected drills, unifaces, and cores from Pinyon House. **a, b.** drills; **c, d.** unifaces; **e, f.** cores. a. O-1295; b. O-1614; c. O-1635; d. O-1699; e. O-85; f. O-1480.

That 14 percent of all unifaces are made of materials other than obsidian, substantially more than is found within most other tool categories, suggests a preference for tough, durable stone. This is in keeping with the considerable force to which the working edges of these implements were subjected in the course of scraping and planing tough, resistant materials. It is worth noting, however, that the high frequency of unifaces made of chert appears in part due to the availability of large thinning flakes produced as byproducts of the manufacture of large, thin bifaces. These thinning flakes were readily manufactured into unifaces by means of limited unifacial edge retouch. Being thin and yet tough, they were ideally suited for shaving wooden objects—bows for example. Despite their suitability as uniface preforms, it is unlikely that these large chert flakes were produced with this specific purpose in mind.

The metric data for unifaces are presented in table 3.12. It should be understood that the unit of measurement for edge angle is not individual artifacts but individual working edges of which there may be more than one on a single tool.

CORES (18 specimens; all obsidian): Cores

TABLE 3.12
Metrical Data for Unifaces from Pinyon House

	Length (cm)	Width (cm)	Thickness (cm)	Edge angle
$\bar{x}$	2.73	1.93	0.61	51.5°
S	0.92	0.51	0.25	15.9°
n	52	80	95	123°
Range	4.9–1.2	3.5–1.0	1.4–0.2	85–15°

TABLE 3.13
Metrical Data for Cores from Pinyon House

	Length (cm)	Width (cm)	Thickness (cm)
$\bar{x}$	3.20	2.34	1.25
S	0.66	0.54	0.36
n	16	17	17
Range	4.5–2.3	3.1–1.1	1.9–0.7

(table 3.9) are worked stone cobbles from which flakes usable for tools or blanks were struck (fig. 3.10e, f). Two unworked pieces of obsidian obviously intended for this purpose were also classified as cores. Except that they are blocky and exhibit extensive scarring from the removal of large flakes, as a group these specimens do not appear to conform to any specific form or pattern of flaking (table 3.13). Evidently the shape of each piece determined the point at which flakes were removed initially and subsequent work proceeded in such a way as to permit the maximum number of large flakes to be detached, the exact steps varying from core to core. Several cores appear to have been split using a bipolar technique, which produces a nearly flat flake scar with a very flat bulb of percussion and leaves anvil bruises at the base of the piece opposite the platform, where core and anvil make contact. That this method was also commonly used to detach flakes is shown by several cores with multiple flat flake scars characteristic of this technique. In one such case (O-1480), the repeated bipolar removal of flakes produced a long, narrow polygon somewhat reminiscent of a miniature Mesoamerican blade core (fig. 3.10f). This same bipolar technique was also employed in the reworking of bifaces, where it left a flat, burinlike flake scar that served as a platform along which a new cutting edge could be formed or a base or tip refashioned.

Of the specimens worked without the bipolar technique, that is, using simple, or direct free-hand, percussion, the most common procedure appears to have been that of removing a series of flakes to form a platform above a broad, unflawed surface from which, with the aid of the platform, large, desirable flakes could then be removed. None of the specimens exhibits any evidence of platform grinding.

All but two of the cores are Fish Springs obsidian, a visually distinct glass from a diminutive source located on the eastern slope of the Sierra Nevada about 9 km south of the archaeological site of Crater Middens. The glass from this source can be correctly identified megascopically with an accuracy close to 95 percent (Bettinger, 1982b; Bettinger et al., 1984). Of the two odd specimens, one (O-1125) is a small, worn stream cobble of Casa Diablo obsidian—another source for which megascopic identification has proved reliable in about 95 percent of all cases. This cobble may have been retrieved from Long Valley, the source location for Casa Diablo obsidian, or from alluvial deposits along Owens River in Owens Valley, where transported obsidian nodules are relatively common. The other core (O-1435) appears to be either Queen or Mt. Hicks glass—two sources that cannot always be reliably distinguished from each other megascopically but which can be reliably segregated from other eastern California sources.

DEBITAGE (5981 specimens; 4500 obsidian, 1481 chert, chalcedony, rhyolite, quartzite): Debitage is flakes and other lithic debris that has not been intentionally modified or retouched subsequent to detachment from the parent block of material—either a core or an artifact. The bulk is chipping waste resulting from tool manufacture and resharpening but some of the larger specimens were probably removed intentionally to serve as blanks or as sharp cutting or light scraping tools without further modification.

The metric characteristics and distribution of the Pinyon House debitage are presented in table 3.14.

TABLE 3.14
Distribution, Composition, and Metrical Attributes of Debitage from Pinyon House

	Structures								Pinyon House South		
	Surface	1	2	3	4	5	10	14	Surface	St. 1	Total
Count	2819	259	1578	842	101	7	55	78	214	28	5981
Weight (g)	1727.5	94.5	326.2	250.9	32.5	6.3	17.7	19.8	231.7	14.4	2721.5
Mean weight (g)											
Obsidian	0.49	0.29	0.14	0.24	0.16	0.42	0.28	0.24	1.51	0.04	0.32
Nonobsidian	0.89	1.05	1.02	0.53	0.47	1.53	0.72	0.39	1.04	0.78	0.86
Combined	0.61	0.36	0.21	0.30	0.32	0.90	0.32	0.25	1.08	0.51	0.46
Percent obsidian											
Count	69	90	92	80	48	57	91	90	8	36	75
Weight	55	71	61	64	24	27	80	84	12	3	53

As the table data clearly indicate, there is a distinct difference in size between flakes recovered by surface collection and those recovered from screens during excavation. The simplest explanation for this is that small flakes are more readily retrieved from screens than from the ground surface. It is quite possible, however, that the difference accurately reflects an aboriginal practice in which only fine stonework was customarily done indoors and the larger flakes were systematically picked up or swept outside, leaving only the smaller ones behind.

It is equally clear from the observed distribution that Structures 1, 2, and 3 contain larger quantities of debitage than the other structures. This parallels the elaborate construction and intensive use they exhibit relative to other structures at Pinyon House but it is unclear whether the debitage stems from their use as dwellings or as abandoned house depressions well-suited to the disposal of debris.

Although the bulk of the Pinyon House debitage by count and weight is obsidian, also present in substantial quantity are chert, chalcedony, and quartzite, which compose the majority of the debitage recovered from certain features and surface collection quadrats. The differential distribution of nonobsidian debitage at Pinyon House is indicated in table 3.14.

The explanation for this differential distribution of nonobsidian debitage is not clear. One reasonable explanation is that it reflects use of the site by groups from different areas, some of whom had ready access to obsidian, others access to chert and chalcedonies. Since obsidian is readily available in Owens Valley, where it nearly always constitutes the vast bulk of lithic debris at archaeological sites, the groups whose chipping waste is dominated by nonobsidian materials—particularly green chert (see chap. 4)—presumably originated elsewhere, perhaps in Fish Lake Valley or Deep Springs Valley to the east of Pinyon House.

It is also possible that the differential distribution of nonobsidian debitage is a function of a shift through time in the use of different lithic materials for the production of tools. If so, then the preponderance of nonobsidian materials in the debitage from Pinyon House South, which appears to be quite late in time—perhaps historic—would suggest that older features and cultural debris are characterized by a preponderance of obsidian debitage, younger features and deposits by a preponderance of nonobsidian debitage. An examination of the Crater Middens debitage provides substantial evidence to support this notion. This shift in the material composition of debitage is apparently related to the rise of a specialized chert biface industry in late prehistoric times (see chaps. 4, 9, 11, and 12).

It is also evident in table 3.14 that nonobsidian debitage is larger ($\bar{x}$ = 0.86 g) than obsidian debitage ($\bar{x}$ = 0.32 g), hence it is proportionally better represented by weight than by count. There are at least three explanations for this. One is that sources of ob-

sidian were farther away than sources of the other kinds of stone, green chert in particular, since it constitutes the vast majority of this material. Were this so, one would expect that pieces of obsidian would tend to reach this site in more finished form and consequently require less shaping and finishing than objects fashioned from other materials; it would then follow that flakes of obsidian ought to be smaller than flakes of other kinds of stone. This is clearly not the case, however, since the source of the green chert has been recently placed in Eureka Valley more than 40 km to the southeast of Pinyon House (C. J. Adams, personal commun.), roughly twice as far away as the closest source of obsidian, which is Fish Springs about 20 km to the southwest.

A second explanation is that, being more brittle, obsidian is simply easier to work in smaller pieces than chert, which is tougher and less easily flaked. Accordingly, aboriginal craftsmen may have made some attempt to fashion something useful from all but the very smallest pieces of obsidian while discarding all but the largest and most conveniently shaped flakes of chert. Although this is probably true at least as a general rule-of-thumb, at Pinyon House the difference in size between obsidian and other flakes seems more closely related to the kinds of implements that were made from these materials.

Accordingly, a third explanation is that materials other than obsidian were principally used for the production of large tools and that the resulting waste flakes were correspondingly large. As just noted, there is some support for this suggestion. The larger bifaces and biface fragments from both Pinyon House and Crater Middens tend to be made of the same green chert (Eureka Valley) that constitutes the vast majority of nonobsidian debitage at these two sites. Indeed, it would appear that broad, thin bifaces of this chert where highly valued as items of trade and that special care was given to their production, perhaps because they could be made larger than bifaces fashioned from other kinds of stone (cf. chaps. 10 and 12). Parenthetically, Steward (1941: 336) reports what seems to be a similar ethnographic case near Battle Mountain, Nevada, where a particularly fine-quality white chert was the center of a craft specialization in which large, highly valued knives were made and widely traded. In any event, at Pinyon House, as at Crater Middens, the greater size of nonobsidian debitage apparently reflects the preferential use of chert in the production of large bifaces, the waste from this activity being larger than the waste from the manufacture of smaller bifaces and other implements, which are predominantly obsidian.

OTHER ARTIFACTS

HAMMERSTONES (2 specimens; 1 quartz, 1 granitic): Both hammerstones in the Pinyon House collection were recovered from the surface of the site (table 3.15). The larger of these (O-1234) measures 8.2 cm in length, 6.6 cm in width, 5.0 cm in thickness, and shows extensive battering on each end and one lateral margin (fig. 3.2e). The smaller example (O-1406) is a small, oblong, stream-rounded pebble of granitic stone. It is 6.1 cm long and about 2.8 cm in diameter and exhibits use-wear on both ends and one side.

SHAFT SMOOTHER: A small piece of pumice (O-266; table 3.15) is interpreted as a fragment of a grooved shaft smoother. The original appears to have been tabular in form, with the two faces ground flat and a groove running lengthwise along one (lateral) side; the opposite lateral side is unmodified. It measured 3 cm in width and 2.0 cm in thickness; the length cannot be determined from this piece, which is one end of the original. Only a small part of the lateral groove is present but it appears to have been about 0.6–0.8 cm in diameter, which approximates the range of shaft sizes that could be worked with this tool.

ABRADERS (2 specimens; 1 limestone, 1 welded tuff): Two artifacts are interpreted as abraders used to shape objects of wood. One of these is an angular fragment (O-1454) of limestone that on one face shows evidence of abrasion that has rounded, rather than flattened, localized protuberances and extends into concavities well below the main surface of the piece. This suggests contact with a soft but resistant material such as wood rather than stone, which produces wear in a single plane and leaves areas below this plane unmodified. Manos and millingstones typically exhibit planar wear, for example.

The other abrader (O-1187) is a small fragment of welded ash or tuff that exhibits a small, flat wear facet on one face. The inference that this is an abrader rather than a mano fragment is based on the excessive friability of this tuff, which would seem to preclude effective use in plant processing.

PENDANT: A small, tabular pendant of slate was found on the surface. It is suboval in outline and measures 2.6 cm long, 2.2 cm wide, and 0.3 cm thick (fig. 3.11a). It is broken at one end, where two small biconical perforations placed close to an edge created a weak point. This snapped, resulting in the loss of the small segment of the pendant margin isolated between the two perforations. Both faces and the entire edge of the piece are ground but there is no other evidence of decoration. The presence of two perforations may indicate that this pendant was designed to be worn with one of its broad faces forward—either by being sewn onto a garment or strung on a cord that passed through both perforations—rather than worn edgewise, as would be the case were it strung on a cord passing through a single perforation. On the other hand, it might be that one of the perforations had broken and that the second was drilled to permit the pendant to be restrung, whereupon it broke during repair or some time thereafter.

Pendants, both incised and unincised, are frequently encountered in archaeological contexts in the Inyo-Mono region but are by no means common (Lanning, 1963: 248; Steward, 1933: 275, fig. 7; Riddell, 1951: 16).

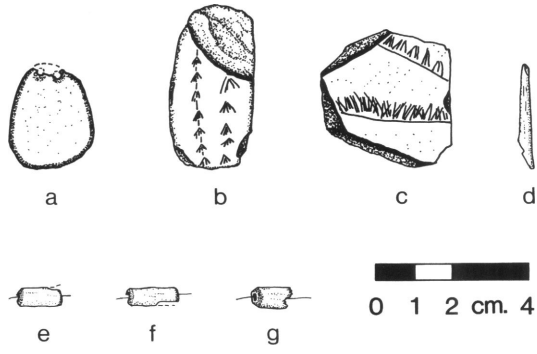

Fig. 3.11. Miscellaneous artifacts of stone and worked bone from Pinyon House. **a.** pendant; **b, c.** incised slates; **d.** bone needle; **e–g.** bone beads. a. O-1248; b. O-231; c. O-1452; d. O-193; e. O-1599; f. O-1607; g. O-1547.

INCISED STONES (4 specimens; all slate): Among the more problematic objects that are regularly encountered at archaeological sites in eastern California are tabular pieces of slate or other stone-bearing incised designs of various kinds. Four of these objects were recovered at Pinyon House (table 3.15). Each merits individual description.

The most carefully made of the four

TABLE 3.15
Distribution of Other Artifacts of Stone and Worked Bone at Pinyon House

		Structures							Pinyon House South		
	Surface	1	2	3	4	5	10	14	Surface	St. 1	Total
Hammerstones	2										2
Shaft smoother				1							1
Abraders	2										2
Pendant	1										1
Incised stones	1			3							4
Stone bowl									1		1
Pot rest					1						1
Worked bone											
Bone beads		1	4	2							7
Awls				2							2
Needle		1									1
Lagomorph mandibles		1		1							2
Unidentifiable		2	3	1			1				7

(O-231), one of three found in Structure 3, is subrectangular in outline and measures 4.4 cm long, 2.3 cm wide, and 0.4 cm thick. This piece has been shaped by grinding on both ends. Incision is clearly evident on only one face, but the reverse face shows faint linear scratches that may be the remnants of an incised design. The more clearly marked face exhibits a complex pattern of incision within which individual designs can be discerned only with difficulty (fig. 3.11b).

A second tablet (O-264) recovered from Structure 3 resembles the first in its subrectangular outline but is much larger. A diagonal break near one end precludes accurate estimate of both the length and width of the original specimen but it was more than 5.1 cm long, at least 3.8 cm wide, and 0.5 cm thick. This tablet is less well worked than the first. Grinding is restricted to one lateral edge, where it is quite pronounced, and one face, where it is rather faint. Some shaping of the outline appears to have been accomplished by light percussion. Incision is limited to a series of light, parallel striations that run diagonally across the face that is ground.

A small tabular piece of slate (O-232) that has been ground on both faces and on two projections along one side, but is otherwise unmodified, was provisionally identified as a tablet fragment. This specimen, which is 0.6 cm thick, represents so small a fraction of the original that neither the length nor width could be ascertained. This artifact lacks the incision noted on the other tablets found at Pinyon House, but was carefully ground, appears to be too small for a millingstone, and is most likely a tablet fragment. It was also found in Structure 3.

The fourth tablet (O-1452) recovered at Pinyon House is from the surface. It is a small triangular piece of slate, two corners of which are broken. One of these breaks appears to have occurred before the piece was made into a tablet and was subsequently ground during manufacture. The other break occurred when the artifact was complete and remains unworked. Both edges adjacent to the more recent break are ground, one at an angle, the other perpendicular to the plane of this tabular piece. One face is lightly ground; the other exhibits carefully patterned incisions (fig. 3.11c).

Unperforated incised stones are reported for several archaeological sites in the Inyo-Mono region (Lanning, 1963: 248, fig. 3; J. T. Davis, 1963: 299; Harrington, 1957: 69, fig. 49) and surrounding areas in California (Hunt, 1960: 267, fig. 72; Ritter, 1980: 103–105, fig. 4; Wallace and Taylor, 1955: 362–363; Lathrap and Meighan, 1951: 24; Meighan, 1953: 184–185) and the Great Basin (McKee and Thomas, 1972; Thomas, 1983). In central Nevada, these stones are clearly of substantial antiquity, being present at least as early as 5000 B.P. at Gatecliff Shelter. The dating of incised stones is less well established in eastern California, but most investigators would place the bulk of them after A.D. 600 (Hunt, 1960; Lanning, 1963: 264).

The function of these objects is even more uncertain, although some connection with magicoreligious beliefs seems clear. It is worth noting that the slates that have been reported from eastern California, including the specimens described here and subsequently for Two Eagles and Crater Middens, differ from those that have been reported from central Nevada (e.g., McKee and Thomas, 1972) in that they nearly always display some edge grinding in addition to incising. Presumably this reflects more careful curation of incised slates, perhaps as personal charmstones, in eastern California. In central Nevada, on the other hand, their importance may have been limited to individual magical or religious performances outside the immediate locational and temporal context of which they ceased to be of value.

MISCELLANEOUS ARTIFACTS OF STONE: There are two objects of stone that have been modified by intentional shaping or use for which no clear function can be inferred. One (O-1679), a piece of vesicular basalt found on the surface of Pinyon House South, may be part of a stone bowl the overall size and shape of which cannot be ascertained from this one fragment although the wall thickness would have been close to 2.0 cm.

The second enigmatic object is a tabular rectangle of siltstone measuring 7.3 cm in length, 5.7 cm in width, and 1.2 cm in thickness. The piece is naturally curved to form a shallow dish. The bottom, or convex face, shows moderate abrasion; the top, or concave side, bears faint scratches. It is possible that

this object was used as a pot or basket rest, but this is largely speculation.

WORKED BONE

BONE BEADS (7 specimens; unidentified rodent or bird bone): Seven worked pieces of rodent or bird bone were identified as beads (table 3.15; fig. 3.11e–g). None is complete. Six of the seven are longitudinal sections, two of which retain portions of both worked ends. One of these (O-1607) is 1.3 cm long, the other (O-1599) is 1.1 cm long. Three of the other four longitudinal pieces (O-223, O-1593, O-1762) retain only one worked end and the fourth (O-1765) is a polished midsection lacking both worked ends. The remaining specimen (O-1547) appears to be a discard trimmed off the end of a longer section that was being made into a bead.

In all cases where a worked end is sufficiently intact to determine method of manufacture, it is evident that the bead was cut to length from a longer section by means of a series of transversely sawn grooves, snapped at the weak point made by these grooves, and then ground and polished at each end.

OTHER WORKED BONE: In comparison to those of stone, artifacts of bone are extremely scarce in all the collections considered in this volume. At Pinyon House, other than beads only 12 specimens were found (table 3.15) and even among these few there are cases in which the evidence of modification is tenuous.

Two fragments (O-222 and O-282) of worked ungulate bone exhibit a distinctive grinding and polish that identifies them as awls. Neither is sufficiently complete to permit inferences as to the size of the tools from which they derive.

A small sliver of rodent bone (O-193), chipped at the narrower end and polished from there back to about its midpoint, was identified as a perforator or eyeless needle used in fine hidework. It is 2.8 cm long, 0.3 cm wide, and 0.2 cm thick (fig. 3.11d).

Two right lagomorph mandibles each retaining one incisor, one from a jackrabbit (*Lepus* sp.; O-1759) and one from a cottontail (*Sylvilagus* sp.; O-281), were identified as possible tools, though neither shows obvious evidence of use; the cottontail jaw, however, which is charred and polished, is broken behind the first molar and the right incisor is snapped at the point where it enters its socket. The jackrabbit jaw is complete and uncharred and shows cut marks on the exterior ascending ramus where muscle tissue and sinew were severed to remove it.

There is ample archaeological evidence that unmodified rodent jaws were employed by North American aboriginal groups in a variety of capacities including hideworking (Valliant, 1931: 313; cf. Flannery and Winter, 1976: 34) and stoneworking (Haury, 1950: 382–383); they would serve equally well as fine chisels in woodworking. This, and the observation that these two specimens are substantially more complete than might be expected given the general character of faunal remains from the site, make it reasonable to assume that they are tools.

The balance of the worked bone collection consists of small fragments that exhibit striations or polish suggesting intentional modification or use but are insufficiently complete to permit reliable inferences as to the tools from which they derive. Two of these are rodent bones, one of which is the left radius of a jackrabbit (*Lepus* sp.). The other five pieces are ungulate bone.

BEADS OF SHELL AND STONE

SHELL BEADS (10 specimens; 7 *Olivella,* 3 *Tivella*): As do all of the specimens from Two Eagles and Crater Middens, the ten shell beads found at Pinyon House can be placed into well-recognized types previously defined for use in central and southern California. Many of these pieces were, no doubt, imported from the south or west and carry roughly the same chronological implications in Owens Valley as where they were made. On the other hand, there is unequivocal evidence of bead production at Crater Middens and it is entirely possible that some local beads resemble recognized shell bead types without carrying the same temporal implications as they do. For the moment it seems reasonable to assign dates to shell bead types in accord with chronologies established elsewhere, recognizing that these dates are tentative.

Represented in collections obtained from the three sites considered in this volume were

TABLE 3.16
Distribution of Shell and Steatite Beads at Pinyon House

	Structures								Pinyon House South		
	Surface	1	2	3	4	5	10	14	Surface	St. 1	Total
Shell											
Olivella											
A1a	1										1
D1			1								1
H1b	1			3							4
H3	1										1
Tivella											
Thin Disk		2									2
Cylinder			1								1
Steatite Disk			2								2

11 *Olivella* bead types, two *Tivella* bead types, two *Haliotis* bead types, and one limpet bead type. The *Olivella* types found at Pinyon House (table 3.16) were Small Spire-lopped (Class A1a), Split Punched (Class D1), Semi-ground Disk (Class H1b), and Chipped Disk (Class H3). Both *Tivella* bead types (Thin Disk and Cylinder) are present at Pinyon House. Save for the Split Punched *Olivella* and *Tivella* Cylinder, which are most likely Baker phase markers, these shell bead types are tentatively dated to the Klondike phase.

STEATITE DISK BEADS (2 specimens): Two Steatite disk beads were recovered (table 3.15). The dating of Steatite beads in Owens Valley is less secure than that for those of shell. Because most were probably made after A.D. 600, and the majority after A.D. 1300, the type is provisionally regarded as a Klondike phase marker (cf. Basgall et al., 1986).

MINERALS

QUARTZ CRYSTALS (3 specimens): Three small, unmodified quartz crystals were found (table 3.17). The largest, which is 1.9 cm long and 1.1 cm wide, and the smallest, which is 1.0 cm long and 0.6 cm wide, retain their terminations and are clear. The remaining piece, which is 1.0 cm long and 1.1 cm wide, lacks the termination and is cloudy rather than clear. It was found on the surface of Pinyon House South.

As no natural source for these crystals is evident in the immediate vicinity of Pinyon House, they were presumably imported by the inhabitants of the site as ornaments or, what seems more likely, as talismans of some sort. It is curious that none of the three is modified, which is in marked contrast to the quartz crystals recovered at Two Eagles, nearly all of which exhibit chipped terminations or ground edges. It is perhaps relevant in this regard, that in comparison to the sample from Pinyon House, quartz crystals are much more common at Two Eagles, where, on the basis of crystal matrix fragments, it would appear they were actively being retrieved from nearby natural outcrops and subsequently trimmed of extraneous material at that site. The small number of crystals represented and the absence of crystal matrix debris at Pinyon House, on the other hand, would indicate that either no crystal source was near at hand or that the inhabitants of the site for some reason—perhaps preoccupation with other activities—chose not to exploit such a potential source.

RED OCHER (1 specimen): A small bit of red ocher was found. This piece is severely weathered and it cannot be ascertained whether it had actually been used as a source of pigment. That it was brought to the site for this kind of use ultimately, however, seems certain.

OTHER MINERALS: Among the other unmodified minerals found (table 3.17), all exotic or rare to the vicinity of Pinyon House, were three pieces of a fine, powdery mineral resembling chalk. Steward (1933: 277) indi-

TABLE 3.17
Distribution of Minerals at Pinyon House

	Structures								Pinyon House South		
	Surface	1	2	3	4	5	10	14	Surface	St. 1	Total
Quartz crystals	1			1					1		3
Red ocher		1									1
Chalk		3									3
Specular hematite		1									1
Black vesicular basalt	2		5								7
Fossil coral/crinoid (?)			2								2

cates the Owens Valley Paiute obtained chalk for use as pigment from a source at the eastern margin of the Poverty Hills near what is today Tinemaha dam, or about 11 km southeast of the site of Crater Middens. It is possible that this is the source of the chalky mineral found at Pinyon House and similar pieces of chalk found at Two Eagles and Crater Middens.

Also on the list of unmodified minerals recovered at Pinyon House was a small, shiny, platy fragment of specular hematite of which several fragments and one complete artifact were also found at Two Eagles (see below).

Seven fragments of black vesicular basalt were recovered. These probably derive from basaltic flows in the vicinity of Crater Mountain or on the east side of the valley south of Crater Mountain and immediately adjacent to Tinemaha reservoir—and thus not far from the chalk source just mentioned. It is likely they were brought to the site as parts of larger blocks that were worked into manos or millingstones or to be traded for this purpose to other groups lacking access to this material.

Lastly, two cylindrical fragments of what would appear to be fossil corals or crinoids, both of which occur in fossiliferous deposits of the Inyo Mountains, were recovered.

ARTIFACTS OF WOOD

PINYON HOOKS: Pinyon hooks are simple or composite staffs fitted with distal hooks that permitted individuals engaged in pinyon collection to shake or bring within reach cone-laden pinyon limbs otherwise beyond their grasp (cf. Steward, 1933: 241). One complete composite specimen and three individual elements thought to be components of composite specimens were found on the surface at Pinyon House (table 3.18). In all cases the material used was slim and relatively straight limbs of what appears to be water birch (*Betula occidentalis*). Each had been trimmed to remove projecting twigs and cropped at its

TABLE 3.18
Distribution of Artifacts of Wood at Pinyon House

	Structures								Pinyon House South		
	Surface	1	2	3	4	5	10	14	Surface	St. 1	Total
Pinyon hooks											
Complete	1										1
Proximal element	1										1
Distal elements	2										2
Cone paddle	1										1
Miscellaneous											
Chips		1						1			2
Basketry element (?)								1			1

tip (at least this is true where enough of the latter remained to determine whether it had been modified in this manner).

The one complete specimen and the largest of the three components were found resting together, the complete specimen in the crotch, the component at the base, of a large pinyon tree. The complete composite piece was made by lashing two limbs to make a pole that is 3.0 m long. The proximal element of this specimen (O-1270/NCA) is the stouter of the two, measuring 2.40 m in length, 3.0 cm in diameter at the butt, which forms the proximal end of the complete implement, and 0.9 cm at the tip, which overlaps the distal element. The distal element (O-1270) is 1.60 cm long, 0.8 cm in diameter at the tip, and 2.2 cm in diameter at the butt, which forms the distal end of the complete implement, this shorter piece being mounted butt-forward so that the weaker tips of both limbs could be lashed together (fig. 3.12). The lashing is in two places, the more distal of the two placed toward the tip of the stouter piece and made of wire, the more proximal toward the tip of the lighter piece and made of leather thong (O-77). The thong remained loosely in place when the site was found in 1972, but had by 1977 fallen away leaving a series of spiraling stains on the lighter element marking its former placement. When still in place, this thong was at least one meter long and exhibited a slot cut into one end, perhaps to secure the other end and fix the lashing in place. Only a small segment of the thong could be found in 1978; it is 0.7 cm in maximum width and 0.2 cm in maximum thickness. The wire used in the upper lashing is 0.2 cm in diameter and binds an area about 10.5 cm long.

Whittled at one side of the extreme distal end of the implement (at the butt of the distal element) is a small notch to seat a lashing which held a shorter section of limb mounted as a barb, thus forming the distal hook. This barb (O-76) was found not far from the base of the tree in which the composite specimen rested. It is 15.0 cm long, 3.3 cm in diameter, has been shaved to a blunt point, and exhibits on one side a whittled notch matching the notch cut into the distal end of its longer mate. Matching frayed ends on this barb and the longer element to which it had once been joined makes it clear that the hook was fashioned by turning a section of the distal element back on itself at a point weakened by pounding. The notches were then cut on the outside of the angle thus formed and in these notches was seated a lashing to prevent the hook from straightening under pressure.

The simple pole (O-1270/NCB) found at the base of the tree in which the complete composite specimen was found is 2.40 m long, 3.3 cm in diameter at the butt, and 1.6 cm in diameter at the tip, which appears to be broken. That this piece is unmodified other than by the trimming of projecting twigs suggests it was the proximal element of a composite pinyon hook similar to the complete one found nearby. Alternatively, it may have been used by itself to beat, rather than shake, ripe cones from high limbs.

Two smaller trimmed limbs, one complete, the other fragmentary, found in association with Structure 7 are of a size that suggests they were distal elements of composite pinyon hooks. The intact specimen (O-1258) is 1.41 m long, 0.9 cm in diameter at the tip, and 2.2 cm in diameter at the butt, which is modified by a shallow cut or ground constriction evidently placed there to seat a lashing used to mount a barb or hook. Unlike the complete composite specimen, however, the butt end adjacent to this constriction does not appear to have been pounded and it is likely that in this instance the barb was made from a separate piece of wood. There is no trace of lashings that might have been used to bind this piece to a larger proximal element and it is possible that this implement was used without being so mounted. The other limb (O-1279) is presently 1.13 m long but is broken at the butt, where it measures 1.2 cm in diameter, the tip being 0.9 cm in diameter. Other than the trimming of the projecting twigs, the piece is unmodified and shows no evidence of lashing. Presumably this specimen was part of the distal component of a composite pinyon hook, but there is the possibility that it is the tip section of a much larger proximal component or that it is part of a simple (i.e., noncomposite) pinyon hook.

CONE PADDLE: A slab of pinyon wood, pried or chopped from the exterior of a downed tree or standing snag and rudely shaped by whittling or chopping, is tentatively identi-

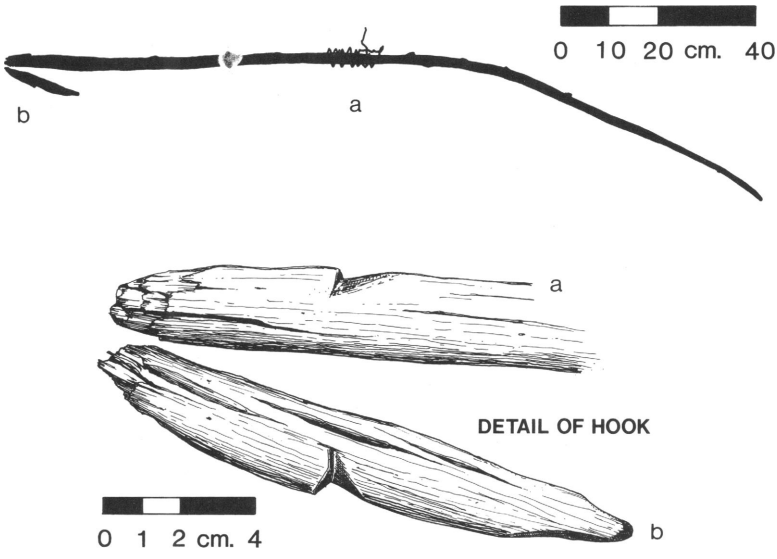

Fig. 3.12. Distal element (a. O-1270) and barb (b. O-76) of composite pinyon hook found at Pinyon House. As described in text, a complementary proximal element (O-1270/NCA; not shown) was attached to distal element by an upper lashing of wire, which remains attached to this distal element, and a lower lashing of thong (O-77; not shown), which had recently fallen away.

fied as a paddle used to thresh pinecones to aid in the removal of enclosed nuts or to scrape cones from roasting fires (fig. 3.13). Found in association with Structure 7 (table 3.18), this paddle (O-1257) is 44.0 cm long, 11.0 cm in maximum width, 3.3 cm in thickness, and sublenticular in plan, with one end narrowed by whittling to form a handle 3.6 cm wide. The ventral face appears to have been hollowed slightly by trimming with an axe; the dorsal face is the barkless concave trunk exterior, channeled by bark-beetle galleries but otherwise unmodified. The distal end of the paddle is both charred and worn, which is consistent with the notion that this tool was used to remove cones from roasting fires. There is, however, nothing to preclude its use as a threshing paddle, for which it is well suited in shape and size, or even as a shovel. There is no ethnographic mention of any similar implement.

MISCELLANEOUS ARTIFACTS OF WOOD: Two chips of axe-cut wood were found, one (O-125) in Structure 14, the other (O-164) in the upper part of the buried deposit in Structure 1 (table 3.18). In both contexts the historic date implied by these objects is consistent with that implied by other sources of evidence (cf. table 3.19).

A single strip of what appears to be a willow basketry element was found in Structure 14. It is 0.4 cm wide, 0.1 cm thick, and its fragmentary length is 2.7 cm.

HISTORIC ARTIFACTS

An extensive assemblage of historic artifacts was recovered by surface collection and excavation at Pinyon House (table 3.19). It is believed that all of this material derives from historic aboriginal occupation of the site and not from visitations by Euro-Americans.

METAL CONTAINERS

ENAMELWARE: Two examples of mottled gray enamelware were found on the surface of the site in association with Structure 9. One of these (O-1529) is a handled pot with rounded sides. It is 10.2 cm tall, 18.0 cm in diameter at the top, 17.0 cm in diameter at the base, and 19.4 cm in maximum diameter, which is midway between the top and base. The handle is perforated and measures 18.5 cm long and 2.6 cm in width. The enamel

Fig. 3.13. Cone paddle (O-1257) from Pinyon House.

coating is missing in several places, allowing the unprotected metal beneath it to rust entirely through. Four of these rusted holes had been patched by inserting a narrow piece of lead through the opening and then pounding this patch on either side to close the opening and secure the lead. These mends indicate that this vessel had become dilapidated before being cached or discarded at the site. Possibly it had been obtained from a refuse dump in this condition or had simply grown worn with sustained use.

The other piece of gray enamelware is a flanged pan (O-1530) that stands 7.8 cm tall and is 24.3 cm in diameter across the flanges, 17.0 cm in diameter at the base, and is 21.5 cm in diameter across the opening inside the flanges. As in the case of the matching pot, this piece has rusted through in several places; there is, however, no evidence of any attempt at patching.

TINWARE: Five pieces of tinware were recovered from the surface of Pinyon House: a pail with matching lid and a plate found in association with Structure 9 and a wash basin or pan and a kettle or pot lid found about 15 m southwest of Structure 9.

The pail (O-1531) is a 19.0 cm tall, 19.6 cm in diameter at the top, and 17.8 cm in diameter at the base. The bottom and side seams are locked and the top edge has been finished by rolling it inside on itself. The matching lid (O-1532) exhibits a simple stamped flange and is 20.9 cm in diameter and 1.5 cm tall. Its locked seams date this specimen sometime after 1895, when cans produced by this method were first made; by 1922 locked seam cans had entirely replaced those made with the simpler lapped seams (Busch, 1981).

The tin plate (O-1533) is stamped with a flange at the rim, the edge of which is rolled to the outside on itself. It measures 26.4 cm across the flanges, 20.1 cm across the bottom, 24.0 cm across the opening inside the flanges, and stands 2.5 cm tall. There appear to be traces of paint on the exterior.

The wash pan (O-1536) is a simple stamped affair with a top flange the edge of which has been finished by rolling it outside on itself. It measures 31.8 cm across the flanges, 25.0 cm at the base, and 30.0 across the opening inside the flanges.

The kettle or pot lid (O-1537) is 18.5 cm in diameter, about 1.0 cm tall. A small perforation at its center has been reinforced by soldering a thin disk of stamped metal to its top. Extending through this is a ⅛ in. (0.3 cm) round-head bolt secured by a square

TABLE 3.19
Distribution of Historic Artifacts at Pinyon House

	Surface	Structures 1	2	3	4	5	10	14	Pinyon House South Surface	St. 1	Total
Metal containers											
Enamel ware											
Pot	1										1
Pan	1										1
Tin ware											
Pail	1										1
Pail lid	1										1
Plate	1										1
Wash basin	1										1
Kettle lid	1										1
Tin cans											
Hole-in-top	1										1
Sanitary	5										5
Can lids	3										3
Glass bottles (fragments)											
Free-blown bottle	15	1									16
Western Meat Company bottle	19										19
Rectangular bottle	13										13
Miscellaneous fragments	3			4							7
Window glass		3									3
Clothing											
Levi-Strauss											
Brass rivets		9									9
Inscribed buttons		6									6
Uninscribed buttons		2									2
Buckle		1									1
Glass buttons				1	1						2
Awl										1	1
Cloth fragments								3			3
Leather											
Thong	1										1
Shoe leather	2										2
Looped wire	1										1

washer; the bolt presumably served to attach a wooden knob, which either burned or rotted away.

TIN CANS: Six tin cans and three can lids, two of them matching cans in the collection, were found on the surface of the site. Of these, one of the cans (O-1534) was found in association with Structure 9, three cans (O-1538, O-1539, O-1540) and a can lid (O-1535) were found about 15 m southwest of Structure 9, and the balance was found within the area gridded in quadrats for surface collection: (O-1523A, O-1227, O-1228, O-1215). With one exception (O-1538) the cans are made with locked side seams, dating them after 1895.

All of the specimens not fitted with lids, i.e., that had to be cut to remove the contents, have been crimped flat along the cut edges, presumably so that they could be subsequently used as containers without danger of causing cuts. As no corresponding cut can tops were found at the site, it is possible that all these cans, and in turn, those fitted with lids as well, were already devoid of their original contents when brought to the site, being carried there to serve as watertight, fireproof containers for cooking and storing water.

The one rectangular can in the collection (O-1523A) is 15.6 cm tall, 12.9 cm wide, and 8.5 cm thick. The side seams are locked but both the top and bottom seams are merely lapped and soldered, a method that seems better suited to containers with square corners. The ragged edges of the opened top have been flattened to permit use as a container.

The largest of the cylindrical cans (O-1540), now badly crushed, was about 22.8 cm tall and 13.5 cm in diameter. The bottom and side seams are locked, and the top seam exhibits a reinforcing band on the inside, locked to the wall. This construction suggests the use of a fitted lid, but none of the proper size was found at the site.

Another relatively large cylindrical can (O-1539) exhibits locked top, side and bottom seams and a cut top, the edges of which have been crimped to permit use as a container. It is 16.7 cm tall and 12.7 cm in diameter.

The only hole-in-top can found at the site (O-1538) is 8.0 cm tall, and 10.3 cm in diameter and was made with the lapped top, bottom, and side seams and lead-soldered pin-hole disk that distinguish cans of this type. In combination, these features suggest manufacture prior to 1922, when the locked-seam sanitary can entirely replaced cans of the hole-in-top type, with the exception of condensed milk cans, which continue to the present to be made with lapped seams and soldered vent hole (Busch, 1981). The specimen found at Pinyon House has been made serviceable as a container by entirely removing the bottom section, exposing the straight base of the can wall, which required no crimping to ready it for use.

The two remaining cans, both with locked bottom and side seams, were fitted with simple stamped flange lids, both clearly marked as "Schilling" products. The larger of the two cans (O-1534) is 9.1 cm tall and about 12.6 cm in diameter. The matching lid (O-1535) is 12.8 cm in diameter, 1.0 cm tall, and is inscribed, "Coffee Schillings Best," in three lines. The other lidded can (O-1227) is 13.3 cm tall and 8.3 cm in diameter; its lid (O-1228) is 8.3 cm in diameter, 2.0 cm tall, and is inscribed, "Schilling's Best 16 oz.," in three lines. The general shape of this specimen is reminiscent of those used today to contain baking powder, but it is entirely possible that its contents were of some other kind, a spice, for example.

The remaining tin can component is an uninscribed lid with a stamped flange (O-1215). It is 7.7 cm in diameter and 0.3 cm tall. Unevenness in the height of the flange raises the possibility that this is not a lid at all but rather the bottom of a lap-seamed hole-in-top can that had been removed to permit use of the rest of the can as a container.

Glass

Glass Bottles: The remains of at least three glass bottles, two of them partially reconstructable, were found. All three are so minutely fragmented that they must have been broken intentionally, perhaps to obtain pieces that could be worked into tools. Very few examples of glass debitage and ony one or two finished tools or identifiably use-worn fragments of glass were recovered, however, which tends to militate against this interpretation. On the other hand, large portions of all three bottles are missing and these may have been carried elsewhere and worked into tools.

One of the reconstructed bottles is represented by 16 dark olive-green fragments (O-72, O-73, O-131, O-145, O-201, O-1491, O-1513) not all of which fit but which nevertheless clearly belong to the same parent bottle. This specimen appears to have been free-blown without the aid of a mold: no seams are in evidence, the lip and base are uneven, and the body and neck are asymmetrical rather than round. There is a deep "kick-up" in the base, the center of which is missing, and a bead of glass has been laid on just below the lip, which is sheared. Both interior and exterior surfaces are marred by bubbles and dimples The wall thickness varies from 0.5 to 0.2 cm. Judging from the fragments that could be fitted together, the complete bottle was round in plan, straight-sided, with rounded shoulders that recurved and tapered to form the neck. The overall shape is similar to that of modern wine bottles. The absence of fragments from the upper sides and shoulders precludes accurate measurement of height, but it was minimally 20.6 cm tall and probably about 27.0 to 30.0 cm in this di-

mension. The body varies from 7.8 to 8.0 cm in diameter at the base; the neck is 2.8 cm in diameter at a point 2.5 cm below the lip, which is incomplete and could not be accurately measured.

In combination, the manufacturing techniques employed to make this bottle date it somewhere between 1840 and 1870 (Newman, 1970). This date is consistent with the earliest permanent settlement of Owens Valley by Euro-Americans at about 1861, which would have made glass bottles and other glass and metal items generally accessible to native groups for the first time. Unfortunately, bottles and other historic materials of this period can still be found in trash dumps in this part of eastern California. Accordingly, aside from its use as an indicator of maximum age, this bottle cannot be assumed to date the historic aboriginal assemblage of which it is a part, since there is the possibility it was scavenged from such a dump long after it had been discarded originally. Granting this, the concentration of fragments belonging to this bottle in association with Structure 1 is at least consistent with other evidence (e.g., items of metal) that suggests reuse of this feature as a pinyon roasting hearth in historic times. Only one of these fragments was recovered from the buried deposit of this feature, but ten others were found on its surface and the other five in adjacent surface quadrats.

The other reconstructable bottle is more complete than the first and consists of 19 aqua-tinted fragments found in one surface quadrat, all of which fit together (O-69). This bottle stands 28.6 cm tall and has a body that is square in plan, measuring 7.5 cm in width and about 16.0 cm from the base to the shoulder. There are mold seams around the base, along two opposing corners of the body, both sides of the neck below the lip, around the base of the lip bulge, and around the inside of the lip. These characteristics mark it as a machine-made bottle produced sometime after 1903 (Toulouse, 1969). Markings on the sides of the bottle provide evidence that is consistent with this estimate. The side bears the word "Primrose" in script, and below this the printed word, "REGISTERED" in a banner, to the right of which is the word, "BRAND," and below this the words, "WESTERN MEAT COMPANY." Another side bears the trademark, "I.P.G.CO." The trademark identifies the bottle as a product of the Illinois Pacific Glass Corporation, a San Francisco glasswork in business between 1902 and 1930 (Toulouse, 1972: 269), which is, thus, the date for the bottle. As with the previous specimen, however, other than as an indication of maximum age, no firm link can be established between the date of the bottle and the date of the aboriginal occupation that resulted in its deposition at the site. It is unlikely, however, that Pinyon House sustained much aboriginal occupation after 1930, native lifeways being well in eclipse by that time and there being at the site none of the characteristic items one might expect from such an occupation, rubber and plastics, for example.

The remaining glass bottle is represented by 13 aqua-tinted fragments found on the surface of the site (O-1368, O-70, O-1379) and one (O-1810) for which the provenience has been lost. These fragments vary in thickness from 0.2 to 0.5 cm. Only two could be fitted together, so no detailed reconstruction of the shape and size of the bottle is possible. It would appear from the few pieces found, however, that the bottle was straight-sided and rectangular in plan with castellated corners, each with five faces. This produced a recessed panel in each of the four sides. There is lettering on at least one of the two wider panels, i.e., one of the two broader sides. The shape of this bottle, the lettering, and seams observed on a few fragments indicate manufacture in a mold. With so few data available, nothing else can be said about this specimen.

Aside from those that could be conclusively identified as belonging to one of the above bottles, seven aqua-tinted bottle fragments were found that might belong to either of the two similarly colored bottles or to one or more altogether different bottles. Three of these (O-87) were found in a discard pile left by a relic seeker in front of Structure 14; the other four were recovered in Structure 3, where they had almost certainly been discarded as trash sometime after that dwelling had been abandoned.

WINDOW GLASS: In addition to the above, three fragments of window glass (O-170), 0.3 cm thick, were found in the buried deposit

of Structure 1. Although no precise date can be offered for these three fragments their presence is consistent with other evidence that indicates historic use of this structure as a pinyon roasting hearth.

Levi-Strauss Clothing Findings

Among the more remarkable historic artifacts recovered at Pinyon House were several metal fastenings that are evidently all that remains of one pair of denim overalls made by Levi-Strauss and Company. These include nine brass rivets (O-153, O-168), each about 1.0 cm in diameter and circularly inscribed "-LS & CO-SF" (Levi-Strauss and Company, San Francisco). This appears in raised lettering on the piece bearing the pillar and in stamped lettering on the piece through which the pillar was inserted. Also plainly marked as products of Levi-Strauss and Company are six metal buttons (O-147, O-158, O-166) and a small metal buckle (O-169). The buttons are 1.7 cm in diameter and circularly inscribed, "Levi-Strauss & CO * S.F. CAL*." Seated in a short, hollow column extending from the back of each button is a small rivet, which served to attach the button. Also found were two smaller, uninscribed metal buttons (O-159, O-167). These are identical in shape and construction to the six larger ones and can safely be assumed to derive from the same garment (see below). Each of these is 1.4 cm in diameter. The buckle is a hollow rectangle within which running lengthwise just to one side of the midline is a movable pillar with two small prongs. The pillar is inscribed, "*L.S. & CO.*."

It seems reasonably certain that these findings all derive from the same garment, not only because the number of rivets and buttons is approximately correct for one set of button-fly bib overalls, but because they were all found in and around a pinecone roasting hearth that intrudes into the main deposit of Structure 1 (table 3.19). As pinyon procurement requires the collector to come in constant contact with pitch, it is not inconceivable that this pair of overalls had become excessively soiled and were for this reason simply discarded at the close of the harvest; alternatively, they may have just worn out. The establishment of Levi-Strauss and Company in 1873 provides a maximum age for this garment and, in turn, the intrusive roasting feature in Structure 1.

Glass Buttons

Two white glass buttons were found at Pinyon House. One (O-211) is 1.1 cm in diameter, 0.3 cm thick, round in plan, and exhibits four holes arranged in a square pattern. The other (O-328) is the front of a button that had evidently been meant to be attached by means of a metal loop. The loop, however, is missing and apparently melted away during a fire that destroyed Structure 4, where it was found. The remaining glass portion is round in plan and planoconvex in cross-section, the flat face serving as the back of the button. It is 1.0 cm in diameter and 0.6 cm thick.

Miscellaneous Historic Artifacts

A piece of thick wire or nail sharpened at one end to make an awl (O-1713) or punch was found in Structure 1 at Pinyon House South. It is 6.0 cm long and 0.4 cm in diameter. The sharpened end of this specimen is finely tapered and would serve well either in hide-work or in the manufacture of coiled basketry. It was the only historic artifact of any kind recovered from this isolated outlier of the Pinyon House site.

Three pieces of machine-made cloth were found during the excavation of Structure 14. Two finely woven black pieces (O-126A) are quite narrow and folded in a manner that suggests they are the edges of garments or strips of reinforcing material sewn onto such edges. The remaining piece (O-126B) is a small fragment of fine white cloth that suggests no particular finished item.

Three pieces of leather were recovered from the surface of the site. One of these is the leather thong (O-77) already described in connection with the pinyon hook to which it had once been attached. The other two (O-75) appear to be fragments of shoe leather.

The remaining historic artifact in the collection is a piece of wire, 0.2 cm in diameter, that has been twisted into a double loop (O-35). This configuration suggests it had been used to secure a barb or hook to the distal

TABLE 3.20
Distribution of Unmodified Vertebrate Faunal Remains at Pinyon House

	Structures								Pinyon House South		
	Surface	1	2	3	4	5	10	14	Surface	St. 1	Total
Neotoma		1		2		1		1		7	12
Spermophilus					4						4
Lynx			1								1
Artiodactyla			1		2						3
Antler	5										5
Lepus	1	6	2	1						4	14
Sylvilagus		1		2				2			5
Dipodomys		1									1
Peromyscus								1			1
No. of identified specimens	6	9	4	5	6	1	0	4		11	46
Total bones	11	48	132	100	36	3	30	12	1	51	424

end of a pinyon hook similar to the complete composite specimen found at the site.

UNMODIFIED VERTEBRATE FAUNAL REMAINS

A total of 424 pieces of unmodified bone was recovered at Pinyon House (table 3.20). Among these were 38 identifiable specimens representing seven different genera and the order Artiodactyla. This sample is far too small to reveal significant patterns regarding either seasonality of site occupation or native exploitative practices. About all that can be said is that jackrabbits seem to be more common than one might expect given the composition of the fauna frequenting the site vicinity today. It is unclear, however, whether this is an artifact of differential preservation, a function of late prehistoric and historic changes in local faunal populations, an accurate reflection of aboriginal hunting patterns, or some combination of these three possibilities.

PLANT MACROFOSSILS

The collection of plant macrofossils from Pinyon House consists substantially of items recovered during excavation (table 3.21). A much smaller quantity of material was identified in flotation samples extracted from hearths or features of other kinds (table 3.22) and treated by water separation in the same manner as the samples from Crater Middens (see chap. 9 for a full description). Except for two small lots of seeds sent to the California State Seed Laboratory, all identifications were

TABLE 3.21
Plant Macrofossils Recovered During Excavation at Pinyon House

		Pinus		
No.	Structure	Nuts	Nut hulls	Cone scales
O-157	1	1	+	
O-181	1		+	
O-182[a]	1			
O-195	1	1	+	
O-209	1	1	+	
O-1589	2	1	+	+
O-1625	2	1+	+	+
O-1647	2	2	+	+
O-1665	2	1+	+	+
O-1675	2	7+	+	+
O-253	3		+	
O-285	3		+	
O-309	3		+	+
O-354	5		+	
O-381	10	4	+	
O-1715	PHS 1	1	+	
O-1722	PHS 1		+	+
O-1726	PHS 1		+	
O-1732	PHS 1		+	

[a] This specimen was an unidentified spherical fruit/berry.

TABLE 3.22
Plant Macrofossils Recovered by Flotation from Features at Pinyon House

No.	Structure	Feature	Contents
F-8	1	hearth	*Pinus* cone scales and nut hulls
F-9	2	roasting pit	*Pinus* cone scales and nut hulls
F-10	2	hearth	*Atriplex* sp. (cf. *lentiformis*)
F-5	3	hearth	*Eriogonum* sp.
F-11	4	hearth	*Pinus* nut and nut hulls
F-6	10	hearth	*Pinus* nut, nut fragments, cone scales, and nut hulls; *Phacelia* sp.
F-7	14	hearth	*Pinus* nut hulls
F-12	PHS 1	hearth	*Pinus* nut hulls

by Kimball T. Harper and Patrick Collins, Department of Botany and Range Sciences, Brigham Young University, who also identified the materials from Two Eagles and Crater Middens.

Unlike those from Crater Middens, the plant remains from Pinyon House are not particularly difficult to interpret because the number of taxa is limited and the contexts from which they were recovered more or less securely establishes their association with aboriginal occupancy and suggests a clear interpretation for that association.

Pinus monophylla: The nuts, nut hulls, and cone scales of *Pinus* dominate the collection. The size and shape of the complete and nearly complete nut specimens suggest that all of this material can probably be assigned to *Pinus monophylla,* the singleleaf pinyon pine. This, of course, is hardly surprising. The site is located within the modern Pinyon Woodland and was so recently occupied as to preclude the presence of pines of other species in any quantity nearby during the period of occupation. It bears mentioning that one complete nut hull (O-253) is large enough (2.0 cm in length) to be either *Pinus quadrifolia,* Parry pinyon, which grows in extreme southern and Baja California, or *Pinus sabiniana,* digger pine, the nearest occurrence of which is on the western slopes of the Sierra Nevada. Recognizing that it may belong to either one of these nonlocal pines, having been

Fig. 3.14. Charred pinyon cone fragment (O-1675) from Structure 2, containing several ripe nuts.

obtained directly or by trade, this specimen seems better interpreted as an unusually large example of *Pinus monophylla.*

Whatever else they tell us, these remains make it abundantly clear that Pinyon House was occupied during the fall, between August and November, when the nuts of the pinyon are mature. Some of the nuts and other plant parts might easily have been charred and deposited as the result of activities in other seasons, however. To be sure, in years of exceptionally large crops, whole, mature nuts can occasionally be found on the ground well into spring. It is possible, therefore, that one or two of our archaeological specimens were scavenged from such leftovers during the winter or very early spring before they had a chance to sprout. Even this seems a bit farfetched, however, and the suggestion that the entire collection represents activity of this kind is ludicrous. A roasting feature in Structure 2 yielded a tightly closed cone fragment (fig. 3.14) containing fully mature nuts that cannot represent any season but fall, which should erase any lingering doubt in the matter.

The activity these pinyon macrofossils reflect is in no more doubt that their seasonal interpretation. Three structures (Structures 1, 2, and 10) contain the remains of what have been termed here pinecone roasting features. These would be difficult to interpret as representing anything other than the processing of green pinyon cones to extract the nuts (cf. Dutcher, 1893). Some of the nuts found in hearths may well represent the remains of cones used as fuel, especially since cone parts were often found in association. Once again, however, to explain the entire collection in

this manner would be silly in view of the more reasonable explanation that at least some fraction of them is residue from the processing and preparation of nuts, or cones containing nuts, for consumption, especially when there are other features that clearly reflect the latter activity.

OTHER TAXA: Unfortunately, the interpretation of the remaining plant macrofossils is not nearly so clear as that of pinyon. In addition to one unidentified spherical fruit or berry, these include in varying quantities seeds of *Phacelia* sp., *Eriogonum* sp., and *Atriplex* sp., each occurring by itself in the hearth of just one structure.

Nothing can be learned from the unidentified fruit and little more than that from the presence of *Phacelia* or *Eriogonum,* both of which represent genera with many members of widely varying seasons of availability and geographical distributions. Since the seeds of each that were found are large and since both taxa include species that are apparently edible and were eaten aboriginally (cf. I. Kelly, 1964: 179; Bean, 1972: 46) there is the possibility that they were lost while being parched in preparation for use as food. This is far from clear, however, and either could have been used as fuel since species of both kinds can be found at or very near Pinyon House, where they would have been a handy source of tinder. Lacking any indication of which particular species are represented, nothing can be inferred about the seasons or locations in which they were collected.

The presence of *Atriplex* seed in the hearth of Structure 2 is another matter because as it happens this genus contains no members likely to be encountered in the immediate vicinity of Pinyon House and as an import the taxon is more likely to represent an element of the diet than material for fuel. Even so, no clear interpretation can be offered because the seeds were referred to *Atriplex lentiformis,* which is almost certainly incorrect even though they most nearly matched this taxon (see chap. 9 for the explanation of an identical case). Because these seeds might be any one of six species commonly found in and around Owens Valley (*A. confertifolia, A. parryi, A. canescens, A. torreyi, A. polycarpa, A. argenta*) about all that can be concluded is that they might have been obtained from as nearby as the wash that runs through Westgaard Pass, 1 km to the northwest, or from as far away as Owens River, 10 km to the southwest, and possibly farther than that, and that they might have been collected as early as May or as late as November. Perhaps the most appealing scenario—and it is no more than this—is that they were gathered in the alkaline flats of Owens River just prior to or during the trip to Pinyon House, to be eaten as the first meal upon encampment there.

CHAPTER 4. PINYON HOUSE: CHRONOLOGY, SPATIAL DISTRIBUTIONS, AND SUMMARY INTERPRETATIONS

CHRONOLOGY

Radiocarbon assays, obsidian hydration rim measurements, and time-sensitive artifacts, historic and aboriginal, provide the essential basis for dating the surface scatter and features at Pinyon House. In addition to these, the proportion of nonobsidian debitage, primarily green chert, which clearly increases with time at Crater Middens (see chap. 8), appears to be time-sensitive. Although some of this information has already been related, it remains to put all the material into a synthetic chronology for the entire site. It should be added that this chronology might have been much more precise had not a large collection of charred pinyon limbs and trunk sections sent for dendrochronological analysis proved entirely useless for dating (Arna Mares Thompson, personal commun.).

RADIOCARBON ASSAYS: There are but two radiocarbon assays available for the site, both on structural beams, one (UCR-1108) indicating a date of A.D. 340 ± 255 for Structure 2, the other a date of A.D. 1490 ± 150 for Structure 3 (this and other chronological information pertinent to all structures are presented in table 4.1). As snags rather than sections cut from live trees were probably used in house construction, these beams probably predate the structures from which they were obtained, perhaps by as much as one or two centuries. In the absence of any reliable method for correcting this, unless otherwise noted, both dates are subsequently interpreted to indicate the age of construction for each house.

OBSIDIAN HYDRATION: A total of 20 small flakes of Fish Springs obsidian drawn from both features and the surface scatter were submitted for hydration rim measurement. The results of these measurements are shown in table 4.2. Two samples showed no visible hydration. Two others exhibited on separate edges hydration rims so disparate in thickness as to indicate two different dates of breakage, each of which is considered a valid indicator of aboriginal activity. A total of 20 individual hydration rim measurements are thus available for the site. Of these 8 (40%) correspond to the Klondike phase, A.D. 1300 to historic times, 6 (30%) to the Baker phase, A.D. 600 to 1300, 3 (15%) to the Cowhorn phase, 1200 B.C. to A.D. 600, and 3 (15%) to the Clyde phase, 3500 to 1200 B.C.

These samples may not faithfully represent the temporal distribution of the entire population of obsidian debitage at the site as they were not sampled randomly from that population. Because of this and because the deposition of obsidian debitage cannot be assumed to correlate perfectly with intensity of occupation, the above percentages cannot be translated literally into estimates of the relative amount of aboriginal activity at Pinyon House at any given time. They do, nevertheless, suggest that the weight of occupation occurred after A.D. 600. Ignoring for the moment the ambiguities surrounding the association between materials found in structures and the occupation of those structures, these hydration measurements seem to place Structure 14 and Structure 1 at Pinyon House South (PHS Structure 1) at the close of occupation (table 4.1), which in the case of Structure 14 is not surprising given that it is relatively intact. They would further tend to place Structure 1 toward the beginning of the most intensive occupation, and Structures 2, 3, 4, and 10 somewhere between these extremes. To be sure, the dating indicated by obsidian hydration for Structures 2 and 4 is equivocal. For the former only one measurement is available, for the latter three widely varying measurements. The previously cited radiocarbon date for Structure 2 tends to place it at least as early as Structure 1, and evidence cited below tends to suggest that Structure 4 is relatively recent, approaching Structures 14 and Pinyon House South Structure 1 in age.

It is curious that all five hydration measurements from the surface scatter (table 4.2) suggest dates toward the earlier occupation of the site. Unless a result of faster hydration in surface artifacts, which may account for some but probably not all of the difference,

TABLE 4.1
Approximate Chronological Order Suggested for Structures Excavated at Pinyon House

Structure	Obsidian hydration	Radiocarbon	Projectile points: Baker	Projectile points: Klondike	Owens Valley Brownware sherds	Beads: Baker	Beads: Klondike	Historic objects	Comments
1	1300 B.C.[a] A.D. 941 A.D. 1181[a]		3	1			2	22	Historic objects associated with intrusive roasting pit
2	A.D. 1501	A.D. 340 ± 255	2	6	3	2			Intrusive roasting pit
3	A.D. 1021 A.D. 1581	A.D. 1490 ± 150	1	8	8		5	5	Historic objects evidently intrusive
10	A.D. 1021 A.D. 1901			1	1				Intrusive roasting pit
4	3061 B.C.[a] A.D. 941[a] A.D. 1821		1	1				1	
PHS 1	A.D. 1821 A.D. 1821			1				1	
14	A.D. 1661 A.D. 1740							3	Standing structure

[a] One of two dates suggested by same sample.

this must either be an artifact of sampling or a true reflection that the surface scatter is in fact largely debris from earlier occupation. Both circumstances may be at work. Certainly sampling error is a possibility because so few measurements are involved. Further, if we assume that some of the surface scatter is refuse from periodic house cleaning and structure reuse, then at any given time the surface scatter should be at least slightly older than the material one might find in structures. Apart from this, as obsidian debitage evidently decreases with time in proportion to chert, chalcedony, and other materials (see below), there should be some bias toward greater antiquity in hydration dates. Taking all this into account, there is no compelling reason to believe that the bulk of the surface scatter predates the features at this site.

PROJECTILE POINTS, CERAMICS, AND SHELL AND STONE BEADS: Time-sensitive artifacts of aboriginal making include Little Lake, Elko, Rose Spring, Cottonwood, and Desert Side-notched projectile points, Owens Valley Brown Ware ceramics, and shell and stone beads. Collectively these suggest occupation between 3500 B.C. and historic times. The ceramics indicate occupation between A.D. 1300 and historic times (see chap. 6) but having no nonperishable functional equivalent in earlier periods, provide no hint about relative intensity of occupation through time. The projectile points and beads, on the other hand, place the bulk of the occupation after A.D. 600, the heaviest activity after A.D. 1300 (see table 3.8). This is compatible with the obsidian hydration dates for structures but, as just noted, not the surface scatter. At face value, these time-markers indicate that Structure 1 is the oldest, Structures 10 and PHS 1 the youngest, the others falling somewhere in between (table 4.1). Given the uncertain association between these materials and the structures in which they were found, it would be unwise to read more into these data.

HISTORIC OBJECTS: The collection of glass, cloth, and metal items of nonaboriginal making found at Pinyon House clearly document its occupation in historic times, perhaps as recently as 1930 (see chap. 6). The recovery of such items in contexts suggesting primary

TABLE 4.2
Obsidian Hydration Rim Measurements for Pinyon House

Specimen no.	UCD–OHL Lab. no.	Provenience	Mean hydration rim reading (μ)	Date
O-112AA	857	Structure 14	1.3 ± 0.1	A.D. 1740
O-112AB	858	Structure 14	1.4 ± 0.1	A.D. 1661
O-192AA	859	Structure 1	5.1, 2.0 ± 0.1	1300 B.C., A.D. 1181
O-192AB	860	Structure 1	2.3 ± 0.2	A.D. 941
O-318AA	861	Structure 3	2.2 ± 0.1	A.D. 1021
O-318AB	862	Structure 3	1.5 ± 0.1	A.D. 1581
O-333A	863	Structure 4	7.3, 2.3	3061 B.C., A.D. 941
O-326A	866	Structure 4	1.2 ± 0.1	A.D. 1821
O-1673CA	871	Structure 2	NVH[a]	—
O-1673CB	872	Structure 2	1.6 ± 0.2	A.D. 1501
O-375AA	864	Structure 10	1.1 ± 0.1	A.D. 1901
O-375AB	865	Structure 10	2.2 ± 0.1	A.D. 1021
O-1186CA	867	Quadrat NE 1	3.0 ± 0.1	A.D. 380
O-1186CB	868	Quadrat NE 1	2.6 ± 0.2	A.D. 700
O-1205CA	869	Quadrat NE 2	3.3 ± 0.2	A.D. 140
O-1205CB	870	Quadrat NE 2	3.5 ± 0.1	20 B.C.
O-1707CA	873	Pinyon House South: surface	6.3 ± 0.4	2261 B.C.
O-1707CB	874	Pinyon House South: surface	NVH[a]	—
O-1724C	875	Pinyon House South: Structure 1	1.2 ± 0.1	A.D. 1821
O-1730C	876	Pinyon House South: Structure 1	1.2 ± 0.1	A.D. 1821

[a] No visible hydration rim.

Notes: Calendar dates calculated as $Y = 800.3X - 831.2$, where X is the rim measurement in microns and Y is the date in years before present, which is taken to be 1950.

association in Structures 4, 14, and PHS 1, documents their relative recency (table 4.1). The historic items found in Structures 1 and 3, on the other hand, evidently reflect secondary use and hence do not speak to the age of these structures.

DEBITAGE: At Crater Middens the proportion of obsidian debitage steadily decreases with time relative to other materials, principally green chert (see chap. 8), so that the ratio of these materials may be said to be time-sensitive there, but it is unclear whether this must also be true at Pinyon House. In particular, the inception and growth in the specialized production of large chert bifaces which evidently accounts for the shift at Crater Middens may not be reflected at Pinyon House, where the range of tasks performed was no doubt somewhat different. That these large bifaces may differ in function from smaller, more abundant, and clearly utilitarian obsidian bifaces, possibly being items of status or commodities for trade, makes this all the more likely. Moreover, Pinyon House was occupied until very recent times, certainly as late as 1900, perhaps as late as 1930, when traditional stoneworking had ceased to be important. Accordingly, the most recent features and areas of activity would not be subject to dating by these means. Indeed, it stands to reason that the debitage found in late historic context is largely attributable to earlier occupations that might be characterized by either high- or low frequencies of nonobsidian debitage depending on their age.

Despite these uncertainties, the distribution of nonobsidian debitage at Pinyon House is clearly concentrated in a manner that lends itself to chronological interpretation. This material dominates the debitage of Structure 4 and four contiguous 15 × 15 m surface quadrats in the central portion of the main

site and both the surface scatter and the contents of Structure 1 at Pinyon House South (see table 3.14). This segregation suggests that nonobsidian debitage is either functionally or temporally distinct from obsidian debitage or, what seems more likely, both, which is the case at Crater Middens.

The high frequency of nonobsidian debitage in Structures 4 and PHS 1, and the surface scatter of Pinyon House South, all of which appear to be relatively late on other grounds, is entirely consistent with the notion that the use of nonobsidian materials increased in late prehistoric times at Pinyon House, just as it did at Crater Middens. This would further suggest that the concentration of this material in the central part of the surface scatter at the main site marks an area of late prehistoric activity or refuse disposal (see below). The dearth of nonobsidian debitage in Structure 14, which is also clearly late in time, can be attributed to its construction after stoneworking had ceased to be important and to its location in an area that had been used for stone tool production, trash disposal, or house site before the late prehistoric period and consequently characterized by high frequencies of obsidian debitage. Conversely, the preponderance of nonobsidian debitage in Structures 1 and PHS 1, in combination with the historic objects associated with them, would suggest they were used from late prehistoric into historic times.

SYNOPSIS OF SITE CHRONOLOGY: Gathering all the above, the first aboriginal visitations to the site of Pinyon House seem to have begun at or about 3000 B.C. and continued sporadically thereafter until about A.D. 300. Occupation occurred with increasing frequency between A.D. 300 and 1300, peaked in intensity between A.D. 1300 and historic times, and terminated probably no later than A.D. 1930.

The first firm evidence of house construction dates to A.D. 340, when Structure 2, a gabled dwelling, was built. Structure 1, a gabled or conical affair, appears to be of approximately the same age as Structure 2, but this cannot be established with certainty; it is by all accounts earlier than any other structure except Structure 2, however. There is certainly no evidence of structures predating these two, but either one might be somewhat older than A.D. 340. Multiple hearths in Structure 1 document its use as a dwelling over a long interval, perhaps until as late as A.D. 1300; artifacts recovered in Structure 2, if not unassociated trash, hint at comparable longevity of occupation. The available evidence points to the burning and abandonment of both prior to the historic period.

The next well-dated construction event is marked by the building of Structure 3, a gabled house, at about A.D. 1490. The data are scanty, but Structure 10 may have been built at about this same time, perhaps slightly later than Structure 3. As were Structures 1 and 2, Structures 3 and 10 appear to have burned and been abandoned prior to the historic period. This would suggest that neither was occupied for periods as long as have been inferred for Structures 1 and 2.

Following this, sometime in the late prehistoric period, Structure 4 appears to have been built at the main site. At roughly the same time the first and only structure at Pinyon House South (PHS 1) was constructed, marking the first intensive residential use of that locality.

Sometime within the prehistoric period, the depressions where Structures 2 and 10 had once stood were evidently put to use as pinecone roasting hearths. The one in Structure 10 must date toward the close of this interval given the dating suggested for that structure; the one in Structure 2 might be somewhat older.

Structures 4 and PHS 1 evidently continued to be occupied into early historic times; both then burned and were permanently abandoned, not necessarily at the same time. The regular use of Pinyon House South apparently terminated with the destruction of its only dwelling.

A welter of historic objects associated with an intrusive pinecone roasting pit in Structure 1 clearly documents the reuse of its depression in connection with pinyon processing relatively late within the historic period. Structure 14, a standing conical/gabled lodge, and Structure 7, a standing lean-to surrounded by a low brush windbreak, were evidently constructed at about the same time. Structure 9, probably employed to collect and store snow for drinking water, was also in use given the metal containers associated with it,

but it is reasonable to assume that it had been built and used prior to this.

Sometime before A.D. 1930 the site was permanently abandoned. Structures 14 and 7 were left intact and several pinyon procurement and processing tools and metal containers, many still serviceable and recently employed, remained in the locations where they had last been used or stored.

Traversing the northern boundary of the site is a skid road once used by a wood cutter hauling pinyon logs to charcoal smelters on the valley floor. This road is probably contemporaneous with the historic aboriginal occupation of Pinyon House. Of only minor importance in the matter of dating, this road speaks silently but clearly of the reasons for site abandonment.

INTRASITE SPATIAL PATTERNING

The composition and dating of the archaeological assemblage at Pinyon House are, of course, fundamental to our interpretation of the site, but it is the spatial distribution of this assemblage that looms especially large as we turn to consider specifically the behavioral patterns it reflects. Not all parts of the site nor all of the artifacts and features found in them are equally susceptible to this sort of analysis. Some kinds of artifacts are simply too scarce to sustain meaningful inferences about distribution and some parts of the site are too sparsely populated with material or were not collected in a fashion which would lend itself to such treatment. Considered here are only the main site of Pinyon House, which was collected in 67 individual 15 × 15 m quadrats, and in this area only those items that appeared in relatively large number by themselves, that could be combined meaningfully grouped with others, or that, though few in number were of sufficient importance to merit attention. These categories are: structures, ceramics, millingstones, projectile points, simple bifaces, roughouts, unifaces, cores, and debitage. The number of each found in the gridded area and other information relevant to their distribution are provided in table 4.3.

Because the grid purposely included marginal areas of the main site where artifact and feature density is low, it is not surprising that all categories except dwellings show marked tendencies to cluster together in certain quadrats as measured by the coefficient of dispersion, their quadrat variance-mean ratio (Grieg-Smith, 1964: 62); dwellings, on the other hand, are simply too large and too rare to exhibit this kind of patterning, unless one were to consider their multiple occupations or uses.

The statistical clustering, then, is at least partly a result of the sampling method. That it does not entirely, perhaps in most cases not even significantly, reflect this sampling effect alone is suggested by the spatial distribution of these categories within the gridded area. When mapped, patterned distributions are visually apparent in the quadrat counts of nearly all categories. That is, quadrats with high counts tend to be clustered together. The following analysis deals almost exclusively with these distinctive concentrations. To simplify matters, the distributions presented here are modifications of the primary data in the following respects. First, maps for each category have been inspected visually for spatial clusterings. When present, quadrat counts within these clusterings (termed principal distributions in table 4.3) are taken to define critical quantities for that category in the sense that the distribution of quadrats containing such quantities should disclose meaningful behavioral patterning relevant to that category. For categories apparently lacking such concentrations, the total distribution of the category is taken to indicate this patterning.

There is some sense an arbitrary air to all this because the visual recognition of patterning and the choice of quantitative thresholds both might unduly bias the outcome. Univariate frequency distributions for these categories, however, generally substantiate the levels chosen; in no case do they suggest obvious alternatives. Experimentation with other quantitative levels and other more sophisticated methods of analysis either led to nearly identical results or made unreasonable assumptions about the data themselves. Perhaps the most serious drawback to our procedure is that a certain amount of information is sacrificed as we transpose the data from interval counts to ordinal ranks. This

seems worth the cost given the increased clarity that results although there is certainly room for more detailed analysis of these data.

The distribution of each category, modified where appropriate as noted above, is shown in figure 4.1a–i. Figures 4.1j, k provide supplementary distributional information about the material composition and mean size of debitage, which are germane to certain of the issues raised below.

As an aid to understanding the spatial associations that exist between the various categories, table 4.4 presents two measures of the overlap between the distributions of pairs of categories. The first is the percentage of space shared by two categories relative to the total amount of space they collectively occupy; in terms of set theory, this amounts to the area of their intersection divided by the area of their union. The principal difficulty with this measure is its sensitivity to the relative sizes of the distributions being compared. In particular, when the two distributions are of unequal size, the highest possible value is always less than 1.00, and this value decreases as the disparity in size increases. It follows that this measure is useful only if we have reason to believe that the two distributions might have been exactly the same under different circumstances and if the distributions themselves are in some sense natural rather than arbitrarily imposed. Owing to the manner in which the data have been modified, the latter condition is not satisfied here and the former requires more assumptions than seem warranted. A second measure unaffected by the relative sizes of distributions is therefore required. This is easily obtained by calculating the amount of area shared between two categories relative to the area of the category with the smaller distribution, which is analogous to Simpson's Index (Cheetham and Hazel, 1969). Both measures are given in table 4.4.

Two other observations are in order before proceeding with the discussion of individual categories. First, be reminded that the number and kind of artifacts that constitute the assemblages of individual structures have already been set forth in relation to the functional interpretation of those structures. The distribution of these items is thus accounted

TABLE 4.3
Distribution of Major Categories in Gridded Area at Pinyon House

	Structures[a]	Ceramic sherds	Milling-stones	Projectile points	Simple bifaces	Roughouts	Unifaces	Cores	Debitage
Number	11 (6)	33	22	35	103	58	48	10	2819
$\bar{x}$ (quadrat)	0.16 (0.9)	0.49	0.33	0.52	1.54	0.87	0.72	0.15	42.1
S (quadrat)	0.45 (0.34)	2.16	0.75	1.40	2.81	1.63	1.39	0.40	104.9
Total area of distribution (m^2)	2025 (1125)	1800	3150	4050	7425	4950	4725	2050	13,275
Area of principal[b] distribution (m^2)	2025 (1125)	1800	3150	1350	2025	2700	2250	2050	2050
Percent of category in area of principal distribution	100% (100%)	100%	100%	66%	68%	83%	77%	100%	83%

[a] Parentheses indicate values for residences (dwellings).
[b] Distribution plotted in figure 10.1.

TABLE 4.4
Spatial Association of Major Categories in Gridded Area at Pinyon House

	Ceramics sherds	Milling-stones	Projectile points	Simple bifaces	Roughouts	Unifaces	Cores	Debitage
Residences (dwellings)	.08/.20	.19/.60	.22/.40	.27/.60	.31/.80	.25/.60	.27/.60	.27/.60
Ceramic sherds	X	.10/.25	.08/.17	.13/.25	.18/.38	.20/.38	.06/.13	.13/.25
Millingstones		X	.11/.33	.15/.33	.24/.42	.20/.40	.10/.22	.15/.33
Projectile points			X	.50/.83	.38/.83	.45/.83	.25/.50	.50/.83
Simple bifaces				X	.50/.78	.46/.67	.38/.56	.80/.89
Roughouts					X	.57/.80	.24/.44	.50/.78
Unifaces						X	.36/.56	.46/.67
Cores							X	.29/.44

First value calculated: $A/A + B + C$, second value calculated $A/\min(A + B, A + C)$, where A is area shared in common between two categories, B is the area of the first not shared by the second, and C is the area of the second not shared by the first. Values calculated on basis of principal distributions shown in table 10.3. See text for explanation.

for and does not figure directly in the analysis that follows except as it contributes to our understanding of the use of structures and where they can serve as a basis for comparison with material found on the surface of the gridded area.

More important, note secondly that the distributions under consideration are quite peculiar owing to our lack of temporal control. In only a few cases is any pair of items dated with sufficient precision to establish their contemporaneity; all of these are conjoining artifact fragments, most of them ceramic sherds. The distributions of features and artifacts with which we are concerned represent many activities and many occupations over a long span of time, patterns that Binford (1980) likes to call "coarse-grained." In this case the presence of patterning within a given category or between two or more categories must represent, directly or indirectly, some persistent constraint on the actions of those who used the site regardless of the time or the special circumstances of the occupation. In general, we would expect that the physical structure (e.g., topography and slope aspect) of this particular location acting in combination with the physical requirements of certain basic activities consistently and repeatedly performed are responsible for such patterning. In turn, the consequences of these basic uses of space would be expected to dictate the distribution of activities less frequently performed or less locationally demanding.

A lack of observed spatial patterning within or between categories, on the other hand, need not indicate the absence of underlying behavioral patterning; the former will reflect the latter only if temporal or functional relationships within and between categories are reasonably clear. Thus, the apparent random distribution of a given kind of artifact might not mean that the activity underlying the distribution was itself random or haphazard, but only that the spatial constraints on that activity were not redundant from occupation to occupation. The same, of course, would be true with regard to the association between two different categories. Thus that, say, houses and bifaces appeared to be distributed independently of each other might not mean that bifaces were individually distributed without respect to house location; it might indicate only that house location or biface deposition varied enough through time to obscure patterning of this kind.

STRUCTURES: Structures are relatively few in number, especially if subdivided by function, so some caution is required in the interpretation of their distribution. Nevertheless, the placement and construction of a structure would seem to require, and is here taken to imply, a conscious act far more deliberate than the discard of individual artifacts. Structure location is then in a sense, ipso facto, evidence of intentional behavior and for that reason meaningful here despite the small number of cases. Our principal difficulty is in understanding what the patterning of structures means when there are so many potentially relevant considerations and

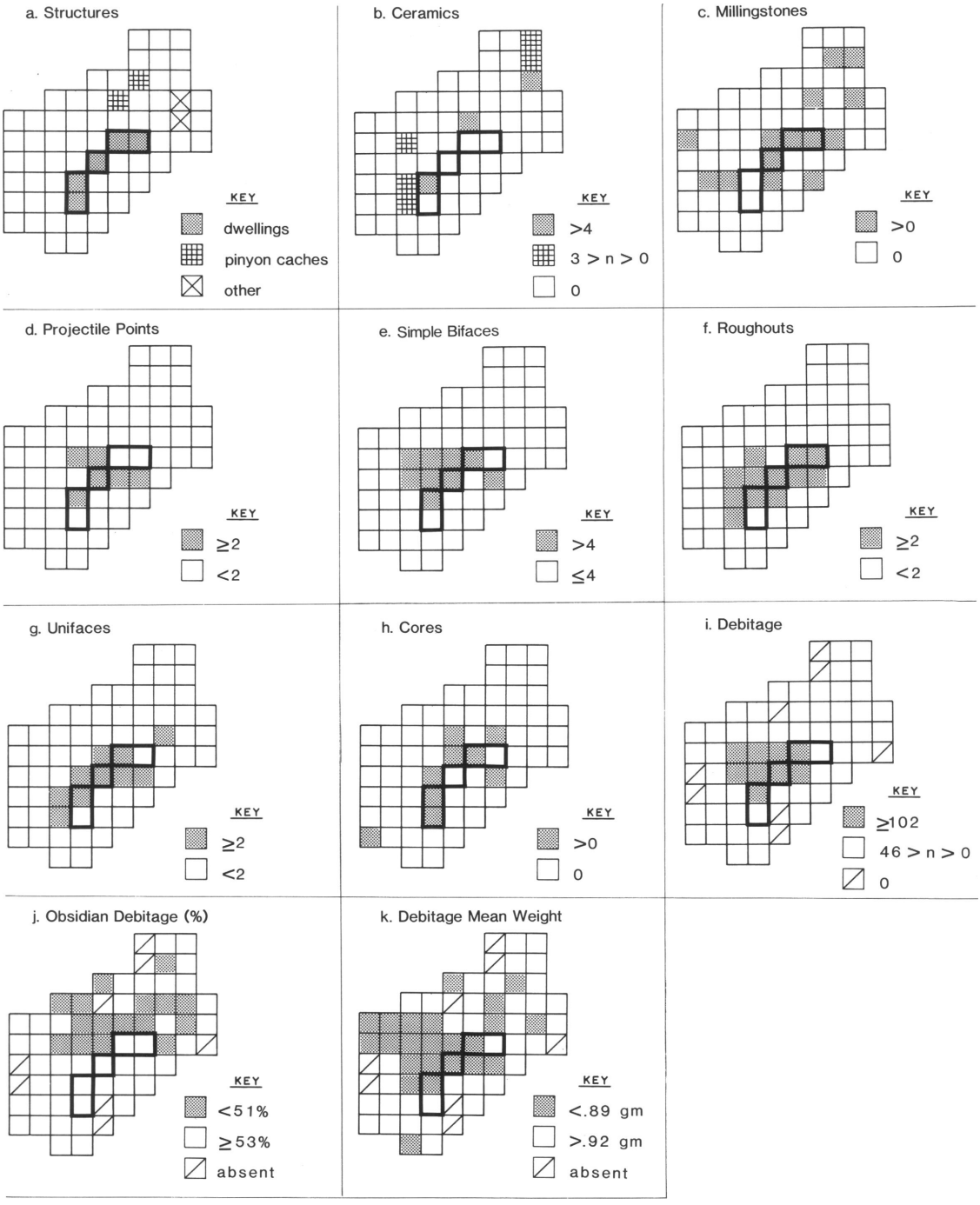

Fig. 4.1. Distribution of major feature and artifact categories at Pinyon House. Location of residential zone is shown by heavy outline. **a.** structures; **b.** ceramics; **c.** millingstones; **d.** projectile points; **e.** simple bifaces; **f.** roughouts; **g.** unifaces; **h.** cores; **i.** debitage; **j.** obsidian debitage by percent; **k.** debitage mean weight.

so few examples to help eliminate the extraneous ones.

As we have it for the site as a whole, Structures 1, 2, 3, 4, 10, 14, and PHS 1 are covered dwellings used for winter residence. Structure 7 is an open lean-to used as a work place or temporary shelter and Structures 5, 6, 8, 11, and PHS 2 are pinyon caches. Structures 9 and PHS 3 are snow basins in which snow was collected and stored for drinking water, and Structures 12 and 13 are of uncertain use, possibly storage or work areas.

Of those found in the gridded area of the main site, the covered dwellings are quite clearly clustered together and segregated from features of other kinds (fig. 4.1a). The two pinyon caches are closely adjacent and the lean-to and two structures of uncertain use are all in close proximity to one another in a different part of the site. Overall, the pattern is that of a residential zone and, some distance away, a peripheral zone for features of more specialized use. There is evidence that Structures 1, 2, and 10 were reused for pinecone roasting, so the residential zone was at least occasionally the location of plant processing, but perhaps not when groups were actually living in one of the dwellings there or at least not in the ones closest to these roasting features.

CERAMICS: The sample of ceramics collected from the surface of the main site is small and all but one occurred in one of three distinct clusters that suggest locations of vessel breakage or trash disposal (fig. 4.1b). Two of these clusters are either in or adjacent to the residential zone previously mentioned, where they might reflect broken household furniture or trash heaps outside dwellings.

MILLINGSTONES: The 22 millingstones found on the surface of the main site exhibit very little tendency to cluster at all but are instead distributed widely across the gridded area (fig. 4.1c). They occur in numbers both inside and outside what we have termed the residential zone. Since nearly all of them are fragmentary, it is clear that this distribution reflects locations of breakage, patterns of trash disposal, or a combination of the two. Whatever the exact circumstances here, the distinction between the residential and nonresidential zones does not appear to be meaningful, although this does not preclude the possibility of patterning between the deposition of individual pieces of milling equipment and individual residences.

PROJECTILE POINTS: Of a total of 35 projectile points collected from the gridded area at Pinyon House (fig. 4.1d), 23 (66%) were found in just six quadrats clustered in the center of the site. All but one of these quadrats are either in or adjacent to the residential zone. Presumably this is the result of tool discard, refuse disposal, or tool production in or near the residential zone but not necessarily in the immediate vicinity of occupied structures.

SIMPLE BIFACES: Sixty-eight percent of the simple bifaces in the surface collection from the gridded area were found in nine quadrats occurring as essentially one cluster in its center, six of them in or adjacent to the residential zone (fig. 4.1e). As with projectile points, the distribution of these items might suggest discard during use, disposal, or production in this immediate area. It is noteworthy, however, that simple biface distribution is virtually identical to debitage distribution in the gridded area (see fig. 4.1, table 4.2). Since most of these bifaces are fragmentary, it would thus appear that biface production or reworking, or the disposal of refuse from these activities, rather than tool discard near locations of use, are principally responsible for the distribution.

ROUGHOUTS: Out of a total of 58 roughouts recovered from the gridded zone, 48 (83%) were present in 12 quadrats, again occurring as a single cluster near the center, eight of them in or about the residential zone (fig. 4.1f). This distribution is regarded as marking locations of tool production, locations where waste from tool production was disposed, or locations where recycled production rejects were put to use as tools.

UNIFACES: Thirty-four (71%) of the forty-eight unifaces recovered from the surface of the gridded area were from just 10 quadrats, of which nine occur as a single cluster that cross-cuts the distribution of the residential zone (fig. 4.1g); the remaining quadrat is an outlier. Unlike projectile points, bifaces, and roughouts, very few of these unifacial tools appear to have broken in production, so it is unlikely that their distribution represents stoneworking or the disposal of stoneworking

debris. It is difficult to determine whether the ones found retain any utility, but at least some are relatively intact and evidently still serviceable. The distribution of some of these may mark the locations in which exhausted tools were discarded; others may mark locations of craft activity (for example, woodworking or boneworking) where tools were lost or simply put down in anticipation of use at some future time. Either way, it can be assumed that the sample in hand consists largely of pieces thought to be of low utility and not worth carrying away.

CORES: The distribution of cores tends to follow that of the other chipped stone artifacts previously discussed and is concentrated in and around the residential zone. It does not, however, show the same degree of clustering evident in those categories, being much more thinly spread (fig. 4.1h). This is no doubt partly due to the size of the sample, which numbers only 10 pieces. Some other explanations, however, should also be considered. It is probably important, for instance, that all of these cores are obsidian which, not being locally available ought to have been discarded only reluctantly and then only after persistent attempts to obtain the last measure of their utility. This sort of behavior would be especially likely if residence lasted for any appreciable interval and stoneworking were an important activity, both of which appear to be true here. It might be, then, that the distribution of these artifacts is more a function of inadvertent losses than simple trash disposal. Alternatively, since much-used cores are often recalcitrant, yielding only to excessive force, this special step, or perhaps all core reduction, might have tended to be more spatially segregated from other activities than the more easily controlled steps of percussion-thinning and pressure retouch. Theodora Kroeber (1964: 182–183) describes just this kind of behavior in regard to the stoneworking demonstrations given by Ishi, a Yahi of northeastern California expert in stonework.

DEBITAGE: Although the 2819 pieces of debitage collected from the surface of the gridded area are broadly distributed overall and some are present in 59 (88%) of its 67 quadrats, 83% of this category was found in just 9 quadrats occurring as a single cluster squarely in the center of the grid (fig. 4.1i). Six of these are in or adjacent to the residential zone; the remaining three are northwest of it. It stands to reason that this cluster marks a principal location of stoneworking or disposal of stoneworking debris.

We have already suggested that the use of obsidian as a raw material declined relative to other materials in later prehistoric times. It follows that quadrats with high proportions of obsidian should mark locations used earlier in time, those with low proportions locations used later in time. In this manner we might glimpse something of the temporal variability in the use of site space, which we have been forced to ignore up to this point.

As a matter of convenience, rather than work with individual quadrat values, we shall simply plot the distribution of the 17 quadrats with debitage less than 51 percent of which is by count obsidian. Again, these ought to indicate locations of stoneworking or refuse disposal more recent than is reflected by the remaining 42 quadrats, which contain obsidian debitage in higher frequency. Actually, we could pick any dividing point between 51 and 64 percent without materially changing the result because only one quadrat falls in this range. This appears to be the only meaningful gap in the frequency distribution of these values and provides a natural division for analysis. As noted earlier, obsidian makes up less than 51 percent of the debitage of Structure 4 at the main site and the surface scatter and Structure PHS 1 at Pinyon House South, which suggests they are roughly contemporaneous with the lithic debris in these 17 quadrats.

When plotted (fig. 4.1j), the distribution of the quadrats with low frequencies of obsidian is clearly patterned, being entirely confined to the northern half of the gridded area. The distribution includes three of the nine quadrats in which debitage is concentrated. One of these three quadrats is adjacent to the residential zone and in particular to the quadrat that contains Structure 4, which is also characterized by low frequencies of obsidian debitage (48%) despite its location in a quadrat where the surface debitage is predominantly obsidian (68%). A simple chi-square test shows the difference in material between this house and its quadrat to be highly significant,

with a value of $\chi^2 = 11.24$ ($p < .001$, df = 1, $\phi = 0.20$).

All this suggests, firstly, that at Pinyon House only about one-third of the total area used for stoneworking or the disposal of stoneworking debris represents late prehistoric activity. This tends to support our suspicion that the amount of space used for given purposes during limited periods of occupation was substantially less than was used for the same purposes over the entire period of occupation. We cannot, of course, be sure that the circumstances that determined the allocation of space to stoneworking in late prehistoric times were similar to those at other times, much less that these same circumstances directly or indirectly determined the allocation of space to other activities. Nevertheless, it is reasonable to think that the overall distributions of most, if not all, of the categories considered here are the sum of a series of smaller and more temporally limited distributions that together reflect the shifting locations of activities connected to those categories. More speculatively, for many categories the proportional relationship between these large and small distributions might well be roughly similar in scale to that observed between the larger concentration of debitage and the smaller concentration of late prehistoric debitage.

Secondly, the concentration of late prehistoric debitage near, but clearly set apart from, the one structure (Structure 4) evidently occupied at the same time (see below) indicates that stoneworking or the disposal of stoneworking debris was segregated from contemporaneous residences. The overlap between the larger concentration of debitage and the entire residential zone might thus be explained as a function of shifts in the location of houses and places of stoneworking or lithic disposal rather than a tendency to work or dispose of debris immediately outside occupied structures. A similar explanation might also account for the distribution of other stone tool categories that overlap the residential zone.

Finally, that the debitage found within Structure 4 does not match that of the quadrat in which it is located suggests some stoneworking took place within individual residences or that lithic debris was selectively disposed of in but not around abandoned structures. For reasons made clear later below, the former is more likely than the latter.

If it is agreed, at least for the sake of argument, that stoneworking or the disposal of stoneworking debris tended at any time to concentrate toward the center of the gridded area, around but probably slightly apart from contemporaneous structures, then it is reasonable to ask whether the debitage outside this area represents the same activity in lesser frequency. That is, is the peripheral debitage merely the result of the occasional use of areas away from the site center for stoneworking or trash disposal or does it reflect some other activity? Certainly the notion that activities shifted in location over time raises the former possibility. This question might be resolved by observing variation in the mean weight of individual pieces of debitage in these two areas, since were they different only with respect to intensity of activity, the mean weight of debitage ought to be the same in both. On the other hand, functional differences between them might (but need not) be evident as differences in the mean sizes of their debitage.

As with the material composition of these samples, it is easier to dichotomize the quadrats, if that can be done meaningfully, than to work with their individual values. As it turns out, when plotted by frequency, the distribution of quadrat mean flake weight is bimodal, the division between the two modal groups falling close to 0.90 g, with 23 quadrats in the group with smaller values, 36 in the group with larger values. Using this separation and plotting the distribution of the quadrats with smaller mean weights (fig. 4.1k) it is clear that intensity of stoneworking activity or disposal is inversely correlated with mean debitage size. All nine of the quadrats in which debitage is concentrated exhibit mean debitage weights of less than 0.89 g. Most of the remaining quadrats with similarly low mean debitage weights are located at the margins of this area, presumably reflecting brief periods of stoneworking activity or disposal; the others are scattered about without obvious pattern. Quadrats with high debitage mean weights are, on the other hand,

invariably located at the margins of the gridded area, often substantial distances from the residential zone.

This spatial bias in debitage size suggests firstly that peripheral areas of the grid were not locations of stoneworking—at least not the same kind represented where debitage is most heavily concentrated—and must reflect some other activity. To argue otherwise, we would need to explain why peripheral quadrats seem to lack the small flakes which dominate the debitage in the center of the grid. One might argue that the by-products of stonework performed at the grid margins were typically caught on mats or hides and subsequently deposited elsewhere, but this would imply that craftsmen working at the edge of the site afterward carried and deposited their trash at its center, which seems silly and even at that would not explain the observed size sorting. The suggestion that this peripheral area is what Binford (1978) calls a "toss zone," into which were cast large, objectionable items that might get in the way of other activities, is no more likely because these quadrats lie far beyond the range of a normal toss. There is the possibility that this material was systematically collected elsewhere and deposited here, but this too seems unlikely since broken millingstones, bifaces, roughouts, and other items apparently no less objectionable than large flakes do not exhibit similar peripheral distributions.

Perhaps the most reasonable explanation for the occurrence of larger flakes toward the margins of the site is that they represent activities that were in some way objectionable or disruptive to activities occurring in and around the residential zone or that would themselves have been disrupted by those activities. Heavy stoneworking, butchering (Yellen, 1977), and craftwork requiring careful attention (Binford, 1978) are three of many such possibilities. As previously noted in relation to the distribution of cores, it is eminently reasonable that the initial reduction and shaping of stone tools would be segregated in this manner since it places standers-by at risk. Although it was probably not a major consideration given other evidence suggesting rather casual attitudes toward the refuse disposal, this would have the desirable effect of reducing the clutter of large flake waste that accumulated near the center of the site.

The idea that butchering might occur in these marginal locations is also attractive since it leaves residue that smells and draws flies and is best done in open spaces away from foot traffic that might contaminate the meat with dust or sand. Moreover, butchering is easily done with large, unmodified flakes, which would have been readily available as waste from the heavy stonework that took place in these same locations.

Having eliminated the possibility that any except the heaviest stonework occurred at the margins of Pinyon House, we turn finally to ask whether the finer shaping and finishing of stone tools took place in the central area where debitage is concentrated or whether these concentrations are trash heaps. The latter would necessarily imply that virtually all stonework of this kind was done within structures, there evidently being no other place for it to occur. This possibility is both unlikely intuitively and inconsistent with certain features of the debitage.

To pursue a line of reasoning briefly touched upon earlier, aside from primary locations of stoneworking, mean debitage weights as low as those observed in the central gridded area are likely only where waste has been dumped from hides or mats used to catch debris generated elsewhere. Thus, at Pinyon House, craftsmen working in houses might have used mats or hides and, upon finishing their work, scattered the debris a discrete distance away outside. In this case very little debitage would find its way into the deposits of structures unless dumped in them following their abandonment. Structures would then either lack substantial quantities of debitage or exhibit mean debitage weights similar to those in other potential areas of dumping. Neither condition is found at Pinyon House: structures typically contain substantial quantities of debitage the mean weight of which is markedly lower than the debitage found on surface quadrats. We can safely conclude, therefore, that the debitage found in structures is predominantly the result of primary stoneworking, not dumping, and that this activity was often done without

mat or hide drop-cloths. Accordingly, debitage concentrations in the central quadrats cannot be easily explained as trash dumps and must reflect intensive stoneworking in the nine quadrats where this debris is concentrated.

It is not at all curious that the mean size of debitage found in these quadrats, which ranges from 0.28 to 0.72 g, is generally larger than that found in structure interiors, which ranges from 0.21 to 0.51 g (see table 3.14). As noted much earlier, this very likely reflects the systematic removal of the large pieces of waste from structures (and thus their systematic deposit on exterior quadrat surfaces), reticence to engage in heavier stoneworking inside structures, or both.

In summary, there are at Pinyon House three different contexts in which debitage occurs: (1) structures, where tool finishing and retouch and systematic removal of large debris led to relatively low mean debitage weights; (2) the central portion of the gridded area, where stoneworking of all except the heaviest kind and the systematic introduction of large pieces removed from structure interiors led to somewhat higher mean debitage weights; and (3) the peripheral portion of the gridded area, where heavy stoneworking and the presence of activities employing large flakes led to very large mean debitage weights.

DISCUSSION: That many of these categories tend to be concentrated near the center of the gridded area should not cause differences in their distribution to be ignored. It is remarkable that no two categories share exactly the same distribution nor is the distribution of any individual category entirely subsumed within the distribution of another (table 4.4). The spatial affinities documented suggest particularly close relationships between debitage and bifaces, on the one hand, and roughouts and unifaces, on the other. The distribution of the first pair probably marks the location of stoneworking, as suggested earlier. The distribution of the latter pair may indicate locations of woodworking, particularly if we interpret the roughouts as rejects pressed into service for heavy cutting, sawing, or gouging. Projectile points tend to occur in equal degree with all four of these categories. Thus, some may represent accidents in point manufacture, others discards removed from hafts in areas where hunting gear was repaired.

Overall, then, these five categories are highly convergent in space. They are not, however, perfectly convergent. Presuming that the differences are not merely due to chance, which is a possibility because so few quadrats are in question, this suggests an area of concentrated male craft activity somewhat internally segregated by task. Of course, aside from the debitage we cannot be sure that these reflect activity locations and not trash disposal by dumping or tossing (cf. Binford, 1978), but even in the latter event, the differences in distribution would suggest some sort of spatial segregation reflected in different patterns of disposal.

The remaining category of stone artifact, cores, shows more overlap with the above stone tools and debris than any other category, but the association is not particularly pronounced. The sample is small but it does suggest that core reduction was intentionally segregated from the activities these other categories represent.

Residences and millingstones, too, show strong convergence in space but only in one direction: residences tend to be accompanied by millingstones but millingstones are only occasionally accompanied by residences. The association between the two makes sense when interpreted as reflecting household refuse disposal or, perhaps, attrition and discard of milling equipment when pinecones were threshed near roasting features in abandoned house locations. The remaining milling equipment is scattered in a manner more suggestive of locations of breakage than trash disposal.

Finally, ceramics show little affinity with any category, although they are themselves highly clustered. It is reasonable to interpret their distribution as marking locations where vessels were accidentally broken, from which larger sherds were culled for use as plates or scrapers, leaving only the smaller fragments behind. Their distribution seems far too spotty and too distantly related to that of other categories to have resulted from trash disposal.

USE AREAS: The distributions of all these categories suggest partitioning of the gridded

area of Pinyon House into the same three areas that can be inferred from the distribution and mean size of debitage. In the main, these divisions match recent ethnographic observations regarding site layout among hunter-gatherers (cf. Binford, 1978; Yellen, 1977; O'Connell, 1987). There is at the center of this locality a residential zone. Excavation of structures here indicates that indoor activities included sleeping, food preparation, fine stoneworking, and perhaps such other craft activities as basketwork or repair.

Immediately outside and essentially surrounding the residential zone is a concentration of debris suggesting intensive activity of several kinds. That stoneworking was one of these is shown by the distribution and character of lithic debris. Whether the other kinds of stone artifacts found here are discards representing deliberate trash disposal, perhaps large items removed from structures, or items more casually dropped or tossed a short distance from centers of craft activity located nearby, is not clear. Each category is somewhat differently distributed from the others, however, which tends to favor the latter interpretation. If this is indeed the case, then woodworking and the manufacture and repair of hunting gear are indicated. Like stoneworking these are both male tasks. If we make the reasonable assumption that pinyon processing was primarily a female task, then pinecone roasting hearths within the residential zone but clearly not within occupied structures indicate use of the central activity area by women as well as men.

Beyond the central area is a peripheral zone in which are located nut caches, a lean-to, two other structures of uncertain use, and, if we include areas immediately outside the gridded area, a facility used to store snow for drinking water. The artifactual debris found here includes broken milling equipment, scattered ceramic sherds, tools for pinyon procurement and processing, several metal containers, and most distinctively, large flakes. The sherds and milling equipment seem best explained as remnants of accidental breakage but might also be trash carried away from the site center. Some of the metal containers and pinyon procurement and processing tools are associated with structures; others appear to have been carefully placed in out-of-the-way locations. These are evidently tools cached or left where last used; a few of the metal containers may be discards. The large flakes, on the other hand, are evidently refuse from core reduction and other heavy stonework. Some of these flakes may have subsequently been used in activities preferentially conducted in this peripheral zone, most likely butchering but perhaps also some kinds of craftwork.

That heavy stoneworking, butchering, and some craftwork would be performed in isolated locations makes sense for reasons noted earlier. Similar considerations probably account for the presence of the snow basin, since its contents might have become contaminated with refuse or muddied by foot traffic had it been situated in an area more intensively used. Nut caches were probably segregated to save space in the central area. Used only infrequently, there was little to be gained by placing them closer to the residences and activity areas. Bedrock and portable milling equipment adjacent to some of these features indicate that some processing, perhaps cone threshing, occurred in the peripheral area on those occasions when caches were opened.

It is not at all clear why the lean-to is set apart from the central area. Perhaps the location, with its sheltering tree, was the best for sleeping and cooking on those occasions when the site was occupied for only short periods and the renovation or rebuilding of covered dwellings was not considered worthwhile. Alternatively, if it was used as a work area perhaps the tasks performed there were best done away from the center of activity, as in the case of butchering.

It is unlikely that these areas were used in their entirety during given occupations or limited periods of occupation, but it is difficult to estimate what fraction of space might actually have been employed at such times. The distribution of nonobsidian debitage tells us that about one-third of the total area used for stoneworking and about one-fifth of the entire residential zone were in use in late prehistoric times, which is of some help. It was then, however, that Pinyon House South was also occupied, and consequently the total amount of space required on the main site may have been lower than at other times. This notwithstanding, it does not seem un-

reasonable to think that less than half of the main site, and perhaps much less than that, was actively in use at any one time.

It is difficult to translate this into an estimate of the group size, especially since we cannot be certain about the specific chronological relationships between structures or the kind of social units or number of individuals using individual structures. The impression given by the quantity of material and number and diversity of structures, however, is that the main site of Pinyon House was often occupied by two or more family-size groups. Pinyon House South, by contrast, seems too small and its assemblage too sparse to be anything more than a single-family camp.

We can be fairly certain that the location and layout of Pinyon House were specifically conditioned by residences and activities that occurred in the central area and that peripheral activities were simply accommodated to these. The spot selected is flatter and more protected from wind than any other on this slope, which evidently met these requirements and explains the location of the residential and central activity area in the flattest and most protected areas, the peripheral activities in steeper, less well-protected areas. A slight, but noticeable, tendency for dwellings to be situated at the margins of the largest expanse of flat ground may indicate their location deferred to the location of certain outdoor activities.

When we turn our attention away from the gridded area, it is curious that almost none of the spatial segregation observed at the main site is evident at Pinyon House South. There, a dwelling, pinyon cache, snow basin, and central activity area are situated within an area of 900 m^2 without any apparent attempt at more deliberate spacing. Two explanations may account for this. First, the saddle on which these features are located is quite small and it may be that the separation ordinarily preferred between them was impossible. If this were so it might be asked why a group would choose to camp here at all and not at the main site where there was more room. This is a separate issue, however, and accordingly is taken up elsewhere.

A second, more intriguing, explanation for this lack of spatial segregation turns on the probable size and composition of the occupying group. Unlike the main site, which seems at least occasionally to have been occupied by two or more families, Pinyon House South was apparently never occupied by more than one. If so, perhaps when only one family was encamped a variety of activities could be safely conducted in a very small space without undue confusion or interference. Being related to and dependent upon all others in residence, individuals would be particularly attentive to the problem of camp order. This would be in their own self-interest, all the various activities in a sense being for their benefit. When several families were encamped in the same location, as they sometimes were at the main site, the degree of confusion would be substantially greater and the problem of crowding more acute. More importantly, with growing numbers of nonkin and distant kin sharing the same camp, individuals would find it increasingly less worthwhile to avoid disrupting other activities if that were inconvenient and made their own work more difficult. Under these circumstances a more or less formal partitioning of site space into activity areas would forestall conflicts between parties with opposing, or at least different, interests. In short, it may be that the differences in the layout of the main site of Pinyon House and the layout of Pinyon House South are as much social and demographic as geographic in origin.

INTERPRETATION

EARLY OCCUPATION: 3000 B.C.–A.D. 300: The first visible sign of human occupation at the site of Pinyon House, or rather the location on which it stands, is sparse scatters of flakes and projectile points found on the main site, a small saddle north of there, and Pinyon House South. Some of this material may date as early as 3000 B.C. but most of it suggests occupation between then and about A.D. 300. An unspectacular petroglyph panel on the saddle to the north, vandalized in later aboriginal times, probably dates to this interval.

With so small a sample, the nature of this earliest occupation cannot be documented in any detail but it is not unreasonable to suggest that hunting was its primary purpose. The nature of the assemblage and the presence of

game trails in the vicinity, particularly the one adjacent to the rock art panel and scatter on the saddle, make this at least the most likely of alternatives. There is no hint whatsoever that pine nuts, a resource central to the later occupation, were exploited. Selective collection of ripe, brown cones that were brittle, their contents readily removed without roasting, would leave few traces, however, and therefore cannot be excluded. As the period in which brown cones are available in any locality is quite short and this spot is without water and not an outstanding hunting stand, with or without pine nuts it is unlikely that these earliest occupants remained here for any length of time. Had they stayed longer, their presence would be more apparent.

MAIN OCCUPATION: A.D. 300–1930: The regular use of Pinyon House begins at about A.D. 300 and ends at about A.D. 1930, thus spanning from the very last part of the Cowhorn phase, through the Baker phase, to the very end of the Klondike phase. The archaeological sample from this entire period is reasonably large but unhappily not uniformly divisible by phase and, with the possible exception of the terminal historic period, certainly not divisible into assemblages representing particular points in time. We cannot, in short, demonstrate that all of these artifacts and features are interconnected as one assemblage or as a series of similar assemblages, if by that we mean they collectively reflect just one kind of activity or one set of activities. Indeed, this is almost certainly not true. There is, on the other hand, little mystery about what the basic activities were, how they fit together, and how they might have varied under different circumstances.

In simplest terms, the location of the site and a brief survey of its contents are sufficient to establish the broad outlines of site function (cf. Bettinger, 1981a). This particular spot affords immediate access to only two important resources, pine nuts and large vertebrates, the latter in small number because the country is so arid. It is not well situated for the exploitation of other resources in adjacent zones, nor is it an especially well-favored place in which to live in other respects, since it lacks ready access to water. The presence of a site of some size and complexity here cannot be accounted for except in terms of resources that could be obtained locally in quantities sufficient to sustain extended occupation and too bulky to be readily transported. The pine nut and only the pine nut fits this description.

Part of the archaeological assemblage at Pinyon House can be related to pinyon procurement directly as tools and features connected with its collection, storage, and processing. These include pinecone roasting pits, pinyon storage caches, pinyon hooks, cone paddles, and bedrock and portable nutting stones, cone anvils, and milling equipment. Abundant pinyon macrofossils, both nuts and charred cone debris, are especially compelling evidence of this activity.

This segment of the assemblage clearly documents at least a fall aspect to the occupation of the site and suggests something of the social composition of resident groups. For one thing, at any given elevation, the pinyon crop is available for a relatively short period, toward the latter part of which competition with other natural consumers, particularly birds, becomes increasingly intensive. Under these circumstances the most effective method of procurement requires groups of at least family size, within which various tasks are assigned by age and sex (cf. Steward, 1941: 279; Stewart, 1941: 374, 1942: 250; Irwin, 1980: 3–7). The nuclear family, then, was probably the basic social unit at Pinyon House, which is in keeping with the range of tools and features observed.

As Steward (1938a: 27–28) noted, unusually large nut crops would support many families in the same location and on these occasions ethnographic groups formed large winter encampments composed of friends and relatives; more distant kin and entirely unrelated families whose nut groves had failed often joined these encampments. The quantity of material found and the apparent spatial segregation of different activities at the main site of Pinyon House hint that such larger, multifamily aggregations were sometimes present.

Occupation by a particularly large aggregation may explain why one family seeking residence here in late prehistoric times set up camp at Pinyon House South, where the shortage of available space and the steepness

of the surrounding terrain made it less attractive than the main site. The only other reasonable explanation would seem to be that an untimely death in a family living at the main site demanded ritual house burning and removal to a nearby location (Steward, 1933: 297, 1934: 432). If that is the case, it would appear that Structure 4 at the main site was the one burned and abandoned, since like Pinyon House South it was occupied in the late prehistoric period.

It is unlikely that we would fully be able to understand Pinyon House without recognizing the importance of pinyon procurement, yet by itself this activity directly accounts for only a minor part of the archaeological assemblage that is present. The balance must be seen as providing support for residents during their stay or reflecting wholly unrelated tasks. This part of the assemblage is particularly revealing of the relationships between pinyon procurement and pinyon camps and how the two were integrated within a larger subsistence-settlement system. The fact that the part of the assemblage unrelated to pinyon procurement is so large and diverse tells us, if nothing else, that resource acquisition was but one of a series of important considerations that collectively determined when this site was occupied and what would take place. This is perhaps most clearly illustrated by the amount and variety of craftwork and equipment repair conducted in the central activity area, which suggests that the period of occupation was generally longer than the period of harvest or that the pace of pinyon procurement did not require the full-time attention of all present, there being in either case opportunities for other activities that needed doing.

Substantial quantities of chipped stone debris including cores and rejected roughouts show that raw material was regularly imported in anticipation that there would be ample time for stonework. Woodworking was by all accounts equally important, perhaps owing to access to materials not readily available in the treeless lowlands. There is little reason to believe that more than a small fraction of what was produced was needed for immediate use nor was all of it utilitarian in nature. The bulk of activity probably centered on the manufacture and repair of gear that would be used later at entirely different locations, principally in connection with resource procurement and processing and other directly practical purposes. The large chert bifaces made in late prehistoric times, however, may have been intended for trade. The source of this chert is in Eureka Valley so its presence at Pinyon House suggests that it was imported from villages on the floor of Owens Valley in blank form or that it was obtained during the course of occupation at this site. If the latter were true, as seems quite possible, access to this valued material directly or indirectly by trade may have been an inducement to occupation here rather than further from the source.

Hunting can be seen in much the same light as craftwork. That it was a regular activity seems a reasonable assumption given the availability of migrating game and number of broken projectile points found, though it is not particularly evident in the faunal remains. It is unlikely that large vertebrates of any kind frequently visited Pinyon House when large groups were encamped, and since this sheltered location commands no view at all, hunters probably sought game elsewhere, perhaps nearer seeps or fall migration routes. Migrating deer inadvertently startled or diverted by harvesters working in the surrounding hills might have been susceptible to ambush at natural defiles not far from the settlement itself, however.

With plant food of high quality readily available, hunting was not essential to subsistence during the pinyon harvest. In the long run, however, it would help stretch plant food stores when these were short or would grow short later. Whatever the particulars, it is clear that hunting necessarily diverted labor that might have been otherwise invested in pinyon procurement, yet did not directly contribute to the support of that activity. In this sense, as in the case of craftwork, it suggests long occupations or slow-paced harvests during which activities other than pinyon procurement came into play in anticipation of future eventualities.

The specific form of pinyon exploitation reflected archaeologically at Pinyon House explains why all these unrelated activities would not be unduly disruptive. The pinecone roasting features found in Structures 1,

2, and 10 are unmistakable evidence of what has been termed "green cone procurement" (Bettinger and Baumhoff, 1983), in which the harvest extends over reasonably long periods and during which only about half of the time is devoted to procurement requiring the participation of both sexes. The balance is set aside for the roasting of green cones to make them easier to handle, a task which falls to females (cf. Dutcher, 1893), leaving males free for other activities. These periods of spare time during the harvest itself, then, at least partly account for the evidence of the activities unrelated to pinyon procurement (for an ethnographic account of this see Steward, 1934: 429).

Some of the structures at Pinyon House, on the other hand, indicate occasional occupations beyond the harvest period during which these activities must have occurred as well. The gabled and conical dwellings simply seem too elaborate and too well used to be explained as temporary fall residences; according to ethnographic accounts (Dutcher, 1893: 377–387), the latter resembled the lean-to built at the margins of the site which, if actually used for that purpose, suggests there were also occupations of shorter duration.

It is reasonable to assume that the variability in length of residency indicated by these structures reflects both success in accumulating surpluses earlier in the year and the size of the local pinyon crop. In all likelihood, some occupations lasted only until the crop was exhausted, possibly not that long provided sufficient surpluses had been set aside elsewhere, presumably on the valley floor. On such occasions, the entire harvest beyond that which could be readily transported might have been cached for retrieval later. In certain years it is conceivable that despite the presence of a good crop, this resource and this and other pinyon camps were ignored altogether. It goes without saying that occupation failed to occur when the crop here was very poor or failed altogether.

The more elaborate gabled and conical houses, of course, testify to much longer occupations. Presumably these occurred in years when the conditions noted above were reversed, that is, in years when other resources had not generated substantial surpluses for winter and when the nut crop was good or at least the best among the available alternatives. Ethnographic accounts (Steward, 1933: 239, 241–242, 1934: 432–434) are wholly in agreement on this point. As a general rule, we might also expect that occupation lasted as long as the cached supply of pine nuts and sometimes ran all winter and into spring.

Craftwork was probably more regular and intensive during these extended winter occupations than at other times. The rhythm of the subsistence-settlement system, in particular the lack of available resources and consequent diminishment of subsistence activity, freed large blocks of spare time in the winter months that could be devoted to equipment manufacture and repair. Since free time might be scarce and was certainly undependable in other seasons, such winter chores were necessary regardless of location. It would have been particularly important, then, to transport the requisite tools, raw material, and gear in need of repair to pinyon camps in the fall when occupation was to last the entire winter; the same effort, however, would be largely wasted in the case of shorter occupations. As much as the need to know the whereabouts of good stands worthy of exploitation, that aboriginal groups kept close watch on the size and maturation of the nut crop (cf. Steward, 1933: 241, 304) can partly be explained in terms of the need to know the probable length of occupation and plan the best manner in which to incorporate pinyon procurement into the other activities essential to the long-term success of the group.

The point driven at here is simple. It is that two broad sets of behaviors are evident at Pinyon House. One set has to do with pinyon procurement, which gives the site its distinctive resource assemblage, general location, basic social units, and to some extent its seasonality. The other kinds of behaviors relate not to pinyon procurement per se, though they were clearly accommodated to it. These behaviors reflect broader requirements of the subsistence-settlement system. Hunting, craftwork, the size of resident groups, length of occupation, kinds of structures, and perhaps even choice of specific geographical location in terms of advantages for trade of social alliances, cannot be understood in terms of pinyon procurement at all. They reflect decisions made within an entirely different

context in which past, present, and future circumstances dictated the choices of action needed for adaptive success.

Binford (1980) would no doubt argue that these characteristics are inherent to "collector" systems, which he sees as being heavily influenced by environmental variables, seasonality in particular, and certainly seasonality is partly to work here. Bettinger and Baumhoff (1982), on the other hand, would have these same characteristics result from what they have called "processor strategies," in which mobility is limited and adaptive success is assured by investing substantial amounts of time in resource processing.

We have shown how at Pinyon House the complex organization of disparate but essential activities was made possible by a focal procurement activity that, while labor intensive, nonetheless provided substantial amounts of spare time owing to the manner in which the resource was processed. In at least this limited sense, the processor-traveler dichotomy more adequately explains the multiplicity of activities observed at Pinyon House. As a more general proposition it does not seem unreasonable to expect that as resource use becomes more intensive and resources requiring more processing are increasingly central to subsistence, the amount of lag time allowed by that processing naturally frees up spare time for some individuals. This spare time then requires that other activities be integrated with the resource activity (procurement and processing) of the moment. In this sense, it is reliance on low-quality resources rather than a simple effect of seasonality which produces the kind of planning we observe at Pinyon House and the kind of planning that Binford identifies with collector-type systems. That such planning was necessary at all also follows from the processor-traveler model, since in processing strategies locally high population densities reduce the ability to avoid resource shortages by moving away from them and requires that they be solved by the shortage of surpluses. As Binford (1980) has made clear, however, that Owens Valley has a resource-poor winter would also lead us to expect some reliance on storage, so it is likely that both seasonality and processing requirements are involved here.

CHAPTER 5. TWO EAGLES: NATURAL SETTING, ARCHAEOLOGICAL PROCEDURES, AND FEATURES

From Westgaard Pass south to Waucoba Canyon, an aboriginal trail route between Owens Valley and Saline and Eureka Valleys to the east, there is a broad and complexly faulted embayment in the Inyo Mountains. Within this embayment, headwardly eroding stream channels have intricately dissected an uplifted block of ancient lake sediments to form an extensive badlands of narrow, fingerlike ridges separated by equally narrow, steep-sided arroyos. At the northern margin of the embayment a series of flat-topped ridges extends southward from the adjacent Inyo foothills into the badlands. The site of Two Eagles (Iny-1756) sits atop one of these ridges, near one of a series of springs fed by subsurface runoff from the Inyo uplands behind the site (fig. 5.1). The largest of these springs is sufficiently vigorous to sustain a small stream that year-round runs along the ground surface for about 700 m before disappearing in a rock gully bottom.

The site consists of 28 rock structures, abundant groundstone implements, moderate quantities of chipped stone tools and waste, and other cultural debris distributed over an area of about 8400 m^2 (fig. 5.2). The bulk of the chipped and ground stone artifacts are concentrated in the lower third of the site, which is that part of the ridge closest to the springs. The structures occur over a larger area. Most are concentrated on the ridge but a few are found on the adjacent foothill pediment of the Inyo Mountains.

Two Eagles lies at an elevation of 1524 m, some 3000 m above the adjacent valley floor, but its location on a southwest-facing slope with maximum exposure to the sun and with-

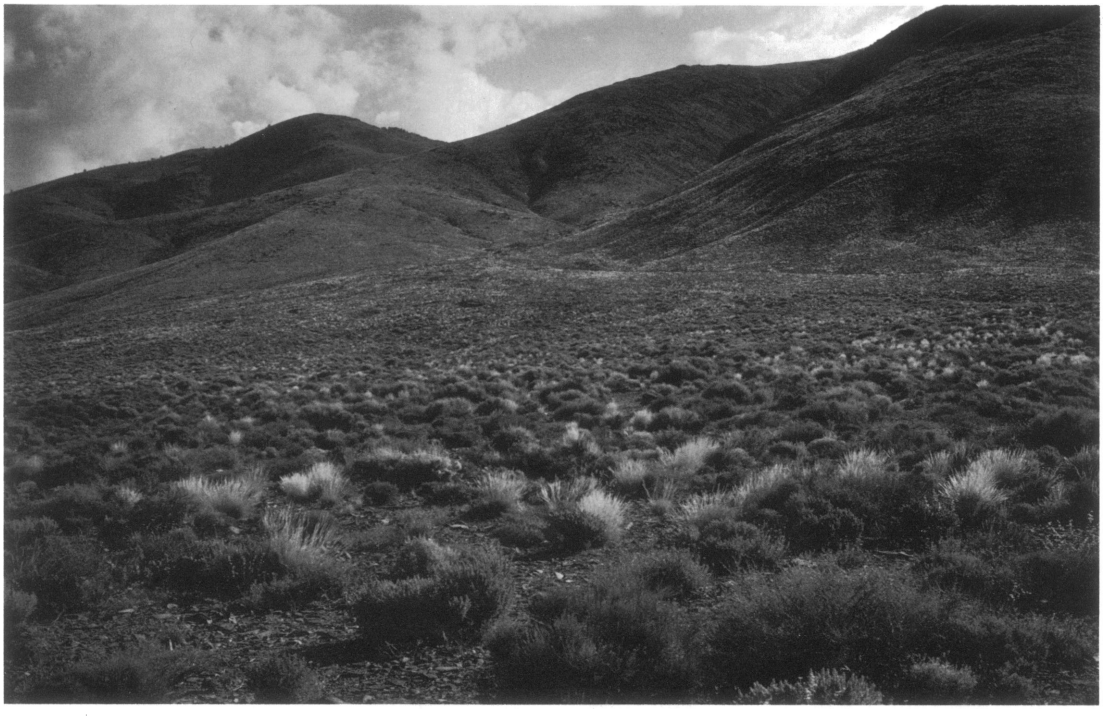

Fig. 5.1. View of Two Eagles looking northeast toward Inyo Mountains and general vicinity of Pinyon House. Lower border of the Pinyon Woodland is visible as a scatter pinyon pine along crest of range.

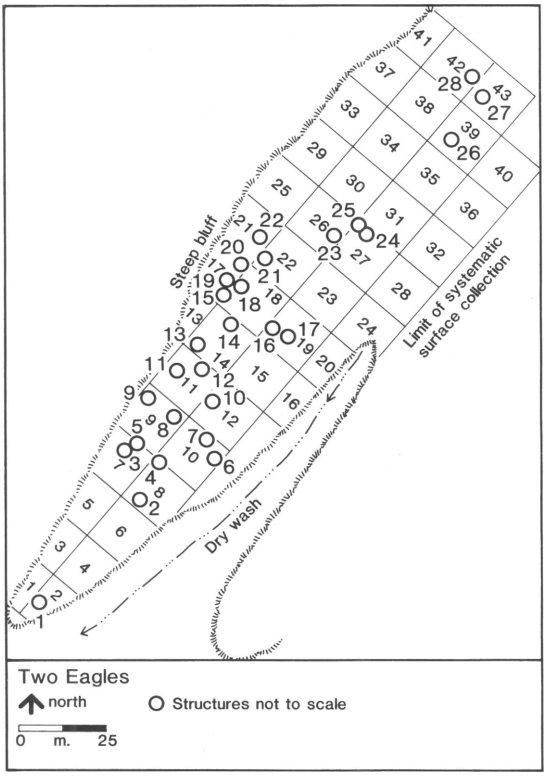

Fig. 5.2. Map of Two Eagles with surface collection grid system superimposed.

in the rainshadow of the Sierra Nevada—well beyond the influence of winter storms that fall principally in the Sierra Nevada uplands but bring incidental precipitation to the eastern Sierra Nevada foothills—produces a local climate much more arid than at comparable elevations on the opposite side of the valley. Maximum temperatures in July average close to 38°C, dropping to about 10°C in February. Mean annual precipitation is probably less than 13 cm.

The vegetation on the exposed ridgetops surrounding the site is an exceedingly depauperate desert scrub association dominated by shadscale (*Atriplex confertifolia*), greasewood (*Sarcobatus vermiculatus*), cottonthorn (*Tetryademia canescens*), spiny hopsage (*Grayia spinosa*), and wolfberry (*Lycium andersonii*). In sandy, sheltered arroyo bottoms, bunchgrasses such as ricegrass (*Oryzopsis hymenoides*), needlegrass, and giant wild rye occasionally flourish, but they are only a minor component on the ridgetops nearby. The lack of protective ground-cover on the relatively stable flat ridgetops has permitted deflation of the soft lacustrine sediments, leaving a well-developed desert pavement. The small spring at the foot of the ridge upon which Two Eagles is located supports a diminutive oasis of riparian vegetation contrasting sharply with the vast and monotonous desert scrub community surrounding it. A few tall cottonwood (*Populus fremontii*) constitute the overstory of this riparian growth. The understory is an impenetrably dense thicket of willow (*Salix* spp.), rose (*Rosa woodsii*), cane (*Phragmites communis*), with low mats of rush (*Juncus* spp.), sedge (*Carex* spp.), dotted by an occasional iris (*Iris missouriensis*) and orchid (*Epipactus gigantea*), occurring in the more open spots.

The catchment commanded from Two Eagles is larger than that of Pinyon House, but much smaller than that of Crater Middens. Access to the north is severely restricted by the steep Inyo Mountains front; the broken badlands topography of the Waucoba embayment interrupts travel routes to the east, south, and west. Given these constraints, the Two Eagles catchment is roughly 116 km^2, 68 percent of which is Shadscale-Sagebrush desert scrubland and 23 percent a halophytic Greasewood-Shadscale scrubland on the valley floor. Pinyon Woodlands east of the site occupy only 2 percent of the catchment. A Riparian zone along an 8 km, stretch of Owens River is an equally minor component, constituting but 7 percent of the total catchment area.

ARCHAEOLOGICAL PROCEDURES

Two Eagles was initially located during the probabilistic surface survey of Owens Valley in 1972, when it was designated site B 25/2 and classified as a lowland occupation site (Bettinger, 1975a). Within this category, Two Eagles was notable not only for its abundance of structural and artifactual remains, but also for the lack of surface disturbance and obvious evidence of depredation by relic collectors. Its major shortcoming as an archaeological site was the lack of buried cultural deposits. The whole of its artifactual assemblage, except for items buried within struc-

tural remains, was confined to within a few centimeters of the present ground surface. Even within individual structures soil deposition is minimal, most floors being covered only by a thin layer of slopewash. With little possibility of establishing stratigraphic control over most of the cultural assemblage at Two Eagles, the range of archaeological problems that could be addressed by excavation there was extremely limited. Nevertheless, once our Owens Valley research turned specifically to consider patterns of seasonality and subsistence, Two Eagles appeared ideal owing to the possibility of recovering plant and animal macrofossils from hearths that might be found within its numerous structures.

The archaeological procedures followed at Two Eagles were essentially the same as those followed at Pinyon House. In 1978, a Federal Antiquities Permit was secured and four structures (Structures 2, 10, 11, 25) were partially or completely cleared. In contrast to those at Pinyon House, none of these features contained either hearths or abundant cultural debris. Because there was a chance that this small sample was unrepresentative of structures at the site generally or that, despite all evidence to the contrary, our excavations had failed to cut deeply enough to expose the true occupation floors, we returned to Two Eagles in 1979. During this second season, a 15 × 15 m grid system was superimposed over the site (fig. 5.2), its long axis oriented 39.5° East of North. The 43 partial and complete squares or quadrats defined by this grid system were numbered in west to east rows, beginning at the southwestern tip or lower end of the site. All cultural materials were completely collected from each square, except for groundstone implements which, owing to their number, were counted but not retrieved.

Upon completion of the surface collection, 9 of the 24 remaining unexcavated structures at the site were randomly selected for excavation. In most instances, only one-half of a structure was exposed, the choice between the halves determined by the flip of a coin. In cases where this partial exposure suggested it might be useful, excavation was expanded to include the remaining half of the structure. In only one structure, Structure 8, was the cultural deposit deep enough to warrant excavation in more than a single stratigraphic unit. In several instances, a small test square was cut into the exposed structure floor to assure that deeper deposits were not overlooked. In no case, however, was any buried floor found by this method.

TABLE 5.1
Description of Strata at Two Eagles

Unit	Thickness	Description
III	2–4 cm	*Loose tan silts.* Uncompacted surface material. Contains pebbles which in places form a well-defined pavement the interstices of which are filled with this loose material.
II	4–8 cm	*Tan silts.* Fine-grained, compacted silts in places showing evidence of mud cracking but no obvious bedding.
I	unknown	*Blocky red soil.* Prismatic structure and evidently high in clay content. Contains large angular cobbles in contrast to the two superior units, in which they are lacking.

STRATIGRAPHY: Although there was no buried cultural deposit at the site and excavation was entirely confined to relatively well-defined features, a discussion of the site stratigraphy on the basis of several small test squares will facilitate understanding of subsequent discussions devoted to structure construction.

In all, three stratigraphic units were noted, a brief description of which appears in table 5.1.

SURFACE FEATURES

Surface features at Two Eagles are of only two kinds: rock art and structures. Each of these categories is described individually below.

PETROGLYPH: The only example of rock art located at the site was found on a small angular cobble of metamorphic rock, 27 × 14 × 9.5 cm, located in Grid 10. It exhibits a single pecked design surrounded by a thin pecked line that follows the ridges between intersecting flat cobble surfaces (fig. 5.3). The design is clearly patterned, rather than haphazard, but does not appear to depict any natural or cultural object. It is best described

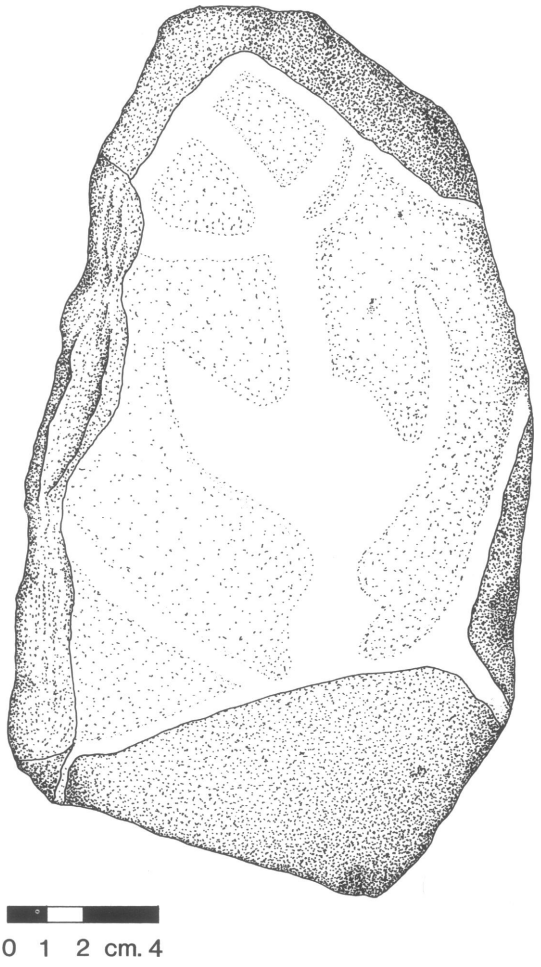

Fig. 5.3. Small pecked petroglyph from Two Eagles.

as a dot or filled circle with several branching projections done in the Great Basin Curvilinear Abstract Style. Unlike the bulk of Great Basin rock art, this example occurs on a small cobble, not a massive boulder or bedrock outcrop; and it was situated in the center of an intensively used site in close proximity to two of its most elaborate structures, not near a game trail some distance from a settlement. Accordingly, it seems unlikely that this petroglyph can be interpreted as having been connected with hunting magic, the explanation generally accorded Great Basin rock art (cf. Heizer and Baumhoff, 1962). Presumably this specimen was of some social, ceremonial, or political significance, but just what this was is presently unclear.

ROCK RINGS (28 examples; 13 excavated): All of the 28 structural features at Two Eagles were rock rings. Although these varied somewhat in terms of size, shape, furniture, elaboration in wall construction, and the presence of attached features, as a group they are roughly circular alignments of metamorphic and sedimentary cobbles and boulders placed in an irregular single course that varies in width and in the number of stones concentrated within that width. With the possible exception of Structure 9, none yielded evidence of organic construction materials. Nevertheless, it is likely that their rude walls served as footings for open or roofed superstructures.

Trees that might furnish suitable building material are rare in the vicinity of the site and no charred log sections were found in excavation, so it is unlikely that large beams were used for construction. Present evidence points to a lighter framed structure—either a domed wikiup built of willow saplings set in a circle, bent inward, and lashed (cf. Steward, 1933: 265) or a conical wikiup of willow or other small limbs or poles leaned inward, lashed or unlashed at the central intersection (cf. Kelly, 1932: 104–105; Steward, 1941: 233, 1943: 272; Stewart, 1941: 378, 1942: 257). Presumably there was a cover of brush or grass—woven, bundled in sheaves, or left loose—held in place by horizontal withes or battens or merely laid on the exterior or woven into the superstructure framework (Steward, 1933: 264–265).

Nearly all the structures incorporate metates, usually as building material. In some instances, however, two or more of these implements are arranged in small alcoves immediately outside the structure, generally to the south or southeast near a south-opening break in its wall (fig. 5.4). Evidently, these alcoves were used for seed milling by the occupants of the house, and were so placed to take advantage of afternoon shade and possibly wind protection afforded by the adjacent domed structure.

Evidence of fire either as hearths or charred structural remains was restricted to three structures. First, a small, central burn area, roughly 35 cm in diameter—apparently a

Fig. 5.4. Milling alcove associated with Structure 10. Grinding surfaces of millingstones at the upper left and lower left of photograph have been rejuvenated by pecking. View is to north.

hearth—was partially exposed in the eastern half of Structure 3. Second, a broad charcoal scatter, 1 × 1 m, possibly leavings from a hearth but more likely charred roofing or flooring, and a small patch of orange oxidized soil, probably the result of burning wall material, were noted on the floor of Structure 9 immediately adjacent to its east wall. Finally, a distinct zone of burned soil, oval in outline and measuring 60 × 40 cm, was found close to the north wall of Structure 8. This feature may represent a fireplace or a bush that burned in a more recent fire.

The floors of most structures show very little relief. The majority appear to have been scraped out of the gently sloping ridgetop leaving a relatively smooth, flat platform, the uphill margin of which is perceptibly lower than the adjacent ground surface, the downhill margin roughly level with it. The rock walls seem most often to have been set outside this scraped platform.

A brief description of each excavated struc-

TABLE 5.2
Attributes of Unexcavated Structures at Two Eagles

Structure	Floor plan	Dimensions (m)	Associated millingstones	Associated features
1	oval	1.9 × 1.2		
4	oval	2.2 × 2.0	1	
5	oval	2.6 × 1.6	1	
7	round	2.1 × 2.0	1	
12	oval	2.6 × 2.3	2	
13	round	1.9 × 1.8		
14	oval	2.2 × 1.7	1	milling alcove
16	oval	2.5 × 2.0		
18	oval	2.3 × 2.0		
20	oval	1.9 × 1.4		
22	oval	2.4 × 1.6		
24	oval	2.3 × 1.5		Structure 25
26	oval	3.1 × 2.5		
27	oval	2.0 × 1.8	2	milling alcove
28	oval	2.0 × 1.5	1	

Fig. 5.5. Exposed floor of Structure 2. Large boulder at upper right edge of exposure is millingstone. Tape extended to one meter provides scale. View is to the south.

ture is furnished below. Salient characteristics of the 15 unexcavated structures are summarized in table 5.2.

Structure 2. This feature is roughly circular in plan, measuring 3.0 m north–south and 2.5 m east–west, enclosing an area of 6.1 m^2. It is well defined and regular in outline, though constructed with relatively few rocks, one of them a millingstone (fig. 5.5). The floor is a flat platform that was probably scraped out of the loose and compacted tan silts that cap the ridgetop (cf. table 5.2). There is an opening on the southeast, presumably a doorway, alongside of which are four metates, two to the north and two to the south. This arrangement suggests use of the structure entrance as a specialized milling area which is in contrast to the separate milling alcove more typical of structures at the site. A shallow depression, servicable as a cache pit or storage area, occurs just inside the opening on its south side (fig. 5.6).

Excavation of this structure yielded a single Owens Valley Brown Ware sherd, a Rose Spring point, four bifaces, two roughouts, a piece of worked bone, a quartz crystal, a fragment of specular hematite, and comparatively large quantities of bone and debitage. It is unlikely, however, that all of this extensive assemblage resulted from activities occurring in the structure. More likely some of these remains washed or were thrown into the feature following its abandonment. That surface cultural debris is concentrated in the vicinity of Structure 2, as in the lower portions of Two Eagles generally, tends to support this notion.

Two obsidian samples from Structure 2 yielded hydration rim measurements of 3.2 (OHL 877) and 3.6 μ (OHL 878), roughly equivalent to calendar dates of A.D. 220 and 100 B.C., respectively. These suggest a greater age for the structure than is indicated by the two time-sensitive artifacts recovered during its excavation: a Rose Spring projectile point, which dates between A.D. 600 and 1300, and an Owens Valley Brown Ware sherd, which dates between A.D. 1300 and historic times.

In view of the uncertain relationship between the items found in Structure 2 and its occupation, however, neither the time-sensitive pieces nor the obsidian hydration dates can be presumed to date the feature reliably, except in the very loose sense that the time span they denote is essentially equivalent to the entire period over which Two Eagles is thought to have been occupied and Structure 2 must date within this interval.

Structure 3. Structure 3 is relatively well defined although its stone wall is irregular and discontinuous, describing a rough oval 4.0 m long and 3.0 m wide (fig. 5.6), with a total floor area of 6.9 m^2. It is possible, though by no means clear, that one of the breaks in the east or north walls is a doorway. The floor was scraped to make a flat platform. A small zone of burned soil centrally located in the structure apparently represents a hearth. In addition to a single metate incorporated in its wall, Structure 3 yielded only a biface fragment and a small quantity of chipping debris. As is the case for Structure 2, and nearly all other structures at Two Eagles, the possibility that these materials are unrelated to the use of the structure cannot be dismissed.

Two obsidian flakes from Structure 3 yielded hydration measurements of 3.4 (OHL 890) and 3.3 μ (OHL 891), which correspond to ages of A.D. 60 and 140, respectively. Just how these particular pieces relate the age of the structure is unclear as is the relationship between the cultural assemblage recovered from the structure and the activities that occurred there.

Structure 6. Structure 6 is more oval than circular in outline. The interior measures 3.0 by 2.0 m, occupying an area of 4.6 m^2, the long axis oriented north–south. The wall is a loose arrangement of rocks, two of which are metates (fig. 5.6). A third metate was found slightly inside what is apparently the main line of rocks that form the southwestern wall of the structure and may have been used or stored there; alternatively, it may simply be a wall rock that was intentionally placed or subsequently rolled off the main line. Although relatively smooth, and sightly concave—possibly as the result of having been scraped prior to the construction of the structure, the floor is unveven and for the most part follows the ground slope in the vicinity of the structure. There is no obvious break in the structure wall to suggest a doorway. A single sherd found on the surface in the northern part of the structure was counted as part of the site surface assemblage and a small quantity of chipping debris was recovered in excavation.

Structure 8. In virtually every respect except size, Structure 8 is atypical of the structures found at Two Eagles. The rock wall, which varies in width from 120 cm in the south to less than 40 cm in the north, is laid out in a circle about 3.0 m in diameter, and encloses a floor space of 6.6 m^2. It is well defined, heavily built, and incorporates 21 metates and metate fragments—far more than any other structure (fig. 5.7). Either by accident or by design, the wall course compensates for the natural ground slope, being higher in the south than the north so that the top is almost level throughout its circumference. In contrast to the floors of the other structures that were examined, which were typically shallow depressions, the interior of Structure 8 takes the form of a bowl-shaped basin measuring 2.5 m north–south, 2.1 m east–west, and 32 cm in depth at its lowest point. It was clearly dug, rather than scraped, through the tan silt unit and into the blocky red subsoil below (cf. table 5.1). The basin is small enough to leave a narrow, unexcavated area around the inside of the rock wall. This shelflike band, composed of the compacted tan silt unit that is the floor matrix in other structures, is 70 cm wide at its broadest point but pinches to only a few centimeters in the southeastern part of the structure owing to the offset location of the basin within the encircling rock wall. It is unclear whether the shelf was used for specific purposes related to the use of the structure (e.g., storage or seating) or whether it was simply left to support a pole framework overhead.

An area of burned soil that is well defined and intensely oxidized and may be the remains of a hearth was situated at the northern end of the basin. At this spot the side of the basin is more gently sloped than elsewhere along its perimeter and the rock wall nearby is both low and discontinuous; it may be that this marks a ramplike entrance to the structure, the hearth placed here to make use of the door as a smokehole. A small quantity of

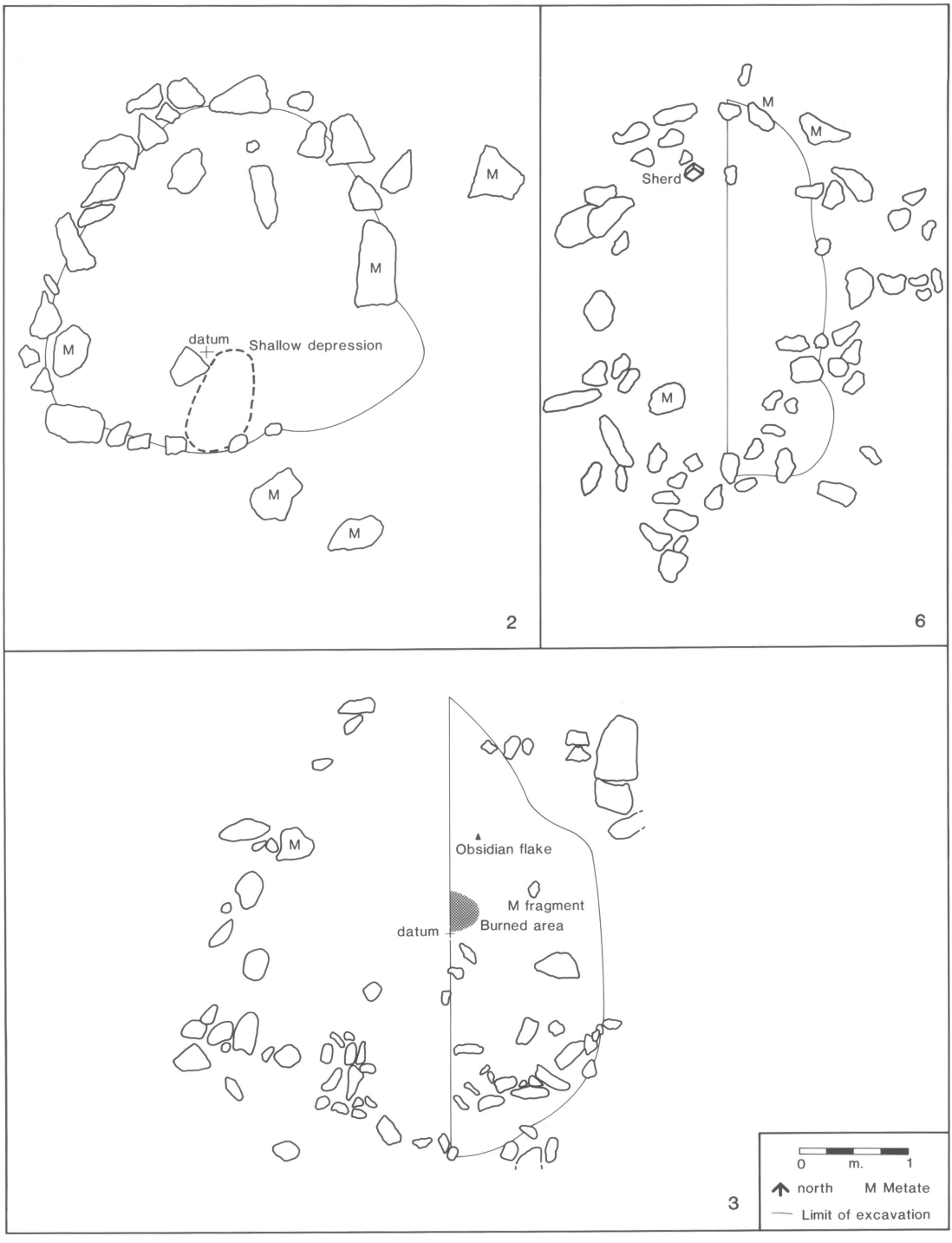

Fig. 5.6. Floor maps of Structures 2, 3, and 6 at Two Eagles.

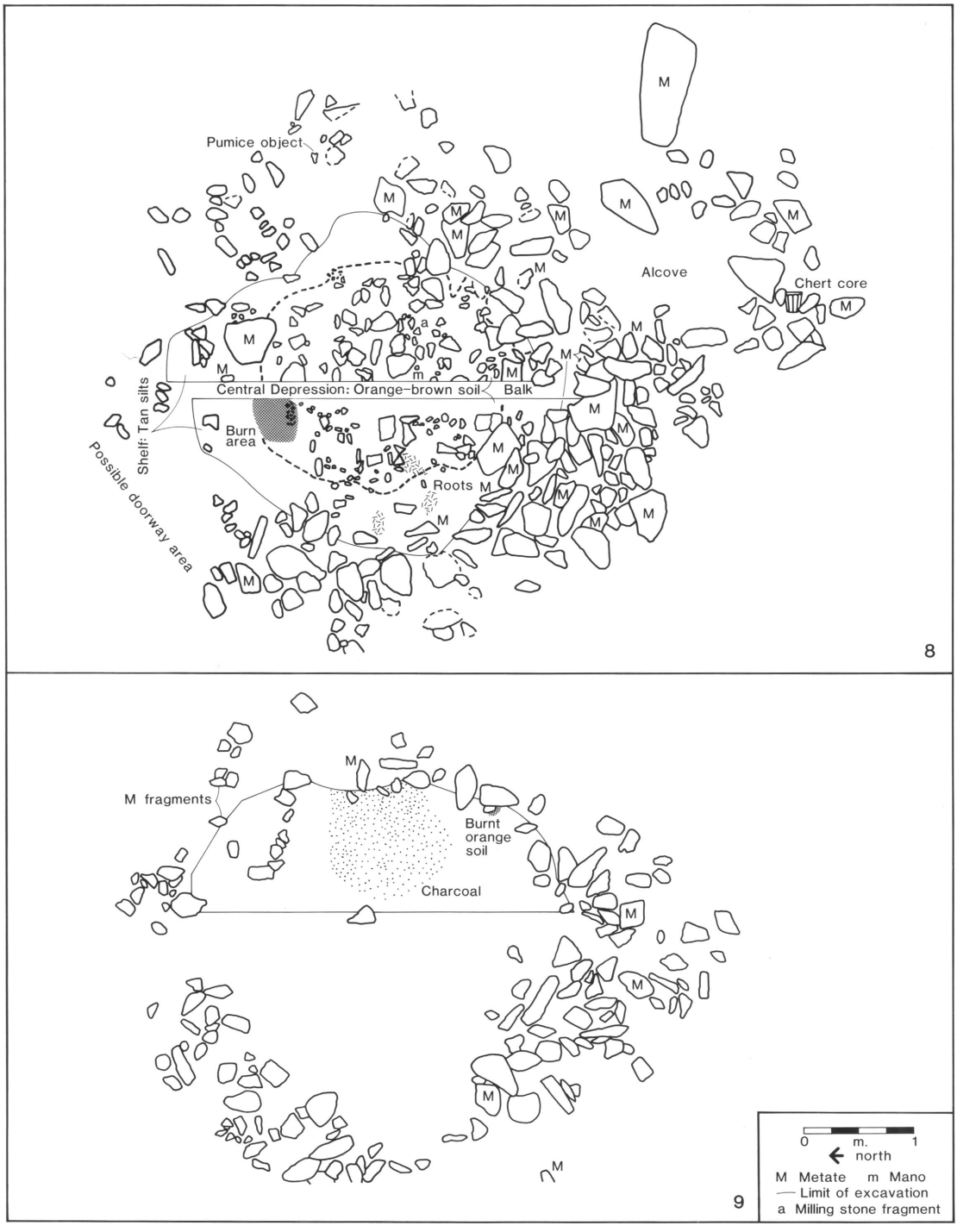

Fig. 5.7. Floor maps of Structures 8 and 9 at Two Eagles.

charcoal from the hearth yieded a radiocarbon date of less than 100 years, which is to say, essentially modern (UCR-1556). There is no evidence of construction material within the structure, and other than the hearth and small bits of charcoal found in the basin fill, there was no evidence of fire.

A milling alcove consisting of a circular rock wall about 1 m in diameter with four associated millingstones was attached directly to the southwestern wall of the structure. Only the northernmost of these implements was in a position useful to an individual seated within the alcove, but any of them could have been used by someone seated outside, as would be the case had its interior been used for storage, e.g., for seeds. The relationship between a chert core found within the alcove wall and the milling activities thought to have taken place there is unclear. One suggestion is that it was stored here for future use. It is equally possible, however, that the association is fortuitous, and that the core was tossed there when its utility in some other activity had ended.

The assemblage of cultural materials recovered from Structure 8 is substantial and includes examples of every major category found at the site. The collection from the other 12 excavated structures combined is small by comparison, the total for every category being less than the total for the corresponding category in the collection from Structure 8. Grinding implements are particularly well represented by 1 complete millingstone, 17 millingstone fragments, and 5 whole or fragmentary manos. The chipped stone assemblage is no less impressive and includes 4 Cottonwood Triangular and 4 Desert Side-notched points, 10 bifaces, 8 roughouts, a battered cobble, 6 unifaces, 3 cores, and 380 pieces of chipping waste. Also found were 10 Owens Valley Brown Ware sherds, a worked sherd, 2 pendant fragments, a quartz crystal, an *Olivella* bead (Class K2), a bone bead, 2 worked bladelike flakes of chert, and a fragment of worked bone. In addition to these items, a rod-shaped piece of vesicular basalt with a shallow hole drilled conically into one end—possibly a pipe preform—was found on the surface among the rocks that form the northwestern wall of the structure but is counted as part of the site surface assemblage.

The bulk of this cultural debris, most of it fragmentary, was recovered in the upper part of the structure fill (Strata I and II) and is probably unrelated to activities that took place in the structure, being, more likely, refuse that accumulated in the deep central depression after the structure itself had fallen into disuse.

The assemblage recovered from the basal deposit (Strata III), however, differs from that of the overlying units as well as that recovered from the site as a whole, which raises the possibility that it is something other than refuse. Beads and pendants, both rare at the site in general, were found in this unit. Similarly, in comparison to the site as a whole, cores and unifaces are more common than would be expected in an assemblage of such size,while millingstones, bifaces, and projectile points are less common than expected. This sample is quite small and therefore unreliable, but the paucity of items used almost exclusively by females (milling equipment) and the relative abundance of items used by males in connection with stoneworking (cores) and woodworking (unifaces) is notable (see below).

An *Olivella* bushing bead (Class K2) found in the basal structure fill and five obsidian hydration measurements ranging from 3.6 to 1.4 μ (equivalent to dates ranging between 100 B.C. and A.D. 1661) obtained from flakes recovered in the same unit (OHL 892, 893, 894, 895, and 896) and Desert Side-notched and Cottonwood Triangular projectile points and Owens Valley Brown Ware sherds recovered from the overlying fill deposit, suggest that Structure 8 was vacated sometime after A.D. 1300. The date of its initial construction cannot be fixed with equal confidence, but if it is assumed that the flakes found in the basal deposit did not stray there by accident but stem from activities that occurred there, a date of close to 100 B.C. would be indicated. If this is so, then Structure 8 was in use during virtually the entire span of human occupancy inferred for Two Eagles. This estimate is consistent with the heavy wall construction of the structure, which may have been continually modified and im-

proved by the addition of new wall stones, including, during the later part of its use, metates and metate fragments left by earlier occupants of the site.

It is unclear why the hearth yielded an essentially modern date, unless it was contaminated before excavation or the sample was somehow contaminated after it was collected. The only other possibility is that the burn area, which was in close proximity to the ground surface prior to excavation, is the charred remains of a bush that grew and was later set afire naturally, perhaps as the result of a lightening strike, long after Structure 8 was abandoned; this notion is made somewhat improbable by the location of the burn area in the proper position for a hearth.

Structure 9. Structure 9 is roughly circular in outline and measures 3.4 m in diameter, with a floor area of 7.6 m^2. The wall is well defined and the rocks within it, six of them metates, are closely consolidated rather than widely scattered (fig. 5.7). There are two breaks in the wall, one to the north, the other to southwest, either of which might be a doorway. A thin scatter of charcoal bits spread over an area about 1 m in diameter was noted adjacent to the east wall; just south of this, directly at the base of the wall, was a small patch of orange oxidized soil. It is believed that both of these resulted from a fire that consumed the structure. The tan silt floor was evidently cleared by scraping, which left a slight depression that, allowing for the natural slope, reaches a maximum depth of about 7 cm roughly 1 m north of center, sloping gently upward from there to the south and more abruptly to the north. Cultural material recovered during the excavation was limited to one roughout and one quartz crystal and seven pieces of debitage. A flotation sample (F-50) recovered from the deposits within the structure yielded seeds of *Muhlenbergia* spp.

Structure 10. Structure 10 is the largest feature at the site. It consists of a sparse rock wall, nearly circular in outline and 3.5 m in diameter, enclosing an area of 9.8 m^2, placed around a shallow, sloping depression about 10 cm in maximum depth (fig. 5.8). One of the breaks in the northeast or southwest wall may be a doorway. Five metates are incorporated into the wall. Just outside the structure to the southeast there is a milling alcove formed by three large metates set in a semicircle and facing inward as though ready for use by an individual seated within (fig. 5.4). Burrowing rodents, probably ground squirrels, gophers, or rats, have made extensive use of the northern two-thirds of the structure interior, breaking through its tan silt floor and penetrating to a depth of at least 25 cm. Within this zone the deposit is thoroughly disturbed by burrow networks. Small bits of charcoal were found during the excavation of this fill but it was impossible to determine whether a hearth, or any other form of furniture, was originally present. This is unfortunate as Structure 10 is so much larger than the other structures at the site that it seems possible it differed from them in function. Cultural materials recovered by excavation include a mano fragment, a uniface, a bit of specular hematite, and a few fragments of bone and debitage.

Structure 11. Structure 11 is irregular in outline and, in places, poorly defined. It appears to be roughly circular in plan and measures 2.5 m north–south and about 1.7 m east–west (fig. 5.8), the total area enclosed being 4.9 m^2. The rock wall includes one metate. The floor is a flat platform scraped into tan silts. There is an opening in the southeast wall which may be a doorway. It leads directly to a milling alcove consisting of three metates and two manos set around an open space that is flanked to the west by a loose alignment of rocks about 2 m long that trends north by northeast and may have been built as a sunshade or windscreen. It is not clear whether the two metates found in this short wall are building material or whether they were stored there while awaiting use elsewhere. Two metates found about 2 m east of the main structure and northeast of the alcove do not appear to be associated with either. No artifacts of any kind were found in excavation.

Structure 15. This is an irregular rock alignment, distinctly oblong in plan, 3.5 m long and 1.6 m wide (fig. 5.9), with a floor space of 4.8 m^2. These measurements are only approximate as the structure walls are not well defined and, except in short segments, do not follow a uniform course, but trace, rather, a

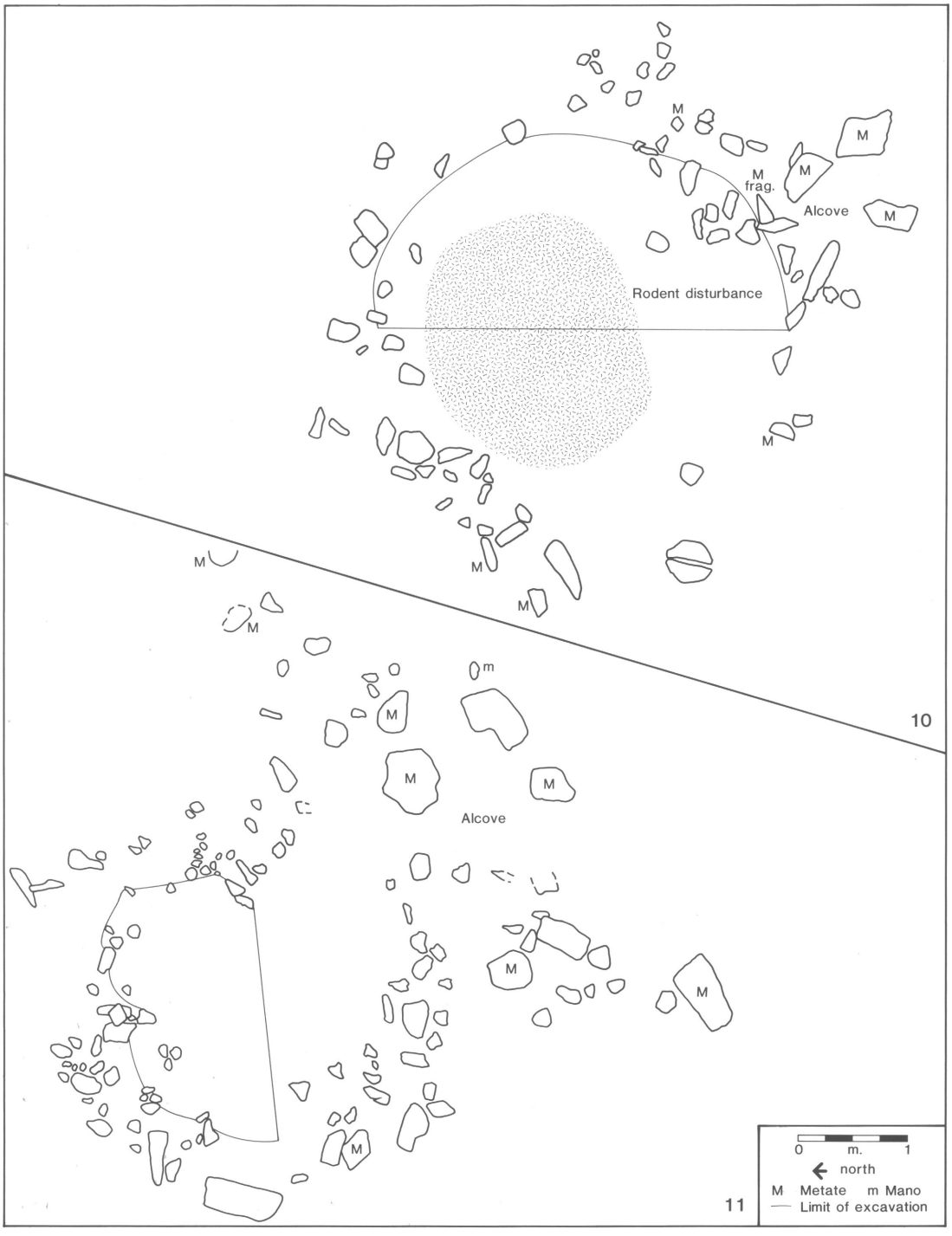

Fig. 5.8. Floor maps of Structures 10 and 11 at Two Eagles.

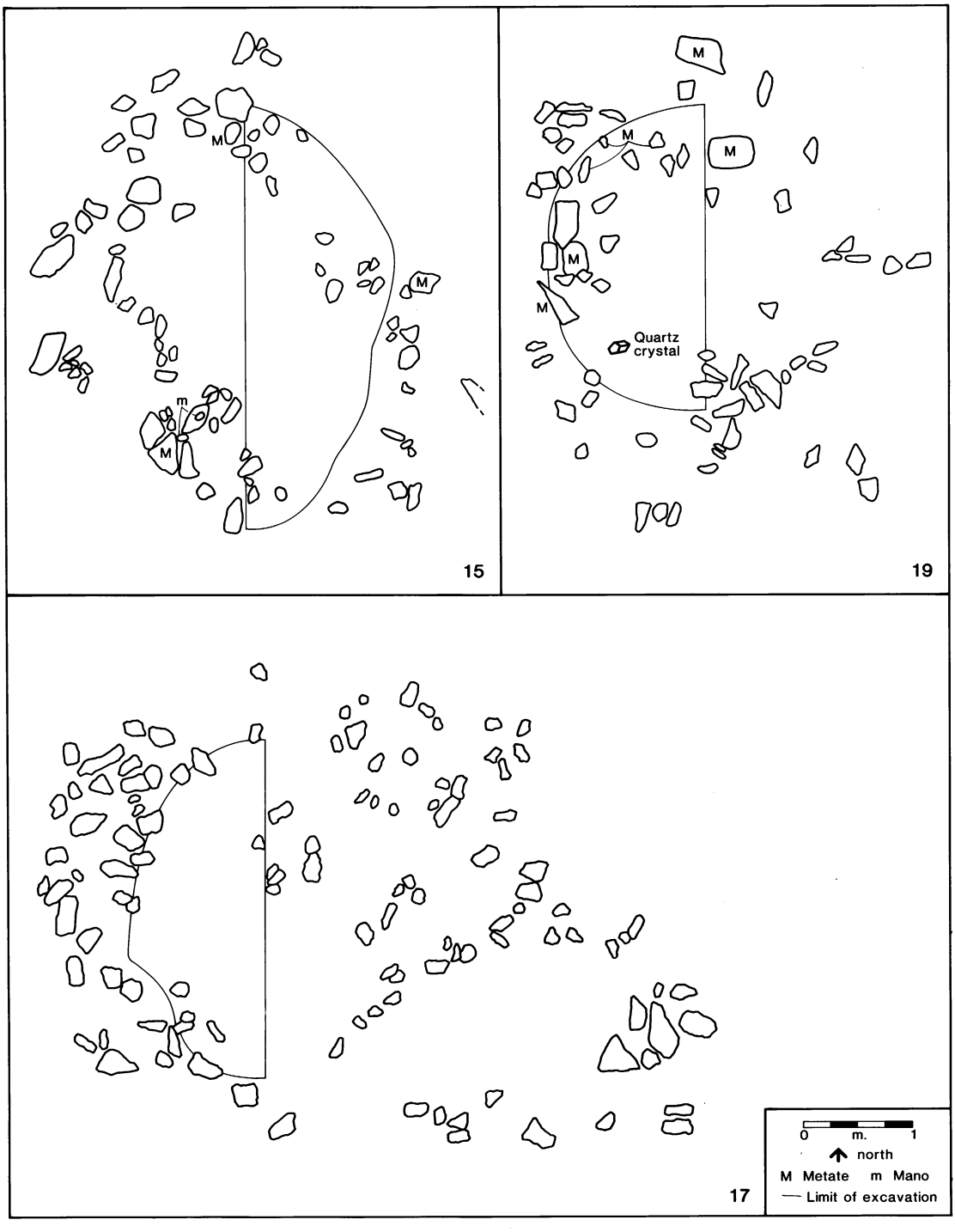

Fig. 5.9. Floor map of Structures 15, 17, and 19 at Two Eagles.

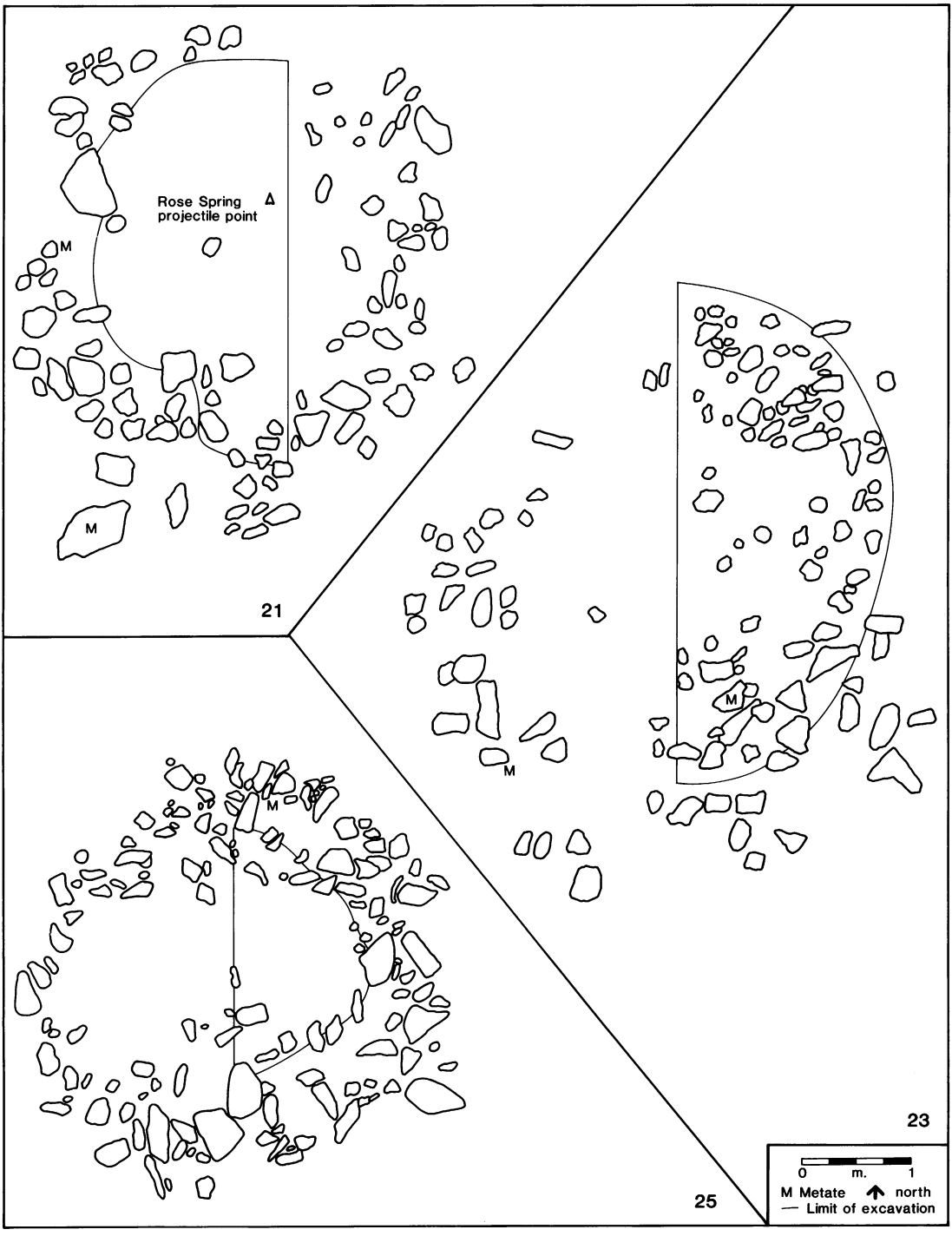

Fig. 5.10. Floor map of Structures 21, 23, and 25 at Two Eagles.

jagged pattern. The floor is a shallow depression scraped into tan silts to a depth of about 6 cm. Three metates and two manos occurred in the wall and may be building material. The two manos and a metate associated with them, however, are situated on the exterior of the wall and could have been stored, or even used, in this spot without disturbing a pole-and-thatch superstructure supported by the wall. Cultural materials were restricted to a cubic mineral crystal—possibly limonite, a bone scrap, and a small bit of charcoal.

Structure 17. Judging from its western half—a clearly defined and well-constructed wall segment, Structure 17 was originally circular in outline, measured 3 m in diameter (fig. 5.9), and encircled an area of 5.6 m^2. The eastern half of the wall appears to have been dismantled and its constituent rocks scattered over the eastern half of the structure. It is possible, however, that the eastern part of the wall was never built, that is, that construction was halted prior to its completion; this seems unlikely, however, as the tan silt floor of the structure appears to have been scraped to make a flat platform, which would have removed the rocks that occurred there naturally. No metates were noted in either the intact or dismantled sections of the wall and save for one piece of debitage no cultural material was recovered during the course of excavation.

Structure 19. Structure 19 is an irregular rock alignment, roughly circular in outline, measuring approximately 2.0 m in diameter with a floor area of 3.8 m^2. The wall is well defined only in its northwestern and southeastern segments; the remaining segments are either open or occupied by sparse scatters of rock that show little evidence of purposeful placement although they tend to be concentrated within the path described by the better built parts of the wall (fig. 5.9). No doorway is evident but any of the open wall segments might have been used in this manner. There are seven metates in or near the wall. Two large ones in the northern part of the structure may have been positioned for use as milling implements, rather than as wall footings, as the course of the wall itself cannot be ascertained with confidence in their vicinity. The floor is composed of tan silts, evidently prepared by scraping a saucer-shaped depression about 2 m in diameter to a maximum depth of 8 cm in the center. This depression is not concentric with the inferred wall outline but offset about 50 cm to the north, the northern quarter of the structure wall runninng through the depression. A quartz crystal, a piece of quartz cull, a uniface, and one flake were found during excavation of the fill overlying the floor.

Structure 21. Structure 21 is nearly circular in outline, about 2.5 m in diameter, with a well-defined rock wall that incorporates a single metate fragment (fig. 5.10) and encloses a floor space of 6.4 m^2. There is an opening in the northern part of the wall that may be a door. The northern half of the tan silt floor has been cleared of stones but otherwise appears unmodified, its contour conforming to the present ground surface in the vicinity of the structure. The southern half was evidently scraped to depth of about 5 cm to form a level platform. A Rose Spring Corner-notched projectile point, a biface, a core, and three pieces of debitage were recovered in the subsurface deposits. A metate south of the structure cannot be definitely associated with it.

Structure 23. This is a loose construction of rocks, rudely oval in outline, measuring 3 m northeast–southwest and 2 m northwest–southeast. The floor area thus encircled is 7.0 m^2. The wall is wide, poorly defined, and patchy, and exhibits several gaps around its circumference any one of which might be a doorway (fig. 5.10). Two metates were evidently used as wall stones. The floor, which is composed of tan silts, shows no clear evidence of having been prepared other than by the removal of rocks. The wall, on the other hand, seems to have been set in a shallow circular ditch, either dug or scraped, that is about 90 cm wide and 7 cm deep; it is the only example of this particular construction technique noted at the site. Its presence may have afforded a solid footing for a pole superstructure and eliminated the need for a more substantial rock wall. Excavation of the feature yielded only a single bit of debitage.

Structure 25. Structure 25 is defined by a well-built rock wall, subcircular in outline, and about 2 m in diameter, enclosing an area of 4.7 m^2, set inside the rim of a saucer-shaped depression about 12 cm in depth at the center

(fig. 5.10). The floor is tan silt. Structure 24, which was not excavated, is directly east of Structure 25, the two sharing a common wall. It is not clear whether their juxtaposition is intentional, which would tend to indicate they were contemporaneous, or merely coincidental. Other than a single metate built into its wall, Structure 25 was devoid of artifactual material, both surficial and subsurficial.

DISCUSSION: With the exception of Structure 8, and possibly Structure 10, the shape, size, and construction of the structures at Two Eagles is consistent with that expected of domed or conical pole wikiups used as domiciles. The only piece of evidence running counter to this proposition is the absence (except in Structure 3) of the central interior hearth, which, in the domed willow wikiup of the Owens Valley Paiute (Steward, 1941: 283), was used for warmth, though not for cooking—which was done outside or in a separate structure. This might reflect occupation of the site exclusively in the summer months, when no interior hearth would be needed for heat, or the diminutive size of the structures, which might have precluded the presence of an interior fire owing to the scarcity of usable floorspace and the fire hazard posed by the proximity of the floor center to the flammable structure wall.

Structure 8 is well within the range noted for other structures at Two Eagles in respect to size, and was probably covered by a pole-and-thatch superstructure as they were, but is singular in terms of its substantial wall, the number of metates it incorporates, and its excavated subterranean floor.

There are several possible explanations for this. One is that Structure 8 is functionally distinct from the other structures, most of which are presumably dwellings. It might be a storehouse or communal men's sweathouse, for example. On the other hand, Structure 8 might be a dwelling, but one belonging to an individual of unusual political, social, or economic standing.

In considering the evidence relevant to these possibilties, use as a storehouse seems the least likely given the presumed presence of a hearth unless it is assumed that this feture is of natural and not cultural origin. It seems equally unlikely that this is a high-status dwelling. It is hard to accept the idea of prehistoric sociopolitical organization so stable and rigid that it would admit at any one time but a single high-status individual who as the result of his influence occupied exactly the same dwelling spot as all his predecessors. This is all the more true because the location of Structure 8, except for its central position, which it shares with several other structures, is not obviously superior as a house site. Too, had the comforts of a semisubterranean house been sufficient to merit use in a high-status dwelling, it is likely that we would have found more extensive evidence of the use of this house form by lower status individuals, especially since the effort involved in digging the basal depression, though not inconsiderable, is not excessive.

The remaining explanation, that Structure 8 is a men's sweathouse, is lent some support by the apparent male bias in the artifact assemblage found in the basal structure fill, provided this is not simply the result of sampling error and represents activities that occurred in the structure. Use as a sudatory, unmarried men's dormitory, and general purpose social center for village males, all recorded for the Owens Valley Paiute sweathouse (Steward, 1933: 265–266), would explain both the unusual wall and interior configuration since a sweathouse would entail structural requirements distinct from dwellings. Further, once built it would likely be renovated as necessary rather than replaced by another built elsewhere, owing to the restrictive confines of the ridgetop and the probable absence of ritual practices that would require its abandonment as might have been true for dwellings upon the death of an owner (Steward, 1933: 297). Following this interpretation, it is possible that the items of personal adornment found within the structure were objects of wager, since gambling was a common activity in the Owens Valley Paiute sweathouse (Steward, 1933: 265).

Three lines of evidence run contrary to the above interpretation. First, projectile points and bifaces, items commonly—though in the case of bifaces not exclusively—used by males and well represented at the site, are poorly represented in the basal structure fill; we might reasonably expect their presence in greater numbers if this structure were a sweathouse and if the material in the basal fill is reflective

of the activities that occurred there. Their absence, however, might be the result of sampling error or of some circumstance that made either the production or use of these items inconvenient within a sweathouse.

The second piece of evidence is not so easily dismissed: Structure 8 is only a little over 3 m in diameter, which would provide very little interior space for the activities commonly associated with a men's social center and dormitory. By comparison, the Owens Valley Paiute sweathouse, a circular semisubterranean afffair with interior beams and a ridgepole, was about 8 m in diameter and provided nearly 8 times the floorspace of Structure 8, which is about 6.6 m^2. Even so, elsewhere in the Great Basin smaller sweathouses somewhat similar in size to Structure 8 were used for a range of activities essentially identical to those for which the larger Owens Valley sweathouse was used (Steward, 1941: 284–285). It is entirely possible, therefore, that the Two Eagles structure could have been put to similar use.

The final piece of contrary evidence is the milling alcove directly attached to the southeast wall of the structure. Although in ethnographic times women occasionally entered the Owens Valley Paiute sweathouse to attend village meetings, this was clearly unusual. Normally the sweathouse and the area immediately around it were the domain of males. The presence of a milling alcove attached to Structure 8 is thus difficult to reconcile with the suggestion it is a sweathouse. The ridgetop upon which Two Eagles is located, however, is quite narrow, which might have precluded the usual segregation of the men's sweathouse and the area around it generally reserved for male activities. In combination with the shade the structure would afford on the hot, treeless ridgetop, this makes the presence of the milling alcove near a sweathouse more understandable.

Bringing these lines of evidence together, the idea that Structure 8 is a sweathouse is more in keeping with the available data than any other alternative proposal as to its function. Nevertheless, inconsistencies in the details of its assemblage, size, and associated features, require that this interpretation be regarded as tentative even though each of these inconsistencies can in varying degrees be reconciled to this explanation.

CHAPTER 6. TWO EAGLES: ARTIFACT ASSEMBLAGE

MILLING EQUIPMENT

MILLINGSTONES: A total of 212 millingstones was found (table 6.1). Of these, 194 occurred on the surface, in association with structures or milling alcoves, or as isolated artifacts. The remaining 18 pieces were recovered during excavation, all of them in Structure 8. The surface millingstones were counted but not collected. Metric data and field sketches, however, were obtained for a sample of surface millingstones present in six randomly selected 15 × 15 m quadrats (1, 6, 7, 9, 27, and 42). The 53 millingstones contained within these six quadrats are considered representative of the entire assemblage of surface millingstones at the site.

All of the millingstones present, surface and subsurface, exhibit flat working surfaces with light to moderate use-wear and are made of locally occurring sandstone or indurated metasedimentary sandstone. These materials grade into each other, which makes attempts at distinction difficult and to a degree arbitrary. The 18 excavated examples and the 53 surface examples for which metric data are available can be further divided according to shape into flat slab millingstones, flat block millingstones, and unclassified fragments.

Flat Block Millingstones (10 examples; 7 sandstone, 3 metasedimentary sandstone). Nine of these are surface specimens. The remaining example was recovered during excavation of Structure 8. They differ from flat slab millingstones both in size and shape (table 6.2). A few are merely thick tabular slabs, but most are large, angular boulders that exhibit a single broad working surface (fig. 6.1). None is so large that it cannot be considered portable, however. The grinding surfaces appear to exhibit use more intensive than is typical of flat slab millingstones and in three cases the grinding face has been rejuvenated by pecking (e.g., fig. 6.1). Several exhibit rudimentary attempts at percussion trimming and grinding along the edges, though none has been substantially modified in this manner. All but one of these artifacts were located in quadrat 9, four in association with Structure 8, one in association with Structure 9. Structures 8 and 9 are among the most carefully constructed dwellings to be found at Two Eagles and are centrally situated with respect to remaining dwellings. It is not unreasonable to suggest, therefore, that this concentration of block millingstones—which are on the whole better made and more intensively used than slab millingstones—reflects prolonged use of the vicinity of quadrat 9 as a residential location conveniently equipped with seed processing facilities.

Flat Slab Millingstones (35 examples; 10 sandstone, 24 metasedimentary sandstone, 1 unclassified). All 17 of the millingstones recovered during excavation and 18 of the 53 millingstones in the surface sample are of this type (table 6.1). The bulk are undressed tabular slabs of sandstone or indurated sandstone that have been put to use as millingstones. A few examples show evidence of having been trimmed by percussion flaking. Among the excavated specimens, in no case is the grinding wear advanced to the point that the entire working surface has become smooth, but one has been pecked to rejuvenate the grinding face, possibly because it had reached this state. Three of the surface millingstones of this type also display pecking, presumably for the same reason. Light scratching observed on a single surface specimen may represent an alternative method of grinding surface rejuvenation, as has been previously suggested for scratched milling surfaces noted at Pinyon House.

On several of the millingstones recovered by excavation, the grinding surface is positioned to take advantage of a thin, crystalline coating occurring naturally on one side of the slab. Possibly this is because this surface was harder, tougher, and, owing to the presence of minute interstices between the crystal faces, offered a roughened working face that would serve to hold small seeds in place and thus facilitate their reduction into flour.

The largest slab millingstones, those greater than about 5 cm in thickness, are too heavy to have been readily moved from site to site, though they would be easily transportable for short distances, for example, from place to place within a site. Several examples, however, are extremely thin and therefore light enough to be carried without difficulty on long

TABLE 6.1
Distribution of Milling Equipment at Two Eagles

	Structures													
	Surface	2	3	6	8	9	10	11	15	17	19	21	23	25	Total
Millingstones															
Flat block	9				1										9
Flat slab	18				17										35
Unclassified	26														26
Unanalyzed	141														141
Manos															
Convex	3				2										5
Flat					1										1
Planoconvex					2										2
Unclassified							1								1
Unanalyzed	23														23
Battered cobbles	6				1										7

collecting trips that might occasion overnight stays away from base camps. Nine of the 17 flat slab millingstone fragments recovered from Structure 8, for example, are less than 2.0 cm thick and would have certainly been useful for this purpose. Among these nine fragments are six conjoining specimens from two different millingstones, one represented by four fitting pieces (fig. 6.2), the other by two.

Unclassifiable Millingstone Fragments (26 examples; 15 metasedimentary sandstone, 11 sandstone). These are fragmentary millingstones too incomplete to be confidently identified as to form. All of them were found in the surface sample and all of them exhibit flat, as opposed to basin, grinding faces. Note that data for thickness, the basis upon which slab and block form millingstones are distinguished, are entirely lacking (table 6.2).

MANOS: A total of 32 artifacts was identified as manos (table 6.1). Of these, 26 were found on the surface and 6 were recovered by excavation. The surface manos were

TABLE 6.2
Metrical Data for Millingstones from Two Eagles

		Length (cm)	Width (cm)	Thickness (cm)
Flat block	$\bar{x}$	45.68	20.96	12.92
	S	17.77	8.48	3.61
	n	7	5	9
	Range	74.0–28.0	31.0–9.0	21.0–10.0
Flat slab surface sample	$\bar{x}$	32.20	18.81	6.02
	S	28.47	9.06	2.30
	n	5	8	18
	Range	82.0–11.0	36.0–8.0	9.0–1.5
Subsurface sample	$\bar{x}$			2.52
	S			1.42
	n			15
	Range			5.7–1.3
Unclassified	$\bar{x}$	30.95	21.62	
	S	6.81	4.66	
	n	11	13	
	Range	43.0–24.0	28.0–13.0	

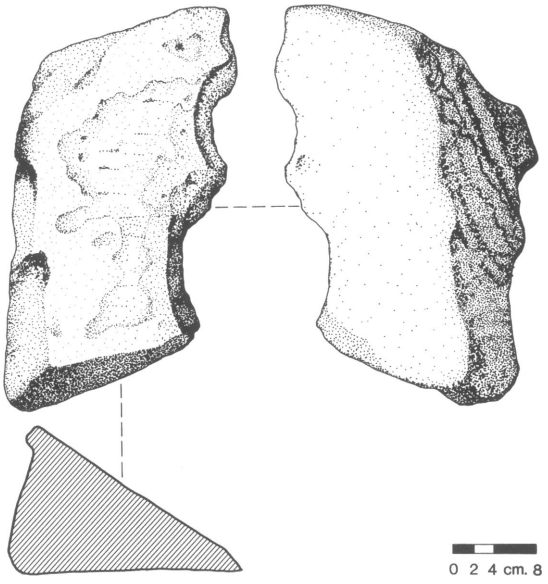

Fig. 6.1. Flat block millingstone (O-1131) from Two Eagles.

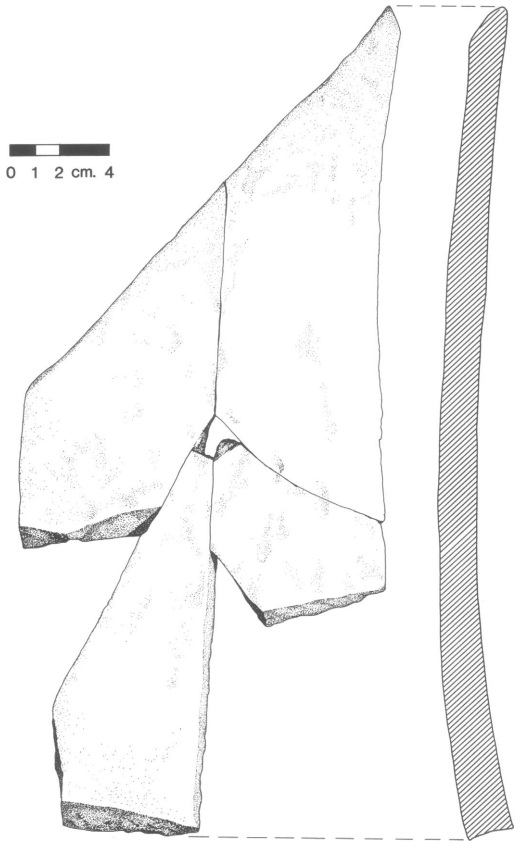

Fig. 6.2. Flat slab millingstone (O-1087, 1739, 1738, 1741) from Two Eagles.

counted but, with the exception of two fitting fragments of nonlocal stone and a specimen wrongly identified in the field as a hammerstone, were not collected or measured. All of the surface examples, save for the fitting pair of fragments that were collected, were of local sandstone or metasedimentary sandstone and none, except for the same fitting pair of fragments, was intentionally shaped other than by rough percussion trimming. As a group, the surface manos differed in no obvious way from the excavated specimens.

The six excavated manos and the three surface manos that were collected are typed as follows.

Convex Manos (5 specimens; 3 sandstone, 2 vesicular basalt). Three of the five manos of this type were collected as surface specimens. Of the three, two (O-825, 898) are fitting vesicular basalt fragments that form a complete bifacial mano that is roughly square in plan, measuring 7.2 × 7.2 cm, and 3.9 cm in thickness. Neither grinding face is severely worn and shaping is limited to minimal grinding to remove surface irregularities on two adjacent sides. It is worth noting that the two fitting pairs of mano fragments found at Pinyon House were also vesicular basalt, perhaps reflecting the ease with which vesicular basalt artifacts are recognized in the field.

The other surface mano (O-878) collected is roughly circular in plan and measures 7.5 cm long, 7.1 cm wide, and 3.8 cm thick. It exhibits a single lightly ground working face and extensive battering on two adjacent sides. It is unclear whether this battering is connected with the use of the piece as a mano or whether it represents secondary use as a hammerstone. The material is a soft friable sandstone.

The two convex manos recovered during excavation, both in Structure 8, are complete unifacial specimens made of sandstone. One (O-1108) measures 12.7 cm long, 8.0 cm wide, and 6.9 cm thick (fig. 6.3a); the other (O-1147) is 14.4 cm long, 9.0 cm wide, and 6.2 cm thick. Each exhibits a moderately well-worn convex grinding face. Neither appears

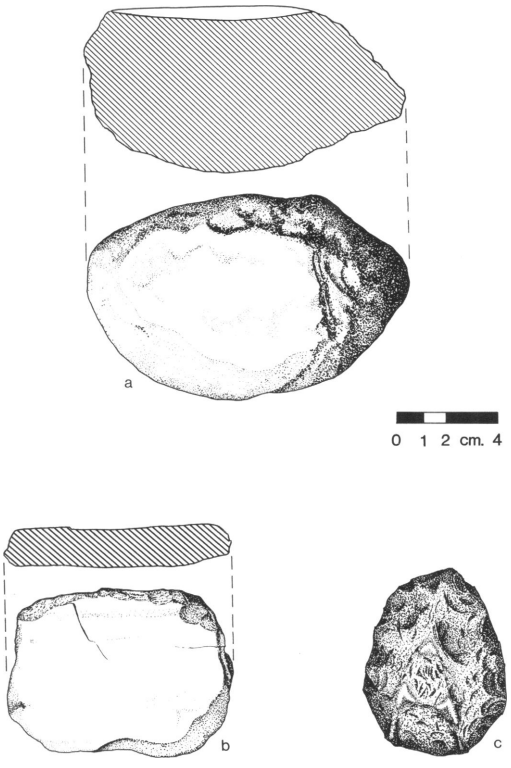

Fig. 6.3. Selected manos and battered cobble from Two Eagles. **a.** convex mano; **b.** flat mano; **c.** battered cobble. a. O-1108; b. O-1109; c. O-900.

to have been shaped intentionally, but the grinding face of the larger specimen appears to have been pecked, probably to rejuvenate a portion of the grinding face that had grown too smooth.

Flat Mano (1 specimen; metasedimentary sandstone). This (O-1109) is a thin, flat cobble that exhibits light grinding wear along the margins, which are raised slightly above the center of the working face. The piece is roughly rectangular in outline and the edges have been rudely trimmed by percussion flaking (fig. 6.3b). It measures 8.9 cm long, 7.1 cm wide, and 1.8 cm thick.

Planoconvex Manos (2 specimens; both metasedimentary sandstone). Each of these is a tabular cobble of hard, metasedimentary sandstone on which one flat natural surface appears to have been used in grinding with a rotary stroke or with a reciprocal stroke while being held firmly parallel to the face of the millingstone, producing a flat grinding surface. In each case, an opposing flat surface has been used with a reciprocal, rocking motion without being held parallel to the millingstone surface, producing a convex grinding face. In both instances, the natural planar surface with flat grinding wear is larger than the one with convex wear. Each specimen bears percussion scars along its margins, but it is not certain whether this is from intentional shaping or from incidental use as a hammerstone. The smaller of the two (O-1091), which is 9.3 cm long, 7.8 cm wide, and 3.0 cm thick, shows, in addition to these percussion flakes, moderate battering at either end. The larger example (O-1742), which is 13.3 cm long, 7.4 cm wide, and 4.6 cm thick, shows no such battering.

TABLE 6.3
Metrical Data for Battered Cobbles from Two Eagles

	Length (cm)	Width (cm)	Thickness (cm)
$\bar{x}$	7.69	6.21	5.31
S	1.02	1.13	0.89
n	7	7	7
Range	9.3–6.4	8.0–5.2	6.9–4.3

Unclassified Mano Fragment (1 specimen; vesicular basalt). A small fragment of vesicular basalt bears evidence of grinding on one face. Judging from its shape, the original piece was a bifacial mano with convex grinding faces, but the fragment is so small that this is largely a guess. No meaningful measurements could be obtained for this artifact.

BATTERED COBBLES (7 specimens; 4 chert, 2 quartz, specular hematite): These seven curious objects were initially identified as hammerstones on the basis of severe battering present along the edges or the corners between the edges of each one (fig. 6.3c). Closer inspection, however, revealed the presence of smooth grinding facets on all of them. In the case of the chert specimens, these facets are polished, though not to the point of being glossy. The absence of similar polish on the nonchert examples is probably attributable to the materials of which they were made—massive quartz and hematite, which resist polish—rather than to differences in the manner in which they were used.

The distribution of the wear facets indicates two distinct kinds of use. In one, the tool was tilted and worked with only an end or lateral edge in contact with the material being processed; this results in a wear facet extending as a unifacial bevel from a working edge onto an adjacent tool face. In the other position the tool was held so that an entire broad tool face was in contact with the material being worked; this resulted in a series of small facets occurring at roughly the same level on raised portions of the tool face.

In terms of gross morphology, these pieces can be described as blocky cobbles shaped predominantly by use-battering which, by edge and corner attrition, has rounded their outlines. Measurements for these objects are summarized in table 6.3, their distribution in table 6.1.

Because the material of which all but one are made is too hard to be useful in percussion work with obsidian and because the wear facets found on them suggest frequent employment in grinding tasks, it is exceedingly unlikely that these objects are hammerstones. Use in the mealing or hulling of seeds or other plant foods, at least in the manner traditionally inferred for manos, is similarly unlikely in that the edges and faces used for grinding would be inefficient for this purpose and would not account for the battering wear observed. The possibility that they were used to shape and finish millingstones is even more remote, as there is no evidence of such shaping on the millingstones found at Two Eagles nor is there any production residue to suggest shaped millingstones were made here and carried elsewhere.

Aside from the battering wear, perhaps the best clue to the function of these tools are the wear facets, particularly those on tool faces, where only the high spots are affected. The margins of these polished facets are sharply defined and contrast sharply with the unworn area immediately around them. This distribution of wear suggests contact with a hard, flat surface, most probably a flat millingstone; the polish, on the other hand, indicates the presence of a soft intermediary substance, probably plant material. The above, in combination with an analysis of a much larger assemblage of similar tools found at Crater Middens (see chap. 8), favors the interpretation that these battered cobbles were employed to process starchy roots and rhizomes—first to pound the stalks, which accounts for the battering observed along their margins, and then to finely grind and divide the pulp, which accounts for the ground facets on their faces and edges. For the latter purpose, which requires more grating than grinding, the steep edges and rough faces of these implements would be more useful than either a flat or convex mano.

It remains to be explained why cherts, massive quartz, and, in one case, specular hematite—all exotic to the site—were favored over locally occurring metasedimentary stone for the production of these tools. It seems unlikely that this can be explained in purely functional terms as very few of the many battered cobbles found at Crater Middens, just across the valley, are silicate. The only plausible explanation would seem to be that the inhabitants of this site were, for whatever reason, enamored with these brightly colored materials and demanded them for the few battered cobbles they made and used at this site—an admittedly unsatisfactory answer.

CERAMICS

All 127 ceramic artifacts recovered at Two Eagles are fragments of Owens Valley Brown Ware vessels (table 6.4). One of these, however, has been reworked and is described separately from the unmodified sherds.

Owens Valley Brown Ware (126 specimens; 7 rim, 119 body): The vast majority of these sherds, 113 in all, was found during surface collections in quadrats 8 and 9. As the sherds from these quadrats are quite similar in thickness and surface treatment and in several instances fit together, it is presumed that they represent a single vessel. Additional sherds found in quadrat 10 (1 specimen), and in subsurface deposits in Structure 2 (1 specimen) and Structure 8 (8 specimens) may be from this same vessel in that they duplicate the range of thickness and surface treatment noted among the sherds found in quadrats 8 and 9. This leaves just three sherds that are sufficiently distinct in appearance from the large group of similar sherds and from each other to suggest that they represent different vessels. Individual Owens Valley

Brown Ware vessels are frequently so variable in thickness and surface treatment, however, that fragments from the same specimen might well be identified as belonging to two or more different vessels, while fragments from different vessels might be indistinguishable. Thus, the inference that four different vessels are represented by the ceramic sherds collected at Two Eagles is somewhat speculative.

The 123 sherds that are thought to represent one vessel vary in thickness from a maximum of 1.0 cm to a minimum of 0.5 cm, but more than half are 0.7 cm. The wall sherds exhibit relatively fine horizontal brush marks on the interior and more coarse vertical brush marks on the exterior. Isolated brush marks oriented perpendicular to the main direction of brushwork were noted on the exterior or interior of several sherds. The exterior appears to have been smoothed just before the vessel became completely dry, which partly obliterated some of the brush marks and in several places left small bits of clay flattened onto the exterior surface. Imperfectly obliterated coil joints were observed on both sherd interiors and exteriors, but are not common. At the base of the interior, the horizontal brushing is replaced by a more haphazard patchwork of brush marks that evidently reflects the joining of a clay disk that formed the vessel base to the coils that formed the vessel walls, which is the ethnographic Owens Valley Paiute method of construction (Steward, 1933: 267). All seven of the rim sherds are direct and the lip is formed by smoothing and tapering slightly the final vessel coil (fig. 6.4a–g). One exhibits a slightly bulging rim, but this is probably an imperfection in construction rather than a product of purposeful behavior. Minor undulations occurring irregularly along the rim are likewise thought to be the result of inattention or lack of concern for this detail.

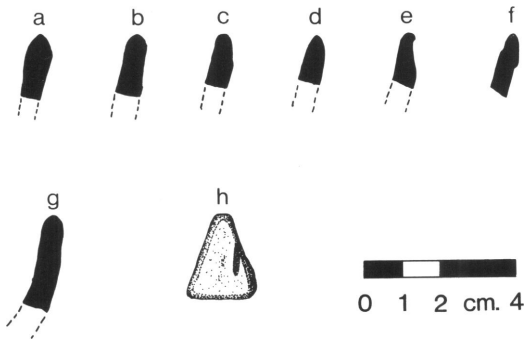

Fig. 6.4. Ceramic artifacts from Two Eagles. **a-g.** rim sherds; **h.** worked sherd. a. O-925; b. O-927; c. O-926; d. O-1812; e. O-924; f. O-1074; g. O-928; h. O-1744A.

Among these 123 sherds, there are five separate sets of pieces that can be fitted together. The largest example consists of 19 conjoining fragments, of which 8 were found in quadrat 9 and 11 in quadrat 8. The four other sets all derive from sherds found in quadrat 9, one consisting of 7 pieces, one of 5 pieces, and two of a pair of pieces.

Despite the presence of these conjoining fragments, the shape of the complete vessel they are thought to represent cannot be inferred safely, except that the walls are straight, rather than curved, and its base is round, which implies a conical form. To this, all that can be added is that the vessel thickens perceptibly toward the bottom. Aplastic inclusions consist of fine quartz and feldspars sparsely distributed through the vessel wall. Hollow interstices left by the carbonization of plant material are also present.

The three remaining sherds which are thought to represent individual vessels per-

TABLE 6.4
Distribution of Ceramic Owens Valley Brown Ware Artifacts at Two Eagles

		Structures												
	Surface	2	3	6	8	9	10	11	15	17	19	21	23	25	Total
Rim sherd	6				1										7
Body sherd	109	1			9										119
Worked sherd					1										1

TABLE 6.5
Characteristics of Owens Valley Brown Ware Sherds from Two Eagles

	Exterior surface				
Interior surface	Smooth	Rough	Random brushed	Parallel brushed	Total
Smooth	0	1	0	2	3 (3%)
Rough	2[a]	1	0	0	3 (3%)
Random brushed	0	3	9[a]	0	12 (13%)
Parallel brushed	1	51[b]	14	6[c]	72 (78%)
Tooled	0	2[d]	0	0	2 (2%)
	3 (3%)	58 (63%)	23 (25%)	8 (9%)	92

[a] Category contains one sherd not belonging to large group of sherds thought to represent a single vessel.
[b] Category contains two rim sherds.
[c] Category contains three rim sherds.
[d] Category contains one rim sherd and one sherd not belonging to large group of sherds thought to represent a single vessel.

mit only simple description. One (O-1002) exhibits a very rough exterior with numerous deep, intersecting brush marks without any obvious directional bias. These have been partly obliterated by smoothing. The uneven interior surface is scored by widely spaced, intersecting brush marks. The entire interior appears to have been partially hand smoothed. Aplastic inclusions are abundant and consist of coarse angular quartz and feldspar particles. The sherd is 0.8 cm thick.

A second sherd (O-1093) is 0.8 cm thick and displays a finely brushed and smoothed exterior and a moderately rough interior on which no brush marks are evident. The paste exhibits very sparse, fine aplastic inclusions.

The third distinctive sherd (O-1149) is 0.7 cm thick. The exterior of this piece is rough but there are a few brush marks. The interior, by contrast, has been deeply tooled by a stick or very hard, fine brush, producing a series of parallel, finely striated, linear gouges or channels. That these were oriented horizontally is clear from a break along an imperfectly joined coil that runs in the same direction. Aplastic inclusions are few and fine and hollow interstices left by fired plant material are present, some of them quite large.

When combined without reference to the different vessels from which they potentially derive, Owens Valley Brown Ware body sherds from Two Eagles large enough to be confidently classified displayed the composition shown in table 6.5 with respect to modes of surface treatment. To reduce the lack of independence, conjoining fragments were treated as single sherds.

For this same combined group of body sherds measured thickness for each sherd, including those within conjoining groups, yielded the following summary statistics.

Wall Thickness (cm)	$\bar{x}$	S	Max.	Min.	n
	0.69	0.05	1.0	0.5	111

These data disclose substantial homogeneity within the Two Eagles ceramic assemblage, at least with respect to interior and joint exterior–interior surface treatment and thickness. The full range of surface treatments noted for Owens Valley Brown Ware is present in the collection, but 78 percent of the sherds exhibit parallel brushed interiors and 55 percent exhibit the joint combination of rough exterior and parallel brushed interior. Likewise, thickness, although it displays a substantial gross range from 0.5 to 1.0 cm, varies within exceptionally narrow limits in that fully 66 percent of the specimens can be expected to fall between 0.64 and 0.74 cm.

The decided lack of variation among these sherds is consistent with the suspicion that with only three exceptions they derive from a single vessel. If so, these data provide at least a rough approximation of the minimal variation to be expected in any collection of Owens Valley Brown Ware sherds. For this

reason, it is hardly surprising that when the body sherd data from Two Eagles are compared to those previously presented for Pinyon House, the Two Eagles assemblage is found to be by far the more homogeneous with respect to interior surface treatment, joint exterior–interior surface treatment, and wall thickness. For the same reason, a nearly identical pattern obtains when the Two Eagles body sherds are compared to body sherds from Crater Middens, which are described in a later chapter. Here again, the Two Eagles collection exhibits substantially less variation in these attributes than does the Crater Middens collection. As a consequence of its greater homogeneity in interior surface treatment when measured by the Robinson index of agreement, the Two Eagles ceramic assemblage shares little affinity with those of either Pinyon House and Crater Middens in terms of this attribute, either alone or in combination with exterior surface treatment (table 6.6).

Given the distinctive character of the Two Eagles ceramic collection and the differences that separate it from the collections from the other two sites, it is remarkable that in terms of the distribution and diversity of exterior surface treatment modes the body sherds from Two Eagles are virtually identical to those of both Pinyon House and Crater Middens (table 6.6). In all three cases, rough exteriors constitute a substantial majority, followed by random brushed exteriors, and either parallel brushed exteriors (Two Eagles and Pinyon House) or smooth exteriors (Crater Middens). The Robinson index of agreement for exterior surface treatment underscores the similarities Two Eagles shares with Pinyon House and Crater Middens in terms of this attribute.

A preliminary conclusion drawn from the above is that at least in central Owens Valley, exterior surface treatment of Owens Valley Brown Ware sherds is invariant. This is not meant in the sense that only one mode is present but rather in the sense that individual vessels appear to display the same modes in the same proportions as larger assemblages comprising many vessels. This further implies that diversity of exterior surface treatment is an unreliable measure of the number of vessels represented in any particular ceramic assemblage. Interior surface treatment, and consequently joint exterior–interior surface treatment, and thickness, on the other hand, appear to vary between individual Owens Valley Brown Ware vessels at least to the degree noted for these attributes in the Pinyon House and Crater Middens assemblages. They are, thus, useful in describing variability in a collection as well as in determining the number of vessels it contains.

TABLE 6.6
Robinson's Indices of Agreement Between Owens Valley Brown Ware Sherds from Two Eagles and Owens Valley Brown Ware from Pinyon House and Crater Middens

	Two Eagles/ Pinyon House	Two Eagles/ Crater Middens
Exterior surface treatment	194	175
Interior surface treatment	146	127
Exterior-interior surface treatment	117	101

WORKED SHERD (1 specimen; body): One small triangular body sherd (O-1744A) appears to have been abraded on all three of its sides and its exterior, perhaps as the result of having been used as a scraping tool in the construction of pottery vessels (fig. 6.4h). This sherd is in most respects similar to the 123 unmodified sherds from Two Eagles that are thought to represent one vessel.

PROJECTILE POINTS

There are 60 projectile points in the Two Eagles collection (table 6.7). Eleven surface specimens were collected in 1972 when the site was first located in the course of probabilistic surface surveys of the Big Pine transect. These lack data regarding specific provenience within the site. The remaining 49 pieces were recovered subsequently during controlled surface collections and excavations conducted in 1978 and 1979.

Only 43 of the projectile points can be reliably identified as examples of the commonly recognized Great Basin projectile point series defined previously in this volume (see chap. 3). Of the balance, 16 are too frag-

TABLE 6.7
Distribution of Projectile Points at Two Eagles

		Structures													
	Surface	2	3	6	8	9	10	11	15	17	19	21	23	25	Total
Great Basin															
Stemmed	1														1
Elko series															
Eared	1														1
Corner-notched	1														1
Rose Spring series															
Corner-notched	6											1			7
Side-notched	2														2
Contracting stem	3														3
Unclassified	3	1													4
Cottonwood series															
Triangular	9				4										13
Desert Side-notched															
Sierra	3				1										4
General	5														5
Unclassified					3										3
Untypable															
Large	2														2
Small	4														4
Indeterminate	10														10

mentary to be typed other than as projectile points and one complete but crude specimen is provisionally typed as belonging to the Great Basin Stemmed series, which is neither well-defined nor well-dated.

GREAT BASIN STEMMED POINT: The Great Basin Stemmed series consists of several large, shouldered, but unnotched, point forms that are individually quite variable and intergrade with each other. The two forms most commonly encountered in the southern Great Basin are Lake Mojave and Silver Lake (Campbell et al., 1937; Borden, 1972; Warren, 1967). The Lake Mojave point tends to be long and lanceolate with a short blade, weak shoulders, and long tapering stem; the Silver Lake form exhibits a relatively long, wide blade, short stem and well-defined shoulders. Bettinger and Taylor (1974) designate Silver Lake and Lake Mojave points as time markers for their *Mohave period,* which is not precisely dated but is thought to have begun before 6000 B.C. and ended before 4000 B.C.

The Two Eagles specimen assigned to the Great Basin Stemmed series is 4.1 cm long, 1.7 cm wide, 0.7 cm thick, weighs 4.1 g, and is made of obsidian (fig. 6.5a). The piece is crudely fashioned but exhibits a short blade and long tapering stem reminiscent of Lake Mohave points. Since there is nothing else in the Two Eagles assemblage to suggest occupation during *Mohave* times and since this point is moderately sand-abraded in contrast to the balance of the chipped stone assemblage, it is presumed that this artifact was retrieved from another, older, site and brought to Two Eagles in much more recent times.

ELKO SERIES: *Elko Eared* (1 specimen; obsidian). A fragmentary basal section was provisionally typed as Elko Eared, primarily because the complete point appears to have been thicker and heavier than those of the Rose Spring series (fig. 6.5b). As no meaningful measurements could be obtained, however, the identification is tentative. The material is red obsidian.

Elko Corner-notched (1 specimen; obsidian). A single Elko Corner-notched point was recovered from the site in 1972. It is 3.3 cm long, 2.7 cm wide, 0.8 cm thick, and weighs 6.3 g (fig. 6.5c). The exceptionally wide expanding stem of this specimen places it very close to the border between Elko Corner-notched and Elko Side-notched points. Cu-

riously, the distal end is intentionally notched, which produces a bifurcate tip consisting of two stubby projections.

ROSE SPRING SERIES: *Rose Spring Corner-notched* (7 specimens; 6 obsidian, 1 red chert). All seven of these are basal fragments. The quality of workmanship is good but there is much variation in the angle at which the notches are executed and in the width of the stem (Fig. 6.6a–g). There is a tendency for the wide points to be thinner than narrow points. None of the specimens was sufficiently complete to permit accurate estimation of weight (table 6.8). One exceptional specimen (O-905) is merely a flake that has been shaped into a point by minimal marginal retouch.

Rose Spring Side-notched (2 specimens; both obsidian). This type is represented by two very different points (table 6.8). One (O-965) is relatively narrow and thick, the other (O-834) is relatively wide and thin (fig. 6.6h, i). In both cases, however, the notches are placed on the sides rather than along the base or at the corners.

Rose Spring Contracting Stem (3 specimens; all obsidian). Three fragmentary points were typed as Rose Spring Contracting Stem (table 6.8; fig. 6.6j–l). The most complete of these lacks only the tip. It exhibits a long parallel-sided stem and square shoulders. The remaining two specimens, both found at the site in 1972, are broken at several points but appear to have concave blade sides and barbed shoulders. In both cases the stem consists of a small nub.

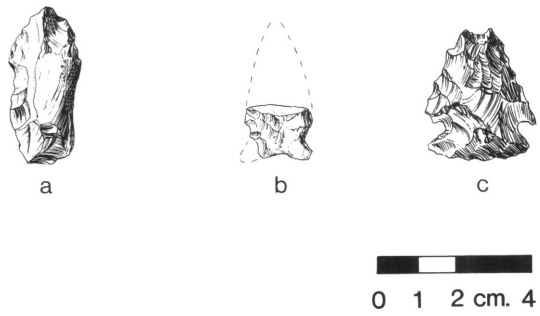

Fig. 6.5. Great Basin Stemmed and Elko series projectile points from Two Eagles. **a.** Great Basin Stemmed (O-818); **b.** Elko Eared (O-2); **c.** Elko Corner-notched (OV-204).

TABLE 6.8
Metrical Data for Rose Spring, Cottonwood, and Desert Side-notched Projectile Points from Two Eagles

		Length (cm)	Width (cm)	Thickness (cm)	Weight
Rose Spring Corner-notched	$\bar{x}$		1.73	0.43	
	S		0.22	0.08	
	n		4	7	
	Range		1.9–1.4	0.5–0.3	
Side-notched	$\bar{x}$	2.70	1.20	0.50	0.90
	S		0.42	0.00	
	n	1	2	2	1
	Range		1.5–0.9		
Contracting Stem	$\bar{x}$		1.60	0.47	
	S			0.06	
	n		1	3	
	Range			0.5–0.4	
Cottonwood Triangular	$\bar{x}$	2.27	1.31	0.34	1.00
	S	0.38	0.15	0.08	0.24
	n	6	10	13	5
	Range	2.9–1.8	1.5–1.1	0.5–0.2	1.3–0.7
Desert Side-Notched	$\bar{x}$	1.88	1.24	0.32	0.63
	S	0.45	0.11	0.06	0.21
	n	4	5	10	3
	Range	2.4–1.5	1.4–1.1	0.4–0.2	0.8–0.4

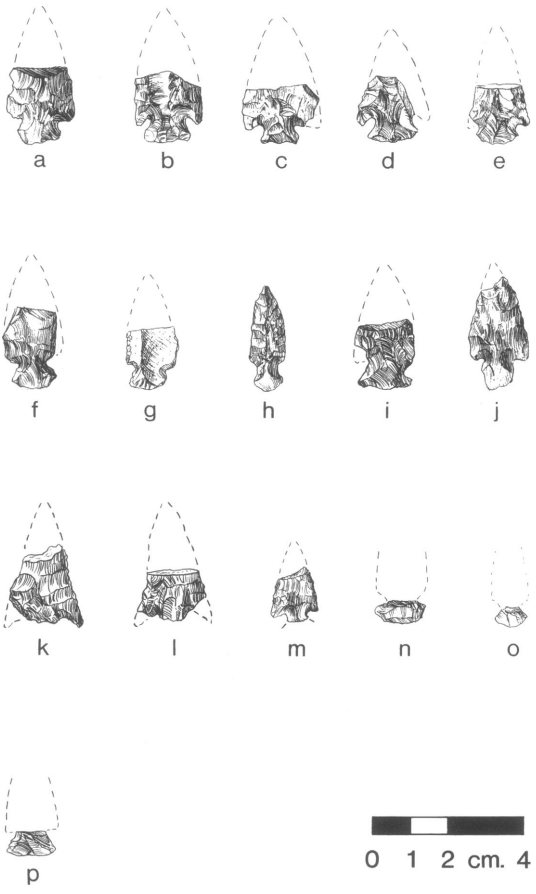

Fig. 6.6. Rose Spring series projectile points from Two Eagles. **a–g.** Rose Spring Corner-notched; **h, i.** Rose Spring Side-notched; **j–l.** Rose Spring Contracting Stem; **m–p.** unclassified Rose Spring fragments. a. O-933; b. O-835; c. O-5; d. O-832; e. O-833; f. O-1165; g. O-905; h. O-965; i. O-834; j. O-3; k. OV-206; l. OV-205; m. O-966; n. O-1005; o. O-848; p. O-1770.

Unclassified Rose Spring Fragments (4 specimens; all obsidian). Four point fragments could not be identified as belonging to any particular type but probably belong to the Rose Spring series judging from their size and shape (fig. 6.6m–p). Three are stem fragments, of which two (O-848, 1770) are evidently from corner-notched points and one (O-1005) from a side-notched point definitely not of the Desert Side-notched series. The remaining specimen (O-966) is the midsection of a small, well-made point that resembles the Desert Side-notched series in size but exhibits notches that suggest it is from a narrow-necked corner-notched point; hence, it was placed in the Rose Spring series rather than the Desert Side-notched series.

COTTONWOOD SERIES: *Cottonwood Triangular* (13 specimens; all obsidian). All 13 Cottonwood series points found at Two Eagles are of the Triangular type (fig. 6.7). There is a good deal of variability in shape and workmanship, but they are consistently light (table 6.8). Four of the 13 exhibit concave bases; all the rest are straight or slightly convex.

DESERT SIDE-NOTCHED: *Sierra* (4 specimens; 3 obsidian, 1 chalcedony). The narrow basal notch that defines the Sierra subtype is the only characteristic shared in common by these four pieces (fig. 6.8a–d). In other respects, particularly size and shape, they are quite heterogeneous. Two examples (O-932, O-1094) have been resharpened.

General (5 specimens; all obsidian). These five points exhibit a range of variability in size and shape comparable to that noted in

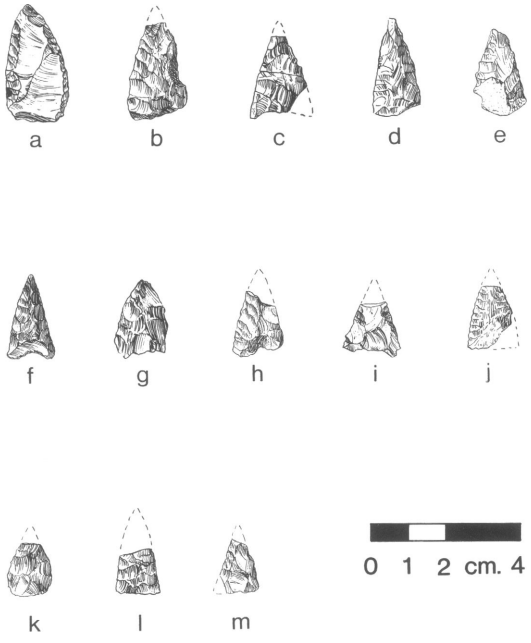

Fig. 6.7. Cottonwood Triangular projectile points from Two Eagles. a. OV-221; b. O-1745; c. O-1098/O-1099; d. OV-210; e. OV-212; f. O-1003; g. OV-213; h. O-1746; i. O-7; j. O-1814; k. O-1004; l. OV-211; m. O-1096.

the Sierra subtype, the only characteristic shared in common being the concave or straight base that defines the General type (fig. 6.8e–i); even the depth of concavity varies substantially in the degree to which it is expressed among the four specimens with this attribute. The fifth specimen is straight-based. One specimen exhibits weak serration along the blade (OV-208) and another (O-930) has been retouched unifacially along one side of the blade.

Unclassified Desert Side-notched Fragments (3 specimens; all obsidian). These three small basal fragments clearly belong to the Desert Side-notched type but cannot be reliably placed in one of its constituent subtypes (fig. 6.8j–l).

Metrical data for all Desert Side-notched points combined are provided in table 6.8.

UNTYPABLE PROJECTILE POINT FRAGMENTS: A total of 16 notched or stemmed artifacts identified as projectile points was too fragmentary to be placed in any particular series. Of these, two are large enough to suggest they are dart points, four are small enough to be considered arrow points, and the balance are simply too small to permit any reasonable estimate of size.

The composition of the Two Eagles projectile point collection is summarized in table 6.9 by archaeological phases as defined by Bettinger (1975a) for central Owens Valley. Collections made in 1972 are distinguished from those made in 1978–79. Added for comparison is the overall composition of projectile point collections from the seven other Desert Scrub occupation sites located during the 1972 survey of the Big Pine transect. Note that Two Eagles was included with these seven sites in previously published references (Bettinger, 1975a, 1977a). The Mohave period point found at Two Eagles in the 1978–79 research is excluded from consideration.

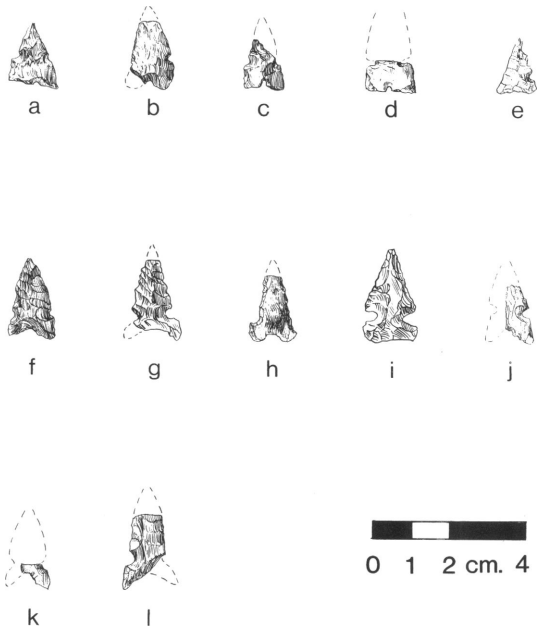

Fig. 6.8. Desert Side-notched projectile points from Two Eagles. **a–d.** Sierra subtype; **e–h.** General subtype with concave base; **i.** General subtype with straight base; **j–l.** unclassified Desert Side-notched fragments. a. O-1094; b. O-8; c. O-932; d. O-931; e. O-6; f. O-904; g. OV-208; h. O-930; i. OV-209; j. O-1747; k. O-1097; l. O-1095.

Klondike phase points clearly predominate at Two Eagles and the other Desert Scrub occupation sites located during the 1972 sur-

TABLE 6.9
Phase Composition of Projectile Point Assemblages from Two Eagles and Other 1972 Survey Desert Scrub Occupation Sites

	Clyde Phase	Cowhorn Phase	Baker Phase	Klondike Phase	Total
Two Eagles					
1972[a]		1 (10%)	2 (20%)	7 (70%)	10
1978–79		1 (3%)	14 (42%)	18 (55%)	33
Total		2 (5%)	16 (37%)	25 (58%)	43
Other 1972[a] sites			2 (17%)	10 (83%)	12

[a] Bettinger, 1975a.

vey. Their importance is particularly apparent when the duration of each archaeological phase is taken into account—Klondike being the shortest (550 years). It is also evident, however, that Baker and Cowhorn phase points make up a much larger fraction of the Two Eagles collection (37%) than they do of the collections from other Desert Scrub occupation sites (17%). This suggests that Two Eagles was occupied relatively more intensively in Cowhorn/Baker times than these other Desert Scrub occupation sites.

To put this in more concrete terms, if we consider only Baker and Klondike phases and exclude the Cowhorn phase, sometime late within which the routine use of Desert Scrub occupation sites is believed to have begun, the intensity of aboriginal occupation at Two Eagles, as approximated in gross terms by number of projectile points deposited per year and later retrieved archaeologically, is about twice as intensive in Klondike times as in Baker times. By contrast, at the other seven Desert Scrub occupation sites located in 1972, Klondike occupation is roughly six times as intensive as Baker occupation. These figures are, of course, quite rough and, in particular, those from the 1972 survey are small and subject to sampling error. Nevertheless, as will be shown subsequently, the notion that Two Eagles is relatively early for a Desert Scrub occupation site is lent some support by obsidian hydration dates. There is a much less pronounced suggestion of greater antiquity when the assemblage of time-sensitive artifacts and obsidian hydration assays from Two Eagles is compared with those of Crater Middens, which is also a Desert Scrub occupation site. These same chronometric indicators also tend to place the aboriginal occupation at Two Eagles slightly earlier than the one at Pinyon House.

OTHER CHIPPED STONE ARTIFACTS

BIFACES: *Simple Bifaces* (72 specimens; 65 obsidian, 4 chert, 3 chalcedony). As a group, the 72 bifaces recovered at Two Eagles (table 6.10) are remarkable for their fragmentary condition (fig. 6.9a, b). Not a single specimen is complete and few exhibit more than one edge (table 6.11). Most pieces appear to represent convex-sided forms. The bases vary from straight or slightly concave to convex or acutely tapered. Among the 37 fragments that could be identified as representing a specific tool segment, 18 are distal fragments, 10 are basal fragments, and 9 are midsections; the remainder are of undetermined origin, but most are probably midsections. Wear is predominantly evident as lateral edge-crushing and abrasion that extend bifacially, which suggests use in cutting and sawing. There are several cases in which edge damage exhibits unifacial bias, however, which suggests use in some sort of scraping task. The broad tool faces are generally free of obvious wear, but one specimen (O-1134) exhibits very fine abrasion on the high points of both faces.

In view of the limited sample sizes relative to the total number of specimens in the collection, it is probably best to regard these metric data with skepticism in the sense that the pieces sufficiently complete to provide usable measurements may constitute a special subset within the larger category of bifaces—for example, these bifaces may have been deemed unsuitable for extensive reworking. As has already been mentioned with regard to the bifaces in the Pinyon House the collection, it would seem from their condition that most of the Two Eagles bifaces represent the by-products of stoneworking, in particular the resharpening of tools or reshaping and re-edging of broken ones. It is worthy of note in this respect that evidence of burin blows using a bipolar technique, with the tool perched on an anvil, are rarer in the collection of bifaces from Two Eagles than in the collection of bifaces from Pinyon House, though the reason for this is not clear.

Flake Knives (2 specimens; both chert). Duplicating the preferential use of chert for this tool type observed at Pinyon House, both flake knives found at Two Eagles are made from large chert flakes; evidently this was a common means for putting to use oddly shaped pieces of this scarce and durable material. In keeping with this, the larger specimen, which is complete, exhibits a deep groove resulting from a hinge-fractured decortication flake scar across one face; doubtless it would have broken had it been subjected to any substantial stress in an attempt to shape it more carefully. It is 5.8 cm long, 4.1 wide, and 0.9 thick. The smaller specimen

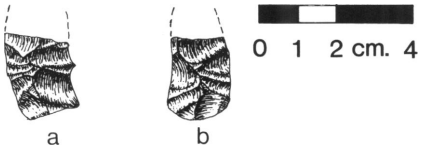

Fig. 6.9. Selected biface fragments from Two Eagles. a. O-1007; b. O-909.

is so fragmentary that its original size and shape cannot be inferred.

Both flake knives exhibit minor pressure retouching along their margins. For the most part this retouch is unifacial though in limited segments it is bifacial. Use-wear is limited to fine abrasion that approaches a polish and is confined to the working edge and immediately adjacent tool faces. In no instance is this wear severe. Both the edge configuration and use attrition that characterize these artifacts is consistent with the notion that they were used in fine sawing and whittling tasks, most likely as light woodworking and hide- and sinew-cutting tools. Both were found in Structure 8 (table 6.10), a somewhat unusual distribution that suggests they were connected in some way to activities that took place in the structure rather than unrelated items of trash that fortuitously found their way into the deposit during an interval of abandonment.

ROUGHOUTS (39 specimens; all obsidian): Roughouts were relatively common at Two Eagles (table 6.10), but the distinctive unifacially retouched triangular blanks presumed to be Cottonwood or Desert Side-notched preforms—the presence of which has already been noted at Pinyon House—are entirely lacking. The absence of the latter is in

TABLE 6.11
Metrical Data for Certain Chipped Stone Artifact Categories from Two Eagles

		Length (cm)	Width (cm)	Thickness (cm)
Simple Bifaces	$\bar{x}$		1.70	0.54
	S		0.50	0.10
	n		3	14
	Range		2.2–1.2	0.7–0.4
Roughouts	$\bar{x}$	2.77	1.85	0.74
	S	0.52	0.30	0.24
	n	9	12	23
	Range	3.9–2.2	2.4–1.2	1.1–0.1
Drills (bits)	$\bar{x}$		0.83	0.45
	S		0.05	0.10
	n		4	4
	Range		0.9–0.8	0.5–0.3
Unifaces	$\bar{x}$[a]	2.69	1.90	0.69
	S[b]	0.55	0.51	0.22
	n[c]	24	24	29
	Range[d]	4.2–1.8	3.3–1.1	1.1–0.3
Cores	$\bar{x}$	2.54	1.93	1.44
	S	0.33	0.46	0.40
	n	9	9	9
	Range	3.0–1.9	2.8–1.1	2.0–0.9

[a] Edge angle 67.19°.
[b] Edge angle 10.15°.
[c] For edge angle 48.
[d] Edge angle 85–40°.

TABLE 6.10
Distribution of Other Chipped Stone Artifacts at Two Eagles

		Structures												
	Surface	2	3	6	8	9	10	11	15	17	19	21	23	25	Total
Bifaces															
Simple bifaces	58	4	1		8							1			72
Flake knives					2										2
Roughouts	28	2			8	1									39
Drills	4														4
Unifaces	27				6		1				1				35
Core tools															
Scraper planes	2														2
Chopper	1														1
Cores	5				3							1			9

keeping with the depauperate character of the less-specialized roughouts recovered at Two Eagles, which are described below.

The 39 roughouts are quite variable in morphology, but the more complete specimens that have been worked into a distinct shape range from subrectangular to oval in outline and are rather thick with respect to width (table 6.11). None could be confidently identified as point blanks and very few appear to be workable into bifacial tools of any sort; most are probably rejects and not blanks awaiting additional attention. This is in contrast to the roughouts from Pinyon House and Crater Middens, at least some of which seem worthy of more work and eventual use as knives or projectile points.

Rudeness of form aside, roughouts from Two Eagles appear to have been originally intended for reduction into the same tool categories—knives and projectile points—as were the roughouts from Pinyon House and Crater Middens. The difference, evidently, is that at Two Eagles all or nearly all suitable roughouts were made into bifacial tools leaving only a small residual of intractable examples. Such a pattern of intensive use of available blanks would also explain the absence of point blanks in the collection. At Pinyon House and Crater Middens, by contrast, roughouts were less exhaustively used and more readily discarded when some difficulty was encountered in working them, presumably because at these two sites the supply of roughouts was greater with respect to demand than at Two Eagles.

As indicated in table 6.10, nearly a third of the roughouts found at Two Eagles were recovered from structures, which is somewhat higher than the corresponding fraction noted for most other tool categories.

DRILLS (4 specimens; 3 obsidian, 1 chert): All four drills found at Two Eagles are narrow bit fragments found on the surface (table 6.10). The longest (3.0 cm) is a tapering distal section (table 6.11). The others are midsections that resemble the distal fragment in taper and size. Three of the four exhibit crushing and abrasion in varying degree along the edges and the distal fragment is abraded on both faces, something not observed on the other three. In the absence of the basal portions, it is not clear whether these specimens were hafted or simply grasped by the hand.

UNIFACES (35 examples; 33 obsidian, 1 chert, 1 chalcedony): Apart from the presence of at least one unifacially retouched working edge, which all of them exhibit by definition, the unifaces in the Two Eagles collection (table 6.10) are quite variable in morphology (table 6.11). All but two are made from flakes, the majority of them curved, twisted, or otherwise flawed in ways that would exclude them from service as preforms for bifacial tools. Eleven exhibit cortical surfaces, which suggests deliberate recycling of this particular kind of stoneworking debris for use as tools. The two unifaces not made from simple flakes are fragments of nodular pebbles of alluvial obsidian that have been split in half and modified by steep unifacial retouch extending from one edge of split face onto the adjacent cortical surface. In these two cases, the configuration of the working edge is convex. The majority of the others are concave. In several instances the working edge is denticulate but it is difficult to determine whether this is an intended edge configuration, a method of edge rejuvenation, or merely a series of small, concave working edges located adjacent to one another on a single tool. Edge damage generally occurs as unifacial edge crushing and abrasion impinging on the intentionally retouched dorsal face.

The dearth of specimens made of chert and chalcedony is remarkable given the observed preference for these materials in the manufacture of bifaces and unifaces in other Owens Valley collections, for example, Pinyon House (see also Bettinger, 1975a), and the availability of chert suggested by several battered cobbles of this material in the Two Eagles collections.

CORE TOOLS: Three large, percussion-flaked core tools used for heavy scraping, pounding, or chopping were found during surface collections (table 6.10). Two of these were classified as scraper planes because they exhibit the steep, unifacial working edges and planar ventral surfaces distinctive of this tool type. The third was classified as a chopper, primarily on the basis of working edge configuration and use-wear.

Scraper Planes (2 specimens; 1 basalt, 1

metasedimentary sandstone). Both of these exhibit a flat natural face that has been used as a platform to detach a series of percussion flakes from the opposing cobble face. This results in a steep unifacial working edge. On both specimens use-wear is evident as battering or abrasion extending ventrally, that is, toward the unflaked planar face, which suggests the tool was used ventral face down and pushed across the material being worked, most likely roots or fiber-bearing plant material.

The larger of the two (O-893) is basalt and measures 11.2 cm long, 7.9 cm wide, and 4.6 cm thick (fig. 6.10a). It appears to have been made from a very large percussion flake, a flat cortical surface of which served as the ventral face from which flakes were detached.

The smaller specimen (O-945) is a very hard, indurated metasedimentary sandstone and measures 8.1 cm long, 6.9 cm wide, and 2.9 cm thick (fig. 6.10b). This piece is wedge-shaped in cross section, the result of two acutely intersecting natural planar surfaces. The working edge is situated along the thin side of the cobble, where these planar surfaces meet, and is convex in plan and denticulate. The use-wear exhibited by this artifact is minimal and consists only of very fine abrasion and a few minute flake scars impinging on the ventral surface. This is in contrast to the abrasion, battering, and step fracturing indicative of heavier use observed on the larger specimen. It may be that the smaller scraper plane was used to shred fine fiber or to remove the skin from edible roots. Light grinding wear observed on the planar dorsal face of this artifact indicates it was reworked from a small millingstone fragment.

Chopper (1 specimen; basalt). This is (O-927A) a large, yet relatively thin, percussion flake of basalt the distal edge of which has been bifacially modified by a continuous series of percussion flakes that extend for a short distance onto the adjacent faces of the tool. Use-wear is present in the form of severe battering confined to the working edge, which has in several spots become quite flat and dull. This sort of edge attrition suggests use in some activity that required application of a great deal of force to a relatively small area. The pounding of fiber, the splitting and pulverizing of bone, and the chopping of wood all fit this description and are considered reasonable inferences as to the tasks for which this tool was potentially employed. The piece measures 11.2 cm in length, 10.7 cm in width, and 4.2 cm in thickness.

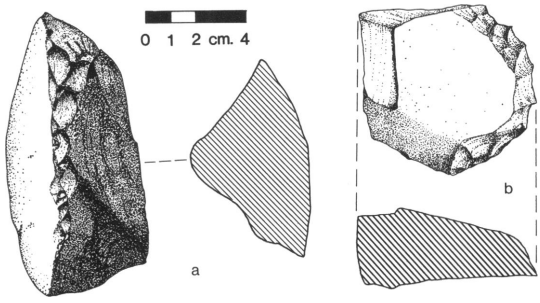

Fig. 6.10. Scraper planes from Two Eagles. a. O-893; b. O-945.

CORES (9 specimens; all obsidian): Of the nine cores recovered (tables 6.10, 6.11), four are fragments of split nodular pebbles of alluvial obsidian that were probably procured along the Owens River, as such pebbles occur sporadically in the segment of the river nearest the site. Two of these fragments, both found in quadrat 12, fit to form a complete pebble. One of these two was subsequently modified by the detachment of a few flakes using the split face as the platform. The other is unmodified. The two remaining fragments are small pebble halves from which additional flakes have been detached from the split face using the cortical surface as the platform. The complete pebble formed by the two fitting fragments is 3.3 cm long, 2.4 cm wide, and 1.9 cm thick. The other two cores were evidently made from pebbles of about the same size.

The classification of these pieces as cores, especially the unmodified example, is provisional and largely a matter of elimination. The size and shape of these pebbles virtually guarantees that, unless one were extraordinarily skilled or lucky, attempts to render them into points or bifaces would be unsuccessful. Split fragments, on the other hand, might easily be made into unifaces, as shown by two such examples in the Two Eagles collection. The four fragments classified here as cores, two of them extensively retouched,

TABLE 6.12
Distribution, Composition, and Metrical Attributes of Debitage from Two Eagles

		Structures											
	Surface	2	3	6	8	9	10	11	15	17	19	21	23	25	Total
Count	2276	290	17	2	380	7	19			1	1	3	1		2997
Weight (g)	1044.5	55.0	11.0	0.5	125.2	0.3	6.0			0.1	0.1	2.1	0.1		1244.9
Mean weight (g)															
Obsidian	0.42	0.19	0.68	0.25	0.34	0.03	0.32			0.10		0.70	0.10		0.39
Nonobsidian	1.40	0.15	0.10		0.25	0.10					0.10				0.94
Combined	0.46	0.19	0.65	0.25	0.33	0.04	0.32			0.10	0.10	0.70	0.10		0.42
Percent obsidian															
Count	96	97	94	100	87	86	100			100	0	100	100		95
Weight	87	98	99	100	90	67	100			100	0	100	100		88

were not made into tools of this sort, however, though each is eminently suitable for such shaping. The only reasonable explanation remaining is that these pebbles were retrieved from the Owens River to be used as a source of small flakes. They are rather small for this purpose, but the collections considered in this volume contain several indisputable cores that are similarly diminutive in size.

The five other artifacts identified as cores are angular or nodular cobbles that have been extensively worked. Three small pieces may be parts of shattered cores. The other two are complete and were evidently discarded as exhausted of usable flakes. One (O-954) is round in plan and roughly lenticular in section; it was worked bifacially using flake scars on both faces as striking platforms, and is about 2.9 cm in diameter and 1.7 cm thick. The other (O-1020) is subtriangular in plan and lenticular in cross section and was worked by means of a flaked platform at one end that facilitated detachment of several long, narrow flakes on one face. The flake scars on this piece suggest use of the bipolar technique in conjunction with some sort of anvil. It measures 3.0 cm long, 2.2 cm wide, and 1.6 cm thick.

DEBITAGE (2997 specimens; 2839 obsidian, 158 chert and chalcedony): The debitage recovered from Two Eagles is remarkably homogeneous with regard to the relative representation of materials. Obsidian accounts for 95 percent of this category by count and 88 percent by weight in the combined surface and subsurface (structure) samples. Further, in no sample of reasonable size, i.e., consisting of more than 30 specimens, are nonobsidian materials in the majority and there is little difference between the surface and subsurface samples with respect to the relative representation of obsidian and nonobsidian materials. These characteristics are made clear in table 6.12.

In contrast to the uniformity of material composition within the Two Eagles debitage samples, there are notable differences in the size of flakes recovered from the site surface and those recovered from structures: flakes recovered from the surface tend to be larger than those recovered from structures. As has already been mentioned with regard to the

same pattern observed at Pinyon House, this might only reflect differential methods of recovery, the use of screens resulting in the more frequent retrieval of small bits of chippage. This is not necessarily the case, however, as debitage collected from certain surface quadrats exhibited mean weights as low as 0.32 g, equivalent to the mean debitage weight in Structure 8, which yielded more of this material than any other individual structure. This suggests that the surface collections were relatively thorough and that the indicated weights can be taken as roughly representative of the debitage present. If so, then it would seem more likely that the debitage found in structures tends to be smaller because the larger pieces were systematically removed from dwellings or because only fine retouch work was carried out there, the heavier reduction work being done outside where the resulting profusion of waste would not be so objectionable.

It is also evident that within structures flakes of obsidian tend to be larger than flakes of other materials; conversely, on the site surface, flakes of obsidian tend to be smaller than flakes of other materials. The simplest explanation for this hinges on differences in the characteristics of obsidian and chert, which makes up the bulk of the nonobsidian debitage. In brief, it might be argued that flakes of chert, being tougher and more difficult to work, cannot be effectively shaped once they fall below a given critical size; obsidian, on the other hand, being more brittle and easily worked, can be readily shaped even in very small pieces. This would account for the larger chert flakes recovered outside structures. By the same token, if it is accepted that only artifact retouch took place within structures, chert pieces—again being tougher—lend themselves only to the removal of small flakes, while obsidian pieces—being more brittle—permit the removal of larger flakes.

The samples of obsidian debitage recovered from the surface and structures at Two Eagles are quite similar in size to those from corresponding contexts at Pinyon House (table 6.13). It is curious, therefore, that chert debitage recovered from the surface of Two Eagles is larger than that from the surface of Pinyon House while that recovered from structures at Two Eagles is smaller than that recovered at Pinyon House.

TABLE 6.13
Debitage Mean Weights by Material for Pinyon House and Two Eagles

	Obsidian	Nonobsidian
Pinyon House		
Surface	0.49	0.89
Structures	0.18	0.72
Two Eagles		
Surface	0.42	1.40
Structures	0.28	0.23

To account for this, one might argue that Pinyon House was situated closer, either by distance or through trade, to a supply of cherts and chalcedonies than was Two Eagles. If it is presumed that at Pinyon House this proximity corresponded to a greater availability of higher quality material, then fewer large pieces of unusable waste would result from the initial reduction and rough-shaping of implements on the site surface and more large secondary retouch flakes might be removed from the better quality biface blanks within structures. On the other hand, the lower quality material available at Two Eagles might result in the more frequent discard of large flawed pieces on the site surface and, owing to the scarcity of cherts, the production of only very small retouch flakes, stemming principally from tool resharpening and finishing within structures. As cumbersome as it is, this explanation has merit in the sense that there is at Two Eagles little evidence for the production of the large, finely crafted green chert bifaces which evidently account for the bulk of the nonobsidian debitage at both Pinyon House and Crater Middens, where much of this waste consists of large flakes of bifacial retouch. What little nonobsidian debitage is present at Two Eagles runs to blocky cortical flakes of low-quality stone, which are correspondingly heavier than the thin chert retouch flakes characteristic of debitage at Pinyon House and Crater Middens. All this suggests that the inhabitants of Two Eagles had limited access to cherts and chalcedonies and that work in these materials was pri-

TABLE 6.14
Distribution of Miscellaneous Debitage at Two Eagles

	Structures													
	Surface	2	3	6	8	9	10	11	15	17	19	21	23	25	Total
Ground flakes					2										2
Notching flake		1													1
Blades															
Prismatic	1				2										3
Bipolar	1														1

marily confined to the retouch of imported tools and the occasional reduction of low-quality cobbles encountered by chance near the site.

Aside from the decided dearth of debitage within structures at Two Eagles, which is in contrast to Pinyon House where debitage is a major component of the structure assemblages, one other notable feature of the debitage at Two Eagles is the degree to which it is concentrated in a very small area. The debitage from a single quadrat, quadrat 6, accounts for fully 54 percent of all the debitage recovered at the site and 71 percent of the debitage recovered from the surface. This rather unusual pattern, which is more fully discussed in a subsequent section dealing with artifact and feature distributions, suggests either very rigid spatial segregation of stone-working as an activity or scrupulous adherence to a regular pattern of stone waste disposal—or both.

MISCELLANEOUS DEBITAGE: Seven pieces of debitage (table 6.14) were sufficiently different from the other specimens recovered to merit individual description. Two have been ground—either by design or inadvertently as the result of use. One (O-1754) is a cortical fragment from a small alluvial obsidian pebble that displays ground facets at the margins of its curved ventral face. These suggest the piece was ground face down on a flat and relatively fine hard surface, perhaps a millingstone. There is no other modification or evidence of use. The purpose of the grinding is unclear unless it was designed in some way to prepare the flake for further modification by flaking. This seems unlikely, however, as the piece is only a little over 2 cm long.

The second ground flake (O-1753), also a cortical fragment though not from an alluvial pebble, exhibits faceting along a small segment of the dorsal margin near the distal end. This grinding exhibits two distinct facet planes, so the agent that produced it must have been both hard and flat; again, a millingstone or flat stone file is the most obvious analog. Whether this grinding was intended to prepare the flake for the detachment of flakes by pressure is not certain. That it is confined to a very small area would tend to indicate use rather than intentional preparation. Included among the rather limited set of uses that might produce the wear patterns noted on both these ground flakes would be the cleaning and light rejuvenation of milling surfaces and removal by scraping or grinding of pigment or mineral powder from tablets or pebbles kept as sources for these materials.

Another odd flake (O-1775), found in Structure 2, is a small, deeply crescent-shaped fragment that is unmistakably the residue from a pressure-flaked notch, probably in a small projectile point. As such notching flakes, the shape of which makes them difficult to overlook, are rare in the Two Eagles collections—and indeed in all the collections from the three sites considered in this volume—and as debitage at Two Eagles tends to be concentrated outside structures, the occurrence of this piece in Structure 2 lends some support to the notion that at least some stone-working—most likely light retouch and final shaping including notching—was done inside dwellings.

Three bladelike prismatic flakes of chalcedony and one bipolar blade of obsidian are sufficiently distinctive to merit individual description. Apart from form, however, each piece exhibits characteristics that are compatible with the more general functional categories recognized throughout this volume:

of the prismatic blades, two are classifiable as flake knives and a third as chipping waste; the bipolar blade is simply a diminutive uniface.

The two smaller prismatic blades of chalcedony are both subrectangular in outline, slightly curved in longitudinal section, and exhibit platforms carefully isolated by pressure flaking. The smaller of the pair (O-916) is unmodified and measures 1.7 cm long, 0.8 cm wide, and 0.3 cm thick. The larger (O-1114) is 3.7 cm long, 1.3 cm wide, and 0.3 cm thick, and exhibits delicate pressure retouch along both lateral edges and the distal edge (fig. 6.11a). The flake scars resulting from this retouch are confined to the margins of the blade immediately adjacent to the edges and in no case approach its midline. The distal retouch is unifacial. The lateral edge retouch on both sides is bifacial with a pronounced unifacial bias, the flakes impinging farther onto one face than the opposing face on the same side. This bias is both laterally and facially symmetrical in the sense that the two more invasively flaked margins appear on opposing faces and opposing sides, which is to say, diagonal to one another when viewed in cross section. The distinctive symmetry of retouch does not appear to be an accommodation to the shape of the unworked blade. Rather, this blade tool seems to have been designed to be hafted or held at one end and used with a unidirectional cutting or scraping stroke, in the manner of a whittling knife, for example. Alternatively, the tool might have been used to saw or cut in the back-and-forth manner suggested for flake knives (which it resembles), the symmetrical retouch resulting from unifacial edge resharpening while the tool was mounted. Use-wear is not pronounced, but the lack of small projections along the edge and the presence of occasional nicks would indicate employment in light cutting, scraping, sawing, and whittling.

A third prismatic blade (O-1115), a proximal fragment retaining the platform, measures 2.2 cm in width, 0.5 cm in thickness, and 3.2 cm from the platform to the point where it has been broken transversely. This piece is larger, flatter, and less bladelike than the other two prismatic blades and, unlike them, displays a platform that is not especially well prepared and is less suggestive of

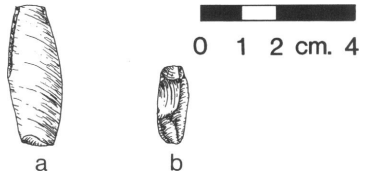

Fig. 6.11. Selected bladelike flakes from Two Eagles. a. O-1114; b. O-915.

detachment from a flat-topped core. One side has been modified by a series of delicate unifacial retouch flakes that extend for a short distance onto the dorsal flake face. There is no obvious evidence of use-wear, but the working edge is so regular, lacking the small projections invariably left by even the most delicate pressure flaking, it seems likely the piece was used in light cutting, sawing, or scraping in a manner similar to that of flake knives.

A fourth blade (O-915) is obsidian and measures 2.1 cm long, 1.8 cm wide, and 0.2 cm thick. It is subrectangular in plan and exhibits fine unifacial retouch extending dorsally along both lateral edges (fig. 6.11b). Use-wear on this diminutive blade consists of fine abrasion confined to the ventral side of the working edge, which would indicate it was employed in light scraping with the ventral surface facing forward with respect to the direction of the working stroke. This blade is significant in that its planar ventral surface indicates it was detached from a small core using a bipolar technique in conjunction with an anvil. It is likely that many of the small bipolar cores found at Pinyon House, Two Eagles, and Crater Middens were used to produce small bladelets similar to this tool, probably for use in tasks similar to the ones for which it was employed. In comparison to the number of cores recovered, however, such blades are very rare in our collections. Presumably, this reflects a pattern of use or curation that caused these blade tools to be lost or discarded at locations away from occupation sites and pinyon camps—which were the object of our excavations. It may be that such prepared blades were incorporated as items of personal tool kits and used for the light repair and maintenance of gear while in the field; items used in such kits would be more likely to be lost or worn out and dis-

carded away from more permanent settlements. Blades of this kind would perform well in a variety of capacities including the preparation of shafts, foreshafts, and basketry withes and wefts, and the working of sinew. Ambro (1970), for example, has described a basket-maker's kit from Lovelock Cave, Nevada, that included as one element a bladelike chert flake.

MISCELLANEOUS ARTIFACTS

STEATITE VESSEL SHERDS (6 specimens; 1 rim sherd, 5 body sherds): Six steatite-chlorite vessel sherds were recovered from the site surface (table 6.15). Four of these (O-921), consisting of two pairs of conjoining fragments found in quadrat 9, obviously derive from the same vessel. They are quite thin, varying in thickness from 0.4 to 0.6 cm with the average thickness tending toward the lower end of this range. The two remaining pieces, a rim sherd (O-1033) found in quadrat 18 and a body sherd found in quadrat 10, appear to be made of the same type of light colored, coarse grained steatite-chlorite as the other four, but are much thicker. The rim sherd exhibits a maximum thickness of 1.0 cm and a minimum of 0.7 cm, with an average close to 0.9 cm. The shape of the rim is similar to that observed on the bulk of Owens Valley Brown Ware ceramic sherds, that is, direct with the rim rounded and tapered somewhat by the shaving of material from the exterior surface. The body sherd is 0.7 cm at its thickest and 0.5 cm at its thinnest. There is on this sherd a distinct break in contour—or shoulder—dividing the thick portion from the thin portion that suggests it is from a vessel that was intentionally shaped to be thicker in one part than another—either to accommodate a flaw or an irregularity of shape in the natural block from which it was made or as a routine element of design motivated by functional requirements or aesthetics.

Although these six sherds are quite variable in thickness, it is the case that the shouldered body sherd bridges these differences, being at its thinnest no thicker than the four thin body sherds and at its thickest no thinner than the thick rim sherd. Given this, along with the similarity in material and the reasonable inference that no more than one vessel of this kind is likely to be present at a site such as Two Eagles, it seems relatively safe to assume that all six of these sherds represent one steatite vessel, the basal portion of which was substantially thinner than the rim.

Steatite vessels have frequently been reported from archaeological sites throughout the Inyo-Mono region (Riddell and Riddell, 1956: 29; Steward, 1933: 268; Enfield and Enfield, 1964: 413), but are nowhere abundant and many of even the largest sites lack them altogether, including the Rose Spring site (Lanning, 1963) and the Cottonwood Creek site (Riddell, 1951). The archaeological surface survey of the Big Pine transect yielded but a single sherd of this kind (Bettinger, 1975a: 162).

PIPE PREFORM: An irregular cylinder of vesicular basalt modified by a conical hole drilled lengthwise into one end was found among the wall rocks on the surface of Structure 8 (fig. 6.12a). It measures 7.0 cm in length, 4.1 cm in width, and 3.5 cm in thickness. The hole is 1.3 cm in depth and varies from 2.2 to 2.9 cm in diameter, which suggests some difficulty was encountered as it was being drilled that prevented smooth rotation of the working bit. There is no indication that this piece was ever handled extensively, but one side is rather flat, perhaps as the result of intentional shaping. It is believed to be an unfinished pipe that was either lost or—what is more likely—discarded as unworthy of further attempts at perforation and dressing. Tubular scoria and pumice pipes that resemble this specimen in size and shape are recorded for several sites in Owens Valley (Riddell and Riddell, 1956: 31; Riddell, 1951: 16), though they are not particularly common.

PENDANTS (5 specimens; all slate): Five artifacts were identified as pendants on the basis of perforation, edge grinding, or incised decoration (table 6.15).

Two perforated pieces of slate are unmistakably pendant fragments. One (O-1141) is conically drilled and evidently subrectangular in outline, though it is broken in such a way that neither its length nor width can be ascertained (fig. 6.12c). All of the original edge that remains has been ground. This piece is 0.2 cm thick. The other perforated fragment (O-1092) is essentially diamond-shaped in outline and exhibits a biconical perforation

TABLE 6.15
Distribution of Miscellaneous Artifact Categories at Two Eagles

	Structures													
	Surface	2	3	6	8	9	10	11	15	17	19	21	23	25	Total
Steatite sherds	6														6
Pipe preform	1														1
Pendants	3				2										5
Incised stones	3														3
Worked bone															
Bone bead					1										1
Spatula	1														1
Untypable		1			1										2
Olivella beads															
J	1														1
K2					1										1
K3	1														1
Steatite disk beads	1														1
Tin can	1														1

at one end (fig. 6.12b). One side is missing, so the width cannot be estimated, but the length is 4.6 cm and the thickness is 0.3. This specimen is not especially well dressed and although there is light grinding at several points along its edges, its diamond-shaped outline is entirely natural in origin, resulting from natural cleavage planes in the slate from which it was made.

A third fragment of slate (O-963/A) exhibits grinding along those edges that are intact and light incisions on one face (fig. 6.12f). On this basis it was identified as a pendant fragment. This specimen is essentially leaf-shaped in outline and measures 2.9 cm long and 0.1 cm thick; owing to a break along one side, its width cannot be estimated with any confidence. The incisions are so faint, either because they were lightly scratched in the first place or have worn thin with time, that it is difficult to determine what patterns or designs, if any, are present.

Two other small bits of slate with ground edges were identified as pendant fragments. One (O-923), found on the surface in quadrat 9, is 0.3 cm thick. The other (O-1001), found on the surface in quadrat 12, is 0.2 cm thick.

INCISED STONES (3 specimens; 2 metasediments, 1 slate): Two artifacts are confidently identified as incised stones and a third is placed in this category provisionally (table 6.15).

One of these three (O-33) was found on the surface in quadrat 8, evidently in association with Structure 7 (fig. 6.12d). It is a tabular slab of slate 0.7 cm thick and rhomboid in outline, measuring 9.0 × 6.2 cm across the corners and 5.6 × 4.9 cm across the flats. None of the edges is ground but the two short sides and one of the long sides appear to be very old, natural breaks that have become rounded through time. The other long side exhibits what would appear to be a much more recent break that is still jagged and seems to have occurred after this piece was incised. One face of the tablet exhibits two pairs of zig-zag lines running from one short side to the other. Owing to natural abrasion and weathering, segments of these lines are indistinct so an exact count of the number of reversals, i.e., where a line stops running in one direction and turns abruptly to reverse itself, is impossible to obtain. For all four lines, however, a count of about 57 would be very close. In several segments, the incision was done with a ragged-ended tool that produced a double line. Curiously, it would appear that these double lines occur in roughly the same segments of each of the four zig-zag lines, as though all four were done together, a segment or hash-mark at a time, rather than consecutively. As, however, is also true of attempts to estimate the number of turns represented in these lines, natural abrasion makes it difficult to be certain about the presence or absence of a doubled line in any particular

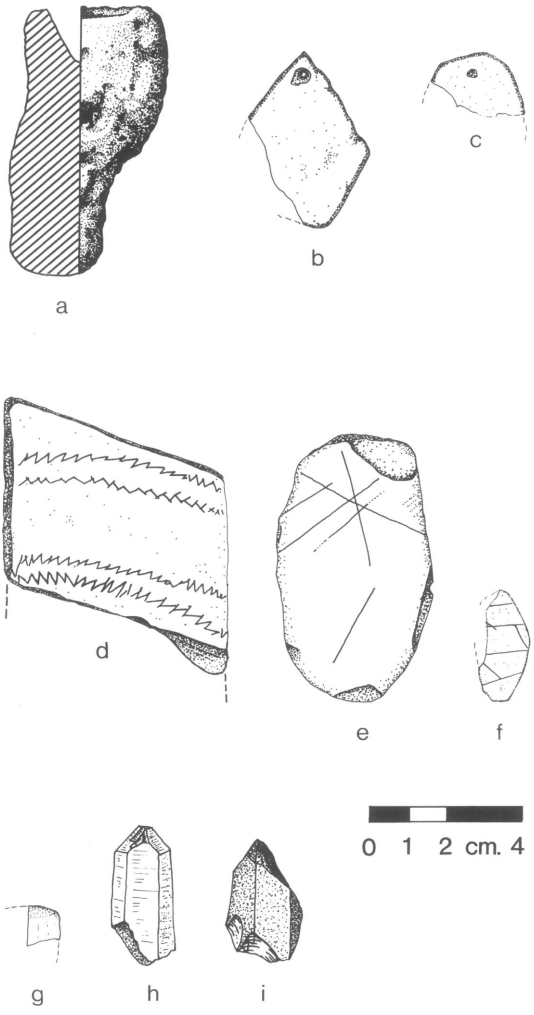

Fig. 6.12. Miscellaneous artifacts of stone and bone from Two Eagles. **a.** pipe preform; **b, c, f.** pendants; **d, e.** incised stones; **g.** bone spatula fragment; **h, i.** quartz crystals. a. O-1069; b. O-1092; c. O-1141; d. O-33; e. O-1811; f. 963/A; g. O-960; h. O-887; i. O-1058.

segment of any of the four lines. Aside from the four zig-zag lines there is no other incision or evidence of modification in any form on this side of the tablet. The reverse side of the tablet has obviously been incised, but the lines are so faint that no specific design can be discerned.

A second, less elaborate, tablet of metasedimentary stone (O-1811) was found on the surface of quadrat 12 in association with Structure 10 (fig. 6.12e). This specimen, which is complete and measures 7.1 cm long, 4.2 cm wide, and 0.6 cm thick, is essentially oval in outline. Although its shape is predominantly the result of natural fracturing and weathering, it seems to have been modified by light percussion trimming of the margins and more clearly by the grinding of two small intersecting facets at one corner. In addition, both faces exhibit very light grinding that is confined primarily to the higher parts of each. Faint incisions are evident only on the flatter of the two faces.

A third artifact (O-902) is provisionally classified as an incised stone. It is a tabular spall of metasedimentary stone that is unmodified except for a few scratches on each face and a small notch cut into one margin. The scratches conform to no obvious pattern and it is possible that they are of natural, as opposed to cultural, origin. This piece measures 5.2 cm long, 3.8 cm wide, and 0.6 cm thick.

WORKED BONE

BONE BEAD: A very small fragment of a highly polished bone bead (O-1125) of which too little remains to provide any useful measurement was recovered (table 6.15). This piece, which retains a section of one worked end, appears to have been made in the same fashion as the bone beads found at Pinyon House. That is, it was brought to length by being snapped at a weak point created by a series of transverse grooves girdling its circumference, after which the rough ends were ground and polished. The intact portion of the ground-and-polished end appears to have been milled by a series of small notches cut into the end. Small transverse incisions on the exterior may be the remnants of manufacture or subsequent decoration.

OTHER WORKED BONE: Other than the tiny bead fragment described above, there are but three pieces of worked bone in the Two Eagles collection (table 6.15). All are too small to permit reliable measurement and the identification of one is considered uncertain. The most distinctive specimen (O-960) is a fragment of a spatula made of ungulate bone the end of which has been modified by grinding a pair of intersecting facets, one on the ex-

TABLE 6.16
Distribution of Minerals at Two Eagles

		Structures												
	Surface	2	3	6	8	9	10	11	15	17	19	21	23	25	Total
Quartz crystals	39	1			1	1					1				43
Quartz cull	6				3						1				10
Specular hematite	5	1			1		1								8
Chalk	1														1
Indurated kaolin	1														1
Red vesicular basalt	7				1										8
Black vesicular basalt	4														4
Pumice					1										1
Slate	2				1										3
Red sandstone	1														1
Fossil (algae?)	1														1
Limonite									1						1
Massive quartz	1						1								2
Opal/hot springs sinter (?)	3														3

terior surface and one on the cancellous surface, to form a bevel (fig. 6.12g). A tool of this sort would perform well in the fleshing and softening of hides and the bevel on this specimen is polished on one facet in a way that suggests it was used for this purpose.

The two other bits of worked bone are more nondescript. One is a polished section of rodent or bird bone; the other is a scrap of heavily scraped ungulate bone.

BEADS OF SHELL AND STONE

Three *Olivella* shell beads and one steatite disk bead were recovered (table 6.15). The *Olivella* collection includes three types, each represented by a single specimen: Wall Disk (Class J), Bushing (Class K2), and Cylinder (Class K3). All three shell bead types and steatite disk beads are regarded as provisional markers for the Klondike phase.

MINERALS

QUARTZ CRYSTALS (43 specimens): Two Eagles is particularly remarkable for the quantity of quartz crystals it yielded (table 6.16). There were 43 of these ranging from 3.7 to 0.7 cm in length (fig. 6.12h, i). The vast majority are clear but several exhibit inclusions, primarily of rutile. There is no doubt that these are artifacts. Nearly all specimens retaining natural terminations exhibit crushing or chipping at this point and several show abrasion at the intersections between crystal faces. A careful survey in the site vicinity failed to disclose a crystal deposit nearby but there are several in the Inyo Mountains behind the site.

Quartz crystals are frequently found as artifacts in archaeological sites throughout North America, including eastern California (e.g., Lanning, 1963: 262), but not in the numbers noted at Two Eagles, which are clearly extraordinary. The aboriginal purpose to which these objects were put is uncertain, though ethnographic evidence consistently indicates a connection with magicoreligious practices (e.g., Levi, 1978). Unless, however, one is willing to accept the idea of Two Eagles as a religious shrine or gathering point for shamans—for which there is little support to be found in the balance of the artifactual assemblage—it is improbable that the presence of these objects in such numbers is attributable to the performance of magicoreligious acts alone. It is more likely that there is a natural crystal deposit near the Two Eagles and that during the intervals in which they were in residence at the site, groups visited this source and procured crystals for their own use and perhaps for trade. That several lumps of quartz matrix from which crystals have evidently been detached were also found at the site (see below) provides substantial support for this view.

TABLE 6.17
Distribution of Unmodified Vertebrate Faunal Remains at Two Eagles

	Surface	Structures 2	8	9	10	15	Total
Neotoma			7				7
Spermophilus			3				3
Sylvilagus			2				2
Lepus			1				1
Dipodomys							
No. identified specimens			13			1 1	1 14
Total bone	61	63	77	6	4	1	212

It is curious, given the effort expended in obtaining these items and subsequently preparing them by cleaning them of matrix and grinding their edges, that these artifacts are so common on the site surface and so uncommon in structures, where it might be presumed that valued objects were kept (table 6.16). Perhaps these pieces are rejects discarded at some point in the process of preparation because they were smaller or less attractive than other specimens being prepared at the same time.

QUARTZ CULL (10 specimens): Ten fragments of quartz matrix evidently detached from quartz crystals were recovered. These are predominantly white or cloudy rather than clear but generally retain small portions of clear quartz crystals. Contrary to what might be expected, these flawed and evidently worthless pieces of cull occurred relatively more frequently in structures than the crystals themselves, which were almost certainly the objects of the reduction process that produced the waste quartz matrix. The observed distribution is given in table 6.16.

Assuming that it is not an artifact of sampling error, there is no obvious explanation for this differential distribution. Crystals being regarded as intrinsically powerful and dangerous, it is possible that when matrix was trimmed inside structures, any flawed crystal rejects or fragments were systematically collected and disposed outside. The matrix, on the other hand, may have been regarded as no different from any other stone and, thus, less carefully collected and removed from work areas within structures.

ADDITIONAL MINERALS: Unmodified bits of mineral obviously exotic to the site were found both on the surface and in structure deposits (table 6.16). Among the most common of these were eight pieces of specular hematite, the mineral from which one battered cobble (O-1743; see above) was made. A single piece of chalk, similar to fragments found at Pinyon House and Crater Middens, may have been obtained near what is today Tinemaha dam and intended for use as pigment (Steward, 1933: 277). A fragment of indurated kaolin, on the other hand, was probably picked up near Hot Creek in Long Valley, where this material is common. Several bits of the same mineral, and very likely from the same source, were recovered at Crater Middens. The provenience of these and the balance of the unmodified minerals found at Two Eagles is shown in table 6.16.

HISTORIC ARTIFACTS

The only historic artifact recovered at Two Eagles is a cylindrical sanitary tin can with locked top, bottom, and side seams (O-1062). This specimen stands 8.2 cm tall and is 6.8 cm in diameter. The construction method used securely dates this can sometime after 1895. Given its peripheral provenience with respect to the most intensively used parts of the site and the absence of other historic artifacts in the Two Eagles collection, it is probably an item of trash discarded by a recent visitor rather than part of the aboriginal assemblage.

UNMODIFIED VERTEBRATE FAUNAL REMAINS

A scant 212 pieces of unmodified bone were found at Two Eagles and of these only 14 specimens were identifiable (table 6.17). All were attributable to genera well-represented in the modern local fauna. Given that it is so vanishingly small and potentially consists in whole or part of items whose presence is attributable to natural as opposed to cultural processes, it would be unwise to speculate regarding the seasonality of site occupation or the nature of aboriginal hunting patterns on the basis of this sample alone.

PLANT MACROFOSSILS

As noted in the Introduction, neither plant nor animal remains were present in any quantity at Two Eagles, a circumstance that subsequently prompted excavation at Crater Middens, where both were relatively abundant. Several flotation samples extracted from the structures excavated were treated by water separation in the same manner as those from Crater Middens (see chap. 9 for a full description). Only two yielded enough charcoal to warrant examination. These, along with samples from Pinyon House and Crater Middens, were sent for analysis and identification to Kimball T. Harper and Patrick Collins, Department of Botany and Range Sciences, Brigham Young University. Of the two samples submitted from Two Eagles, only one, that from Structure 9 (F-50), contained any identifiable charred seed at all. These were referred to *Muhlenbergia* sp., or muhly, and might belong to any of three species that regularly occur in the Inyo and White Mountains: *M. asperifolia,* scratch grass, *M. filiformis,* pull-up muhly, and *M. richardsonis,* mat muhly. To these might be added *M. montana,* mountain muhly, the distribution of which encompasses Inyo and White Mountains, though it has yet to be identified there. This last suggestion is particularly attractive for mountain muhly was evidently eaten by the Southern Paiute (Kelly, 1964: 153, cf. *Muhlenbergia trifida*). If the charred specimens in this sample are indeed that plant, then its seed-bearing period from July through September would furnish some hint as to the season in which Two Eagles was occupied. The other three species would suggest occupation sometime between about July and November. In any of these cases it would need to be assumed the seeds were collected at this site and not imported from another. Because all four species may have been readily at hand within the foraging radius around Two Eagles (in the case of mountain muhly this is clearly speculative) there is also the possibility these seeds represent plants used for fuel rather than food.

It would obviously be unwise to draw any firm seasonal or behavioral interpretations from this one taxonomically uncertain sample.

CHAPTER 7. TWO EAGLES: CHRONOLOGY, SPATIAL DISTRIBUTIONS, AND SUMMARY INTERPRETATIONS

CHRONOLOGY

Obsidian hydration rim measurements and time-sensitive artifacts, primarily projectile points and ceramics, provide the bulk of the chronometric evidence at Two Eagles. We can safely discount the one charcoal sample large enough to be assayed by standard radiocarbon methods, which yielded a date of less than 100 radiocarbon years (UCR-1556) and thus evidently is not of aboriginal origin.

Fashioning a chronology from these data is made more difficult by the lack of buried deposits that might provide a framework from which to begin. There is no midden deposit outside structures and the structures themselves typically contain only a thin veneer of loose dust that renders their contents susceptible to mixture with materials from the surrounding site surface. Indeed, with the exception of Structure 8, the buried deposits of which were deep enough to provide some protection against the possibility of mixture, Two Eagles is in essence a surface site and, as will become apparent momentarily, subject to all the difficulties that surround the dating of such assemblages.

OBSIDIAN HYDRATION: Including a series of nine previously published (Bettinger, 1980a), a total of 29 hydration rim measurements on small flakes of Fish Springs obsidian are available for Two Eagles (table 7.1). Three of these showed no visible hydration rim. The remaining 26 specimens range in thickness from 3.8 to 1.2 μm, which, according to the hydration rate used here, suggests an occupation spanning from about 260 B.C. to A.D. 1821. Of these, 21 (81%) fall between 260 B.C. and A.D. 600, within the last third of the Cowhorn phase, 2 (8%) fall between A.D. 600 and 1300, within the Baker phase, and 3 (12%) fall between A.D. 1300 and 1821, within the Klondike phase. As will be made clear shortly, these dates are not at all in accord with those suggested by the time-sensitive projectile points found at Two Eagles, 95 percent of which are assigned to either the Baker or Klondike phases.

Owing to the thinness of their deposits and the dearth of material contained therein, structures were considered poor candidates for obsidian hydration dating and rim measurements were obtained only for three: Structures 2, 3, and 8. At face value, these date Structure 2 between 100 B.C. and A.D. 220, Structure 3 between A.D. 60 and 140, and Structure 8 between 100 B.C. and A.D. 1661. The dates for Structures 2 and 3, however, are suspect owing to the aforementioned lack of integrity in their deposits. That the hydration dating for both is perfectly compatible with the dating of the surficial artifact scatter is particularly suspicious in this regard.

The dates suggested by hydration rim measurements for flakes from Structure 8, on the other hand, are notably younger than those that characterize the surface scatter. In all, the samples from this feature account for four of only five hydration measurements obtained from the site as a whole indicating dates younger than A.D. 600. In light of this, it is worth considering whether the one hydration reading suggesting an age of 100 B.C. might not have found its way into this feature by accident since it is some 1200 years older than the other four, which cluster between A.D. 1181 and 1661. Since our sample is small, however, we shall accept all five hydration dates at face value.

TIME-SENSITIVE ARTIFACTS: Forty-three typable projectile points of forms firmly dated in the western Great Basin, 127 sherds of Owens Valley Brown Ware, three *Olivella* shell beads (Classes J, K2, K3), and a steatite disk bead comprise the collection of time-sensitive artifacts from Two Eagles. The sherds, the vast majority of which probably derive from one vessel, document occupation of the site sometime between A.D. 1300 and historic times (Lanning, 1963). Eleven of these found above the basal fill of Structure 8 are thought to have washed or been tossed into that feature following its abandonment, apparently fixing that event after A.D. 1300. The only other sherd recovered from any structure, a single fragment found in Structure 2, is not particularly helpful in establishing the

TABLE 7.1
Obsidian Hydration Rim Measurements for Two Eagles

Specimen number	UCD-O number	Provenience	Mean hydration rim reading (microns)	Calendar date B.C.	Calendar date A.D.
O-19BA	877	Structure 2	3.2 ± 0.2		220
O-19BB	878	Structure 2	3.6 ± 0.1	100	
O-1067CA	890	Structure 3	3.4 ± 0.1		60
O-1067CB	891	Structure 3	3.3 ± 0.2		140
O-1121CA	892	Structure 8, lower unit	3.6 ± 0.1	100	
O-1121CA	893	Structure 8, lower unit	2.0 ± 0.1		1181
O-1128C	894	Structure 8, lower unit	1.7 ± 0.1		1421
O-1145CA	895	Structure 8, lower unit	1.4 ± 0.2		1661
O-1145CB	896	Structure 8, lower unit	2.0 ± 0.2		1181
O-817C	879	Quadrat 4	NVH[a]		
O-874CA	880	Quadrat 6	1.2 ± 0.1		1821
O-874CB	881	Quadrat 6	3.5 ± 0.1	20	
O-874CC	882	Quadrat 6	3.2 ± 0.2		220
O-914CA	883	Quadrat 8	3.5 ± 0.1	20	
O-914CB	884	Quadrat 8	3.1 ± 0.1		300
O-914CC	885	Quadrat 8	3.3 ± 0.2		140
O-1022CA	886	Quadrat 12	2.9 ± 0.2		460
O-1022CB	887	Quadrat 12	3.0 ± 0.2		380
O-1027C	888	Quadrat 15	2.8 ± 0.2		540
O-1045C	889	Quadrat 22	2.9 ± 0.2		460
OV-244.0	831	Surface, 1972 survey	3.73 ± 0.20	180	
OV-244.1	832	Surface, 1972 survey	3.28 ± 0.20		140
OV-244.2	833	Surface, 1972 survey	3.03 ± 0.20		380
OV-244.4	835	Surface, 1972 survey	2.85 ± 0.20		460
OV-244.5	836	Surface, 1972 survey	3.75 ± 0.20	260	
OV-244.6	837	Surface, 1972 survey	NVH[a]		
OV-244.7	838	Surface, 1972 survey	3.83 ± 0.20	260	
OV-244.8	839	Surface, 1972 survey	3.38 ± 0.20		60
OV-244.9	840	Surface, 1972 survey	NVH[a]		

[a] No visible hydration rim.

Notes: Calendar dates calculated as $Y = 800.3X - 831.2$, where X is the rim measurement in microns and Y is the date in years before present, which is taken to be 1950. Hydration Laboratory numbers 832 through 840 are those of the hydration dating facility at the University of California, Riverside, and refer to samples processed there.

age of that feature owing to the possibility that its association is fortuitous.

Disregarding one possible Great Basin Stemmed projectile point which seems to have been scavenged elsewhere and brought to the site in aboriginal times, a total of 43 time-sensitive projectile points was recovered from Two Eagles. Of these, two (5%) are attributable to the Cowhorn phase, 16 (37%) to the Baker phase, and 25 (58%) to the Klondike phase.

Along with the sherds just mentioned, four Desert Side-notched and four Cottonwood Triangular projectile points recovered from the upper and middle deposits of Structure 8 suggest its abandonment after A.D. 1300 if we assume that only the lower deposits accumulated during occupation. Singleton Rose Spring projectile points recovered in Structures 2 and 21 are not regarded as reliable indicators of the age of those features.

SUMMARY OF CHRONOLOGY: The contradictory lines of evidence cited above are not going to fall neatly into a simple chronology of occupation at Two Eagles. It is especially difficult to understand the divergence in dating suggested by the hydration dates on surface debitage and the projectile points since the two tend to be distributed in a manner that would seem to connect them (see below).

Despite this, hydration measurements place the bulk of the debitage prior to A.D. 600, while most of the points fall after that date.

The discrepancy is most easily dismissed by arguing that all but one of the hydration dates suggesting ages in excess of 1350 years are on surface artifacts, which would have been subject to abnormally high environmental temperatures and therefore faster than normal rates of hydration. This, of course, would fit with the hydration dates obtained from the basal deposits in Structure 8, which we have noted are substantially younger than those indicated for surface artifacts.

Against this, it is worth noting that the provisional obsidian hydration rate used here relies substantially (though not exclusively) on surface artifacts, so one would not expect grossly distorted results when working with surface pieces. Of course, it is not entirely out of the question that the rate itself is in error since the total number of projectile points on which it is based (41) is relatively small. Even so, this particular rate formulation has elsewhere been shown to produce favorable results when compared with obsidian hydration dates obtained on glass from sources for which the rates are better established (cf. Bettinger et al., 1984b).

It may be of some consequence that the collection of projectile points from the surface of Two Eagles is as a whole relatively old, older at least than the collections of typable points from the surfaces of Pinyon House and Crater Middens. At Two Eagles points of types dating earlier than A.D. 1300 comprise approximately 50 percent of the typable surface specimens; at Pinyon House these types comprise only about 40 percent of the surface total and at Crater Middens only about 30 percent of the surface total. It is possible, then, that the relative antiquity of the surface scatter in combination with surface exposure accounts for these discordant obsidian hydration dates.

Alternatively, since material for stone tools seems to have been in short supply and there is some evidence of artifact scavenging, it is conceivable that the residents of Two Eagles habitually sought out older sites for workable stone, thus giving their chipping waste the appearance of great age when assessed by obsidian hydration rim measurement.

There is clearly no easy resolution of this problem. Forced to choose between the dates suggested by hydration rim measurements and those suggested by projectile points, the latter are clearly better understood and provide the firmer basis for a site chronology. As we have said, they would place the initial occupation of the site sometime between 1200 B.C. and A.D. 600, and the bulk of occupation between A.D. 600 and historic times. The absence of any historic artifacts in solid association with the aboriginal assemblage would suggest use of the site terminated before A.D. 1860.

The only structure that can be confidently dated is Structure 8. If we accept the dating of its basal deposits on the basis of an *Olivella* bushing bead (Class K2) and obsidian hydration rim measurements, taken on flakes not subject to excessive hydration rates, this feature was occupied from at least A.D. 1181, perhaps as early as 100 B.C., and abandoned sometime after A.D. 1661. Time-sensitive artifacts recovered from the deposits overlying the basal fill of the structure support the dating of the latter event.

No precise dating can be offered for the 27 shallow structures that remain but their group resemblance to Structure 8 in size, use of millingstones for wall material, and presence of milling alcoves tends to place them sometime between A.D. 600 and historic times. That millingstones are so consistently associated with structures further suggests that the majority of the unassociated surface milling assemblage is at least roughly contemporaneous with these features, and hence dates to the same interval.

This leaves only the enigmatic surface scatter of chipped stone, the bulk of which, if we disregard its hydration rim measurements and believe its time-sensitive artifacts, appears to date between A.D. 600 and historic times, which is to say at least grossly contemporaneous with Structure 8 and, therefore, the 27 other structures and the millingstones. The anomalously large hydration rim readings seem best explained as resulting from surface exposure and, possibly, the reworking of older artifacts.

SPATIAL PATTERNING

Since for the most part we cannot convincingly demonstrate that any two artifacts

TABLE 7.2
Distribution of Major Categories in Gridded Area at Two Eagles

	Structures	Ceramics sherds	Millingstones	Projectile points	Simple bifaces	Roughouts	Unifaces	Cores	Quartz crystals	Debitage
Numbers	28	115	194	39	58	28	27	5	38	2276
Maximum density	4.5	105.3	33.7	14.0	24.0	8.0	8.4	5.0	5.0	1612.0
Total area of distribution (m^2)	4050	900	8775	2025	2700	2025	2025	900	4050	5175
Area of principal distribution[a] (m^2)	1800	225	1575	450	225	2025	2025	900	4050	225
Percent in area of principal distribution	55%	87%	55%	67%	41%	100%	100%	100%	100%	71%

[a] See figure 7.1.

Notes: Partial quadrats were treated as complete (i.e., as having an area of 225 m^2) in calculating area of total distribution and area of principal distribution.

or features are related to each other in time or function (conjoining sherds and milling alcoves attached to structures are notable exceptions), the patterns with which we are concerned are of the most general sort and speak to the broader patterns of site use rather than specific events. We presume that these patterns reflect basic constraints having to do with the kinds of activities performed and the sizes of groups performing them and that they persisted for much of the time in which the site was occupied or at least those periods responsible for the bulk of the assemblage.

Only nine categories are common enough in the surface assemblage of Two Eagles to merit serious attempts at inferences regarding their spatial arrangement: structures, ceramics, millingstones, projectile points, simple bifaces, roughouts, unifaces, quartz crystals, and debitage. For the sake of completeness and to facilitate comparison with the other two sites treated in this volume, cores are also considered in passing though there are but five of them in the surface assemblage.

The distribution of these categories is examined below following essentially the same methods employed in the analysis of the surface assemblage of Pinyon House, to which the reader is referred for a more detailed explanation of concepts and procedures. As in that case, the gridwork of 15 × 15 m quadrats used to control the surface collection provides the framework for analysis. Within this gridwork, the distribution of each category was plotted and visually inspected for clustering. Univariate frequency distributions aided in recognizing and confirming the presence of such clusters which, when present, were taken to define critical densities (principal distributions) resulting from meaningful patterns of behavior relevant to the category in question. Where the distribution of a category failed to disclose obvious evidence of clustering, its total distribution was taken to indicate this patterning.

Table 7.2 furnishes data relevant to the distribution of each of the ten categories noted previously. Figure 7.1a–i, k plots these distributions, some of which have been modified along the lines noted above. Figure 7.1j provides distributional data pertaining to mean debitage weights, which are relevant to certain aspects of the analysis.

It is important to note that because of the shape of the blufftop on which the site is located, the superimposed grid system includes several incomplete quadrats (i.e., those whose surface area is less than 225 m^2). Accordingly, in figure 7.1 and as noted in table 7.2 the distributions for all categories are given as densities per 225 m^2 rather than actual quadrat counts. These partial quadrats preclude calculation of simple density statistics, most notably variance and, hence, Coefficient of Dispersion, which are dispensed with.

Table 7.3 furnishes two measures of spatial association between the ten categories of features and artifacts considered here. The first indicates the amount of spatial overlap between the principal distribution of each pair of categories as a fraction of the area both

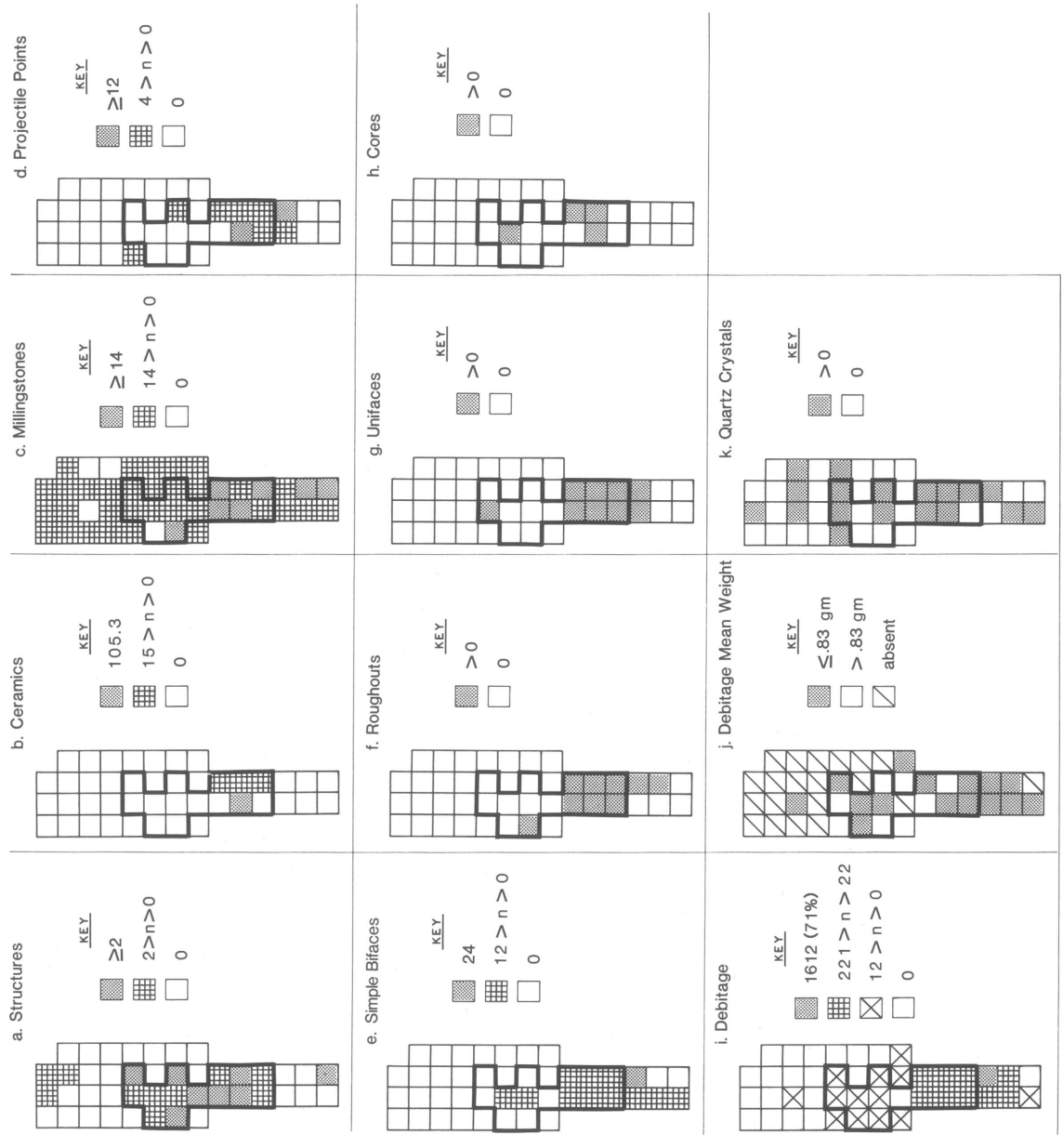
a. Structures
KEY
≥2
2>n>0
0
b. Ceramics
KEY
105.3
15 > n > 0
0
c. Millingstones
KEY
≥14
14 > n > 0
0
d. Projectile Points
KEY
≥12
4 > n > 0
0
e. Simple Bifaces
KEY
24
12 > n > 0
0
f. Roughouts
KEY
>0
0
g. Unifaces
KEY
>0
0
h. Cores
KEY
>0
0
i. Debitage
KEY
1612 (71%)
221 > n > 22
12 > n > 0
0
j. Debitage Mean Weight
KEY
≤.83 gm
> .83 gm
absent
k. Quartz Crystals
KEY
>0
0

TABLE 7.3
Spatial Association of Major Categories in Gridded Area at Two Eagles

	Ceramic sherds	Milling-stones	Projectile points	Simple bifaces	Rough-outs	Unifaces	Cores	Quartz crystals	Debitage
Structures	.13/1.00	.36/ .57	.11/ .50	.00/ .00	.31/ .50	.21/ .38	.20/.50	.24/ .63	.00/ .00
Ceramic sherds	X	.14/1.00	.50/1.00	.00/ .00	.11/1.00	.11/1.00	.25/1.00	.06/1.00	.00/ .00
Millingstones		X	.13/ .50	.00/ .00	.60/ .85	.33/ .57	.22/ .50	.19/ .57	.00/ .00
Projectile points			X	.50/1.00	.22/1.00	.22/1.00	.20/ .50	.11/1.00	.50/1.00
Simple bifaces				X	.11/1.00	.11/1.00	.00/ .00	.06/1.00	1.00/1.00
Roughouts					X	.64/ .77	.30/ .75	.29/ .67	.11/1.00
Unifaces						X	.30/ .75	.35/ .78	.11/1.00
Cores							X	.16/ .75	.00/ .00
Quartz crystals								X	.06/1.00

Notes: First value calculated $A/A + B + C$, second value calculated $A/\min(A + B, A + C)$, where A is the area shared in common between two categories, B is the area of the first not shared by the second, and C is the area of the second not shared by the first. Values calculated on the basis of principal distributions shown in table 7.2. See text for explanation.

categories occupy collectively (i.e., the area of intersection divided by the area of the union). The second indicates this spatial overlap as a fraction of the area of the smaller of the two principal distributions.

Given that the samples for many categories are small and the quadrats relatively few in number, yet large in relation to the surface area of the site, it would be unwise to place great stock by the distributions depicted in figure 7.1 and the values listed in table 7.3. Some simple inferences, however, seem warranted.

DISTRIBUTIONS: The 28 structures present, though widely distributed overall, show a distinct tendency to cluster within what may be called a residential zone at the center of the site (fig. 7.1a). A handful of structures seems to have been placed apart from the others deliberately, at the extreme northern and southern site margins. There is enough usable living space between these separate structures and the residential zone to discount the possibility that the outliers were occupied as a simple response to crowding. As proposed for Structure 3 at Crater Middens (see chap. 8), these isolated features may have been occupied by expectant families during the period just before and after childbirth or, as proposed for Structure 1 at Pinyon House South, occupied when deaths in the family required the ritual burning and abandonment of houses that had been occupied in the residential zone. Other possibilities include use by groups not closely related to families living in the residential zone or at times when weather or accumulations of debris rendered that part of the site unattractive.

The distribution of ceramic sherds (fig. 7.1b) is concentrated in a manner that suggests vessel breakage within the residential zone. That nearly all of the sherds recovered seem to derive from a single vessel lends substantial weight to this notion. The suggestion that they had been methodically gathered up elsewhere and dumped here, presumably by those living in the residential zone or in a structure farther away, seems less likely: refuse could have been more efficiently disposed of along the steep bluff slopes that bound the sites and are conveniently near at hand from anywhere within its confines.

Millingstones are impressive by the sheer numbers in which they occur even though

←

Fig. 7.1. Distribution of major feature and artifact categories at Two Eagles. Location of residential zone is shown by heavy outline. **a.** structures; **b.** ceramic sherds; **c.** millingstones; **d.** projectile points; **e.** simple bifaces; **f.** roughouts; **g.** unifaces; **h.** cores; **i.** debitage; **j.** debitage mean weight; **k.** quartz crystals.

none shows evidence of more than moderate use. These tools tend to cluster within the residential zone as the result of their recycling as building material for structure walls or use in milling alcoves attached to structures (fig. 7.1c). Concentrations of millingstones in other areas and the broad distribution of this category across the site in general, however, suggest caching or use outside the residential zone. Since many specimens are fragmentary, it is also possible that this wider distribution reflects intentional tool disposal. As noted with reference to the distribution of ceramics, however, the bluff slopes that surround the site on three sides seem better suited as refuse dumps than any part of the site proper.

Projectile points, simple bifaces, and debitage all share very similar distributions (fig. 7.1d, e, i). Though they extend partly into the residential zone, their overall distributions are more southerly and reach peak densities outside the residential zone very close to the southern site boundary. Projectile points, however, also show equivalent concentrations within the residential zone.

Like the previous three, roughouts (fig. 7.1f) and unifaces (fig. 7.1g) occur mainly in the southern part of the site, but neither one shows any marked concentration there, either inside or outside the residential zone.

Unlike any of the above chipped stone categories, cores (fig. 7.1h) occur primarily in the residential zone but as there are only five it is difficult to make much of this.

These distributions tend to place the principal locations of stoneworking, woodworking, and other crafts outside and apart from the residential zone. The secondary concentration of projectile points within the residential zone and, perhaps, the smaller quantities of bifaces, roughouts, unifaces, and debitage that occur there suggest craft activities of a less intensive sort, the daily minor repair and touch-up of hunting gear, for example. An alternative possibility is that of occasional tool production within the residential zone when few people were present.

Mean debitage weight tends to be somewhat higher within the residential zone than the area to its south we have tentatively identified as a location of intensive craft activity. Mean debitage weights for surface quadrats at Two Eagles range between 0.10 and 2.40 g, most (65%) falling between 0.10 and 0.83 g. The larger value (0.83 g) is nearly identical to the upper boundary of mean debitage weights characterizing areas thought to have been used for all but the heaviest stoneworking at Pinyon House (0.89 g). It is not surprising, therefore, that at Two Eagles quadrats with mean weights less than 0.83 g characterize the zone inferred to have been most intensively used for stoneworking (fig. 7.1j).

In other respects the distribution of debitage by size at Two Eagles is quite different from that found at Pinyon House. In particular, at Pinyon House quadrats with the larger mean debitage weights tended to occur at the site margins, evidently reflecting heavy stoneworking and the use of flake tools in butchering and other tasks producing objectionable refuse. At Two Eagles, on the other hand, the quadrats with larger mean flake weights tend to occur within the residential zone where one would not expect activities of this kind.

To be sure, the larger debitage weights characterizing the residential zone at Two Eagles are to some degree misleading because many quadrats there contained only one or two flakes. Indeed, in comparison to Pinyon House, where quadrats with the larger mean flake weights (greater than 0.85 g) account for approximately 12 percent of the debitage total by count, at Two Eagles these quadrats account for only about half that much (6%). This would suggest that Two Eagles lacked the frequency of heavy stoneworking, and perhaps as a consequence, flake tool use, observed at Pinyon House.

Discounting those with very small samples still leaves us with a few quadrats containing reasonable quantities of debitage characterized by large mean weights in the heart of the residential zone at Two Eagles. These may reflect flake tool use in connection with light tasks such as routine equipment maintenance, which we have previously suggested took place in and around structures in the residential zone. They might also reflect heavy stoneworking or butchering at a time when the residential zone was not being heavily used.

Since very little material was recovered from most of the structures at Two Eagles,

the notion that the southern artifact concentrations are refuse dumps, not work areas, merits consideration. That is, it might be that most work took place in and around structures but the debris was routinely removed and deposited at the southern margin of the site. At first glance, this seems unlikely since it would require reasonably long trips from the more northern houses when an adjacent bluff edge was readily at hand. Further, the scatter of fragmentary millingstones across the site seems to speak of rather casual attitudes toward refuse disposal. Alternatively, to judge from the exhaustive use of tools and roughouts, material stocks seem to have at least occasionally been hard pressed at the site and it may be that, anticipating this possibility, its inhabitants deliberately chose to dispose of their stone waste in one place against the chance they might later have to sort through it for recyclable material. The spectre of material shortage would not by itself require refuse dumping of this kind, however; confining workshop activity to a single area would serve the same purpose.

There is clearly room for alternative views, but the artifact concentrations in question seem more adequately explained as workshop locations than dumps.

Lastly there is the distribution of quartz crystals (fig. 7.1k), which is particularly difficult to interpret because the function of these objects is uncertain. Thin and patchy but covering virtually the whole of the site, this distribution fits with what one would expect from multiple individual events the location of which varied with time and circumstance. These episodes probably centered on sorting and the trimming of matrix (cull) from crystals obtained near the site, or the disposal of waste therefrom. The distribution is clearly different from that of the chipped stone scatter, which would suggest that, whatever their exact use, these crystals were not intended for reduction into tools.

DISCUSSION: A basic problem in confronting the archaeology of Two Eagles is that of deciding how many "sites" there are to be dealt with. We have just reviewed the artifact and feature distributions as though there were just one settlement, intermittently occupied over a long span of time. It must be kept in mind that this may not be true.

To make the case at least plausible, minimally we must assume that four basic constituents of the assemblage are functionally related: Structure 8, the 27 remaining shallow structures, the surface scatter of chipped stone, and the surface scatter of millingstones. The summary of site chronology presents the strongest case that can be reasonably made that these entities date within the same block of time (A.D. 600 to historic times). It does not by any means assure functional relationship between these entities, however. Like most archaeological chronologies (and the one for Two Eagles is more crude than most), it is simply too imprecise to permit the linking of individual features and artifacts to a specific occupation. And without knowing which things go with which, there is no assurance that most of the various individual elements of the assemblage are associated.

In practical terms, this means we are without any direct means of estimating the number of houses or amount of site area in use at any given time during the interval in which occupation is thought to have occurred. We cannot, moreover, ascertain specific contemporaneity between Structure 8 and any of the shallower structures at the site, which is of interest given the differences between it and them. Nor can we directly connect the chipped stone scatter to the rest of the assemblage, although that it is so connected is the simplest interpretation of the data.

In the absence of clear indications to the contrary or of any equally parsimonious alternative interpretation, these associations must simply be assumed without disallowing the possibility that other interpretations are correct. All this is by way of making it clear that while the following observations about site use are our best approximations given current understanding of the data, we do not regard them as decisively conclusive.

The range of tools and features found at the site would seem to assure that both men and women were present together, presumably as nuclear families or kin-cliques. The total number of individuals in residence at any one time, however, can only be guessed. It is possible that no more than one family occupied the place at a time. The apparently deliberate segregation of the chipped stone scatter and, somewhat less clearly, a few out-

lying structures from the residential zone, would be difficult to understand under these circumstances, however. In a family camp one would expect such segregation on much smaller scale. In particular, locations of craft activity would be expected to move along with the locations of individual residences rather than remaining fixed in one place as they seem to have been at Two Eagles.

The presence of larger groups, for instance four or five families, would make this segregation more understandable. This larger population would imply greater volume and range in potentially conflicting activities and hence more pressing need to reduce the possibility of interference between them. One might also expect that in the presence of relatively large groups, particularly if they included individuals only distantly related, greater care might be taken to observe the ritually prescribed physical separation of certain activities or isolation of certain individuals.

It is perhaps most reasonable to suggest that resident groups at Two Eagles varied from as few as one to as many as four or five nuclear families. As suggested below, plant procurement appears to have been of special importance at this site and the size of this group probably depended on the productivity of seed plants in its immediate vicinity relative to those that could be obtained elsewhere.

When smaller groups were present, craft activities might well have taken place only a short distance away from the structure then in use and shifted with the location of each such residence; this, rather than routine equipment maintenance, might account for the light scatter of chipped stone in the southern portion of the residential zone. When larger groups were present, on the other hand, the most intensive phases of craft activity may have been confined to one area well apart from the residential zone. Since larger groups imply a greater abundance of resources and presumably stays of longer duration, craft activity may have been more common when such groups were present. This, in addition to the more obvious observation that large groups are likely to produce more refuse than small groups, probably accounts for the denser concentrations of chipped stone in this separate activity area.

Since less elaborate facilities would suffice for shorter occupations, the structures themselves suggest occupation of some duration, perhaps two weeks to a month. Occupations much longer than this and occupation during the winter months, on the other hand, both seem unlikely in that these structures lack internal fireplaces and, with the exception of Structure 8, appear more rudimentary than would suffice for either purpose. The suggestion of occupation during the warm season, between late spring and early fall, is in keeping with the large numbers of millingstones found, these presumably being used to process seeds, the dominant warm season crop in ethnographic times.

Quite apart from its possible seasonal implications, the nature of this milling assemblage is pivotal to understanding the functional role of Two Eagles. That there are so many of these tools suggests that seeds were prepared, and presumably collected, in quantity. Indeed, milling implements so dominate the archaeological assemblage of Two Eagles that we can safely infer seed procurement was a major motive, perhaps the principal one, for occupying the site. The flat working surfaces of these millingstones suggest that small, hard-seeded species akin to ricegrass were the ones being processed. So many of these millingstones show evidence of only light use, however, that these plants cannot have been processed intensively. Perhaps they were only lightly milled—threshed and hulled—to ready them for transport elsewhere. The evident lack of diversity in functional form and material within this category is notable here: there are no basin millingstones or any pieces made of nonlocal stone, both of which we would expect in a collection of this size had the preparation of food, and not merely the processing of seeds, been an important activity. In summary, these data seem to indicate that the abundance of millingstones at Two Eagles stems not from its use as a residential site richly equipped with household implements but as a location where seeds could be obtained in large quantity for consumption somewhere else. The site is clearly some kind of residential base and some of its millingstones are clearly household furniture, but the milling assemblage seems far too large and too uniform to be accounted for in this manner.

Though it is not evident from the poorly

preserved faunal assemblage and its relative contribution to the diet of those living at the site is uncertain, hunting seems to have been an important activity here as well. As one indication of this, the ratio of projectile points to other major categories of worked stone (bifaces, roughouts, unifaces, and cores) is greater in the surface assemblage of Two Eagles (1:3.3) than in the surface assemblage from the gridded portion of Pinyon House (1:7.3), which is surprising given that Pinyon House seems better situated for this activity. Presumably hunters working out of Two Eagles directed their efforts to animals that could be taken in the Inyo Mountains immediately northeast or at one of several larger springs much closer at hand. It is possible the site was located at Two Eagles rather than one of these seemingly more attractive springs, which show little evidence of any kind of aboriginal use, in order not to disturb watering game. If so, it is an additional clue to the season in which the site was occupied. This spring complex, while actively used by many kinds of animals year-round, is particularly important to game during the dry season from late spring to early fall.

There is also evidence of stoneworking and other craft activities, most of them presumably performed by males. None of these, however, is particularly well represented in comparison to the size of the milling assemblage at this site. Heavy stoneworking was certainly of minor importance as shown by the scarcity of cores and by the near absence of surface quadrats with mean debitage weight in excess of 0.85 g, which would indicate this activity. Moreover, even though Two Eagles lies between Pinyon House and Crater Middens and is apparently fully contemporaneous with them, it lacks any evidence whatsoever of the specialized large chert biface industry that characterized those sites in late prehistoric times. The evident paucity of craft-related items cannot be attributed to lack of demand for tools, however: both the roughouts and bifaces from Two Eagles are highly fragmentary and hold little promise of further use, suggesting they had been worked to exhaustion.

The inference that follows, then, is that men traveling to Two Eagles brought with them a limited supply of tools of various kinds but very little material with which to make new ones and had no chance to obtain additional supplies while in residence there. Thus, when occasionally forced to stay longer than expected, probably when the seed harvest was particularly good, their only recourse was to rework what few tools they had down to a nub. As noted earlier, there is limited evidence suggesting the possibility that at such times other sites were scavenged for raw materials, which might account for the anomalous hydration readings on the surface assemblage.

This interpretation is consistent with other suggestions regarding the use of this site, particularly the length of, and reasons for, its occupation. If we accept the idea that seed procurement was their principal objective (which is difficult to deny given the assemblage of millingstones), these occupations would normally have been too short to warrant carrying extensive amounts of gear and raw material to the site or the stocking and maintenance of caches there. Further, it would have been the abundance of seeds locally available, not the supply of stone tools and raw materials, that determined the length of each occupation. Accordingly, under the appropriate circumstances these occupations might well have been prolonged far longer than had been expected, causing tool stocks to be drawn perilously low or exhausted altogether.

IMPLICATIONS

Steward (1938a: 33) was perhaps the first to note that in the Great Basin it was generally the abundance and distribution of plant resources that governed choices of settlement location and the timing of movements between these locations and that other activities conformed to rather than dictated such choices. Taking his cue from Steward, Flannery (1968) much later inferred that a similar approach to decision-making, which he termed "scheduling," might account for the annual movements of prehistoric hunter-gatherers in the Tehuacan Valley, Mexico.

In the intervening years, it has become commonplace to explain prehistoric settlement and subsistence patterns with reference to schedules of this kind, generally in the absence of any concrete evidence that would demonstrate how the performance of a fa-

vored activity hindered the performance of another—which is the essence of scheduling. Indeed, the impression is often given that aboriginal plans and schedules were so perfectly conceived that activities of different kinds seldom impinged on each other: root gathering did not hinder deer hunting, nor pinyon procurement antelope drives.

Steward, of course, recognized that this was not so and that in particular Great Basin hunters often had to be content to stalk game in decidedly inferior habitats if the distribution of plant resources so dictated. Steward does not say so explicitly, but it is reasonable to assume that many other activities in which men engaged were similarly compromised by plant procurement, a task that fell almost exclusively to women.

The archaeological assemblage of Two Eagles illustrates the point nicely. Seed procurement and processing, presumably conducted by women, was almost certainly the principal activity at this settlement, but men also regularly resided and worked here. Yet while occupation of Two Eagles worked no special hardship on gatherers living there (material for milling equipment was readily at hand and did not have to be imported, for example), for hunters and toolmakers this was not always so: the raw material needed to make implements was often in short supply and whatever game was attracted to these springs was certainly made more shy and difficult to capture by the presence of people living nearby (cf. Bettinger and Baumhoff, 1982). In this light, perhaps the most important lesson to be learned here is that late prehistoric subsistence-settlement systems in central Owens Valley required frequent compromises between mutually incompatible economic demands, and insofar as we can tell from Two Eagles, these compromises favored plant procurement to the disadvantage of hunting and other activities.

CHAPTER 8. CRATER MIDDENS: NATURAL SETTING, ARCHAEOLOGICAL PROCEDURES, AND FEATURES

Between the town of Big Pine and the town of Independence, 40 km to the south, is an extensive lava field of volcanic craters and cinder cones. The largest and northernmost of these is Crater Mountain, which rises to an elevation of 1830 m and is more than 6 km in diameter at its base. This massive crater dominates local drainage patterns, diverting most streams around it, but on the northern flank a small east-flowing creek channel has breached an outlying basaltic lobe and cut a small canyon into the underlying colluvial deposits derived from the steep Sierra slope to the west. Once out of the canyon, where its periodic flow is confined and therefore strong, the channel quickly shallows and broadens, changing from a deep arroyo to a series of braided gullies in less than a kilometer. The archaeological site of Crater Middens (CA-Iny-1700) is situated along the northern bank of this channel (fig. 8.1). It begins about 100 m below the canyon mouth and from there extends 500 m downstream. Throughout this distance, the site is confined entirely to the area lying within 100 m of the channel bank.

Crater Middens is at an elevation of 1311 m, 213 m lower than Two Eagles, but its location on a northeast facing slope in close proximity to the Sierra crest—and within the influence of Sierra storms, more than compensates for this elevational difference, producing a local climate not unlike that of Two Eagles, but with slightly more rainfall. Daytime maximum temperatures average close to 38°C in the hottest month of the year (July), near 10°C in the coldest month (January). Mean annual precipitation is close to 13 cm.

In keeping with these climatic features, site vegetation is that of a typical desert scrubland dominated by xeric species, including such shrubs as blackbrush (*Coleogyne ramosissima*), indigo bush (*Dalea fremontii*), big sagebrush, spiny hopsage, rabbitbrush (*Chrysothamnus* spp.), cottonthorn, lambs tail (*Eurotia lanta*), budsage (*Artemisia spinescens*), and buckwheat (*Eriogonum* spp.). A variety of grasses is present, among them ricegrass, needlegrass, and squirrel tail. These herbs compose only a minor fraction of the plant cover in the immediate site vicinity but are relatively abundant in the lava fields of Crater Mountain south of the site, where they occur in protected, sand-filled depressions within the rough basaltic flows.

At present (1982), the nearest source of water is Big Pine Creek about 800 m to the north. As recently as 1976, before its diversion and loss of flow through decreased water tables, there was water year-round in the Little Pine Creek channel only 400 m to the north. Despite the presence of these water sources, the location of Crater Middens adjacent to a deep, but now dry, stream channel is difficult to explain unless it is assumed that the channel contained water during the period of occupation or that water was obtained from wells dug in the channel bottom. Since Euro-American items are only scantily represented at the site, perhaps the channel carried Little Pine Creek until 1872, when its course may have been altered by ground movements accompanying a major earthquake in that year. In turn, this may have forced aboriginal removal from Crater Middens to a site nearer water. A more recent historic aboriginal site along the modern Little Pine Creek channel 1 km northeast of Crater Middens lends support to this notion. Strewn with items of metal, glass, and porcelain, but apparently lacking a prehistoric component, this site may have been settled by the former occupants of Crater Middens. It is this historic site that E. S. Curtis visited and photographed in the early 1900s when it was still inhabited. His photograph of a dwelling there, entitled "A Mono Home," appears in a posthumous collection of his work (fig. 8.2; Curtis, 1972: 151).

Travel north and east from the site is unimpeded by either major changes in elevation or broken terrain, the only obstacle of note being Owens River and its narrow marshland. The rough lava slopes of Crater Mountain to the south and the Sierra Nevada foothills to the west are only slightly more confining. This gentle local topography afforded the occupants of Crater Middens ac-

Fig. 8.1. View southwest across Crater Middens toward the Sierra Nevada crest. Basaltic flows of Crater Mountain (itself not visible) appear just below the distinctively rounded peak of Kidd Mountain. Mt. Gayley is the taller, Mt. Alice the shorter, of the two small peaks to the right of Kidd Mountain.

cess to a catchment of 165 km^2, nearly one and a half times the catchment area of Two Eagles and more than twice that of Pinyon House. Of this, 43 percent is a valley bottom Greasewood-Shadscale scrubland, 30 percent Shadscale-Sagebrush-Blackbrush scrubland, and 17 percent broken lava flows dominated by grasses. The remaining 10 percent of the catchment is Riparian wetlands along an 18 km section of Owens River.

SITE DESCRIPTION AND ARCHAEOLOGICAL PROCEDURES

Although Crater Middens is recorded as a single site, it consists of five separate sites or localities (fig. 8.3).

These were designated *Middens* and numbered I to V in their order of occurrence from west to east along the main axis of the general site area. Because these middens varied in the range and quantity of cultural materials and surface features they exhibited and because they were spatially distinct, each was treated as a separate archaeological entity. Table 8.1 summarizes the salient dimensions of these middens and the size and distribution of the surface and subsurface samples obtained from each.

MIDDEN I: Midden I, unlike all the others, lacks either a subsurface cultural deposit or a culturally altered soil matrix. Its surface assemblage is limited to three crude stone rings (Structures 1, 2, and 3), a few bedrock milling features and portable groundstone implements, and a chippage scatter so sparse that its limits are difficult to establish (fig. 8.3). No work was carried out at this midden in 1979.

In 1981, a permanent midden datum was established near the apparent center of the surficial artifact scatter and the area was surveyed using a Keuffel and Esser transit and stadia rod. Midden I was then surface colleted, for this purpose being first divided into four magnetic compass quadrants. The

Fig. 8.2. "A Mono Home." Taken by E. S. Curtis (1972) in 1924, this photograph shows an aboriginal domed wikiup with rock foundation in a historic village situated on the outskirts of the modern town of Big Pine, scarcely a kilometer northeast of Crater Middens. Crater Middens is located at the foot of the basalt fields of Crater Mountain visible to the left of the dwelling. Kidd Mountain dominates the central skyline. Compare these natural features with those appearing in figure 8.1.

southern two quadrants (SE, SW) contained the bulk of the surface assemblage, and were subdivided into 15 × 15 m quadrats. All cultural materials were removed from these save for millingstones, which were counted but not collected. One 2 × 2 m square in the southeast quadrant and one stone ring (Structure 3) were subsequently excavated.

The excavated square confirmed our suspicion that no subsurface cultural deposit was present and was abandoned as sterile at 10 cm. The ring contained the best preserved hearth unearthed at Crater Middens, yielding enough carbonized wood for a radiocarbon assay. Other than beads of shell, steatite, and glass, however, it produced relatively little cultural material.

MIDDEN II: Midden II is the largest and most intensively occupied part of Iny-1700. It consists of a surface artifact scatter 80 m long and 60 m wide, covering an area of 3656 m^2, near the center of which is a zone of culturally modified soil 40 m long and 30 m wide, covering an area of 777 m^2 (fig. 8.4). Surface features include 10 stone rings (Structures 4–13), several bedrock mortars and metates, and one pitted boulder petroglyph. In 1979, one ring (Structure 12), two 2 × 2 m squares (A and B), and one 1 × 1 m square (F) were excavated in Midden II, all within the area of culturally modified soil.

In 1981, a permanent datum was established and the locality was surveyed by transit and stadia rod. The site was then divided into magnetic compass quadrants and each of these subdivided into 15 × 15 m quadrats. Within

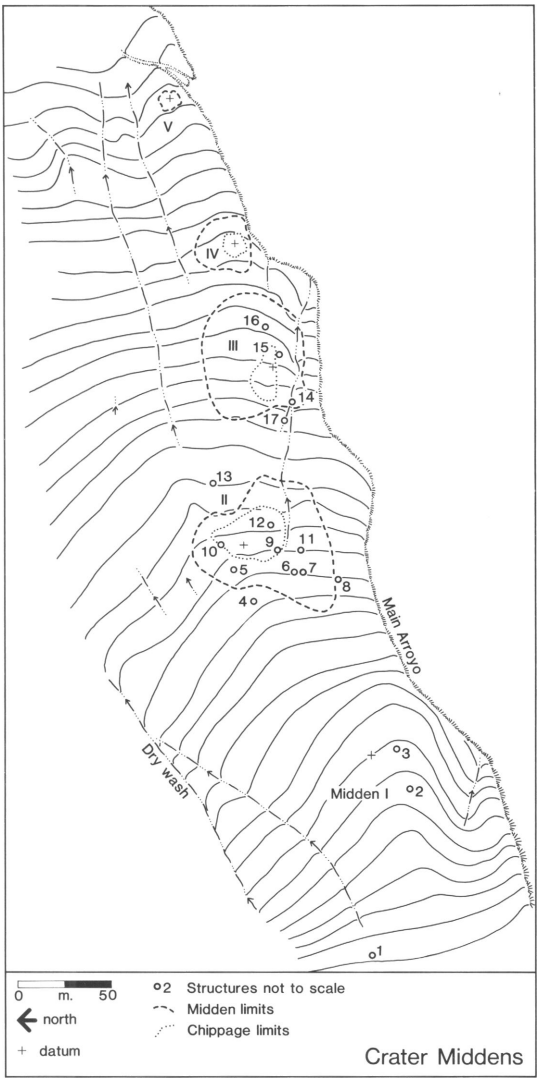

Fig. 8.3. Contour map of Crater Middens showing locations of structures and Middens I–V.

each quadrant a single 15 × 15 m quadrat was entirely surface collected. In the remainder of each quadrant surface collection was restricted to rare elements (items other than roughouts, unifaces, cores, and debitage) and groundstone. Following this, 12 2 × 2 m squares and 3 stone rings (Structures 7, 9, 10) were excavated. All 12 squares and 2 of the rings were located within the area of culturally modified soil.

MIDDEN III: The cultural assemblage present at Midden III resembles that of Midden II in most respects, but is smaller and suggests less intensive use. There is an extensive surface artifact scatter covering an area 70 × 60 m, some 2931 m² in all, within which is located a patch of culturally modified soil measuring 30 × 15 m, 230 m² in total area (fig. 8.5). The surface features are more limited in number and kind than those at Midden III, consisting of several bedrock metates and four stone structures (Structures 14–17). Excavation at Midden III in 1979 was limited to a single 2 × 2 m square (C) within the zone of culturally modified soil.

In 1981, a permanent datum was established and the area was mapped by transit and stadia rod. Following the same procedure used in Midden II, Midden III was then divided into magnetic compass quadrants centered at the permanent datum and each quadrant subdivided into 15 × 15 m quadrats. One 15 × 15 m quadrat in each of the four quadrants was entirely surface collected; surface collection in the remainder of each quadrant was restricted to rare elements (see above). Millingstones were noted by number and kind but not collected. Six 2 × 2 m squares in or near the area of culturally modified soil and one ring (Structure 16) just south of this area were excavated.

MIDDEN IV: Midden IV exhibits a small area of culturally modified soil, about 15 m in diameter, covering 116 m², centrally located within a larger area, about 30 m in diameter and 727 m² in total extent, sparsely scattered with cultural debris consisting mostly of chippage (fig. 8.5). Surface features are limited to three bedrock mortars and several bedrock metates. In 1979, a single 1 × 1 m square (D) was excavated in the midden area.

In 1981, a permanent datum was established near the center of the artifact scatter and the area was mapped by transit and stadia rod. Midden IV is small enough that a square consisting of four 15 × 15 m quadrats centered at the datum and oriented as magnetic compass quadrants effectively covered the surface artifact scatter. Each of these quadrats was entirely surface collected. The 1981 excavation at Midden IV was limited to a single 2 × 2 m square located within the area of culturally modified soil, not far from the square excavated in 1979.

TABLE 8.1
Dimensions by Midden of Surface Lithic Scatters and Middens and Sample Size and Distribution of Surface Collections and Excavations at Crater Middens

	Midden					
	I	II	III	IV	V	Total
Surface area (m^2)	1800[a]	3656	2931	727	300[a]	9414
Midden		777	230	116	78	1201
Lithic scatter outside midden	1800	2879	2701	611	222	8213
Area sampled by 15 × 15 m quadrats (m^2)	1800	900	900	900	300[b]	4800
Midden		83	44	116	78	321
Lithic scatter outside midden	1800	510	785	611	222	3928
Offsite		307	71	173		551
Area of rare elements collection (m^2)		3063	2102			5165
Midden		694	186			880
Lithic scatter outside midden		2369	1916			4285
Area excavated by squares (m^2)	4	57	28	5	5	99
Volume excavated by squares (m^3)	0.4	18.3	13.2	2.5	2.0	36.4
0–10 cm depth	0.4	5.7	2.8	0.5	0.5	9.9
10–20		5.7	2.8	0.5	0.5	9.5
20–30		3.7	2.4	0.5	0.5	7.1
30–40		2.8	2.0	0.5	0.5	5.8
40–50		0.4	2.0	0.5		2.9
50–60			1.2			1.2

[a] Area approximate.
[b] Area collected by methods employed elsewhere for 15 × 15 m quadrats but not subdivided into quadrants or quadrats.

MIDDEN V: Midden V is similar to Midden IV, consisting of a small area of culturally modified soil, roughly 10 m in diameter and 78 m^2 in area within a larger, but very sparse, artifact scatter, the limits of which are vague but certainly less than 20 m in any dimension (fig. 8.4). Surface features consist of a few lightly used bedrock metates. A single 1 × 1 m square (F) was excavated within the zone of modified soil in 1979.

In 1981, a permanent datum was established, the site surveyed by transit and stadia rod, and the surface assemblage entirely collected without subdivision of the site into quadrants or quadrats. One surface millingstone was counted but not retrieved. A single 2 × 2 m square was then excavated in the area of culturally modified soil.

SURFACE FEATURES

BEDROCK MILLING FACILITIES: As is the case at many sites in California and the Great Basin, the segregation of bedrock from portable milling equipment is in part arbitrary. The distinction used here is based on size, degree of finish, and obvious evidence of transport: bedrock features are those that are too heavy or too oddly shaped to be conveniently moved and that lack obvious indications of having been intentionally trimmed or moved from their natural locations.

Bedrock milling facilities are present at each of the five middens but display considerable variation in both number and kind between these middens. These features are often severely eroded but their original size and shape can usually be estimated without much difficulty.

The margins of the larger bedrock facilities at Crater Middens are frequently lined with cobbles, particularly on the western and southern sides. These are believed to be the remnants of footings for perpendicular sunshades, probably simple pole and brush affairs, built for the comfort of individuals engaged in grinding during the summer months. It is possible that they served as windscreens

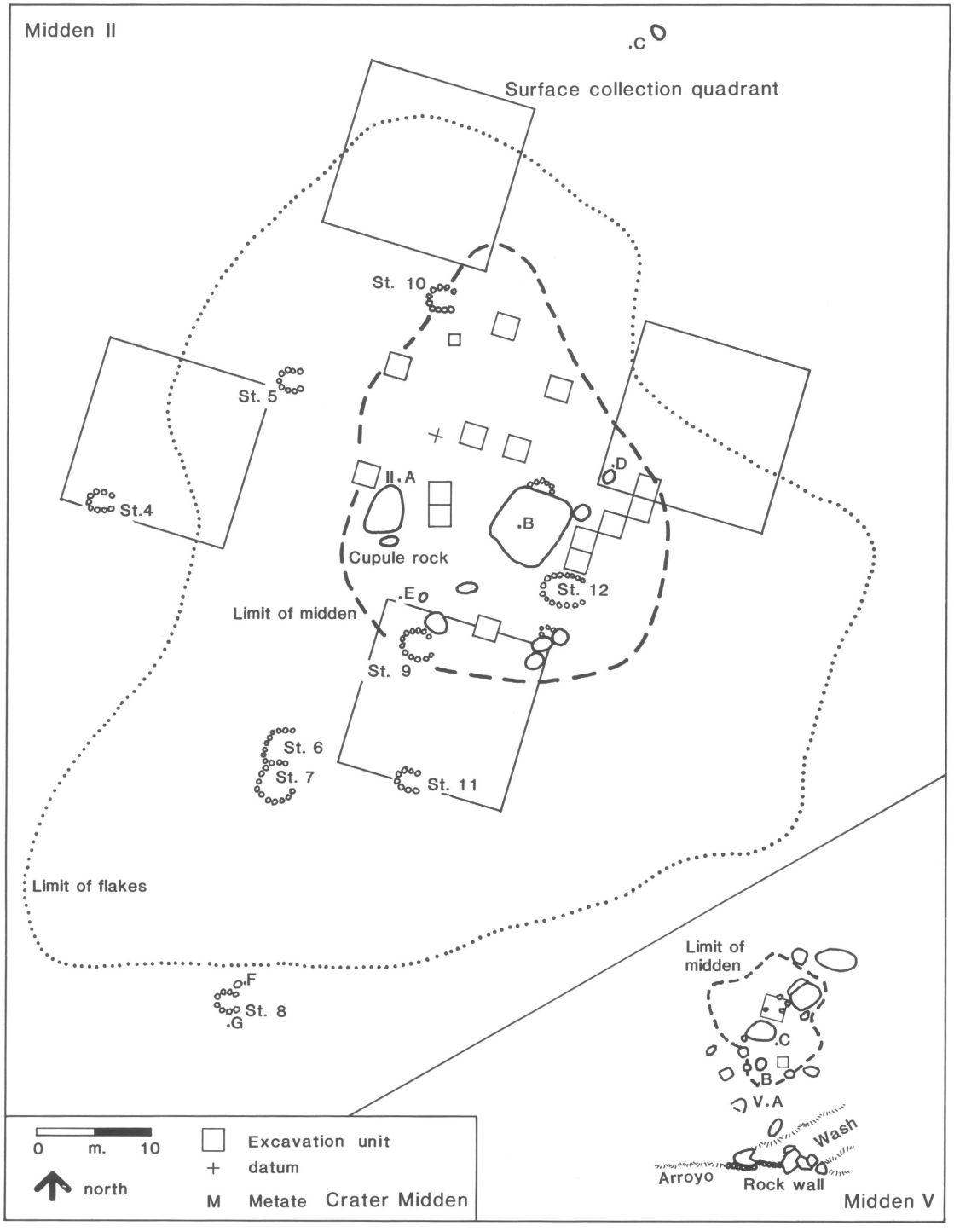

Fig. 8.4. Maps of Middens II and V at Crater Middens.

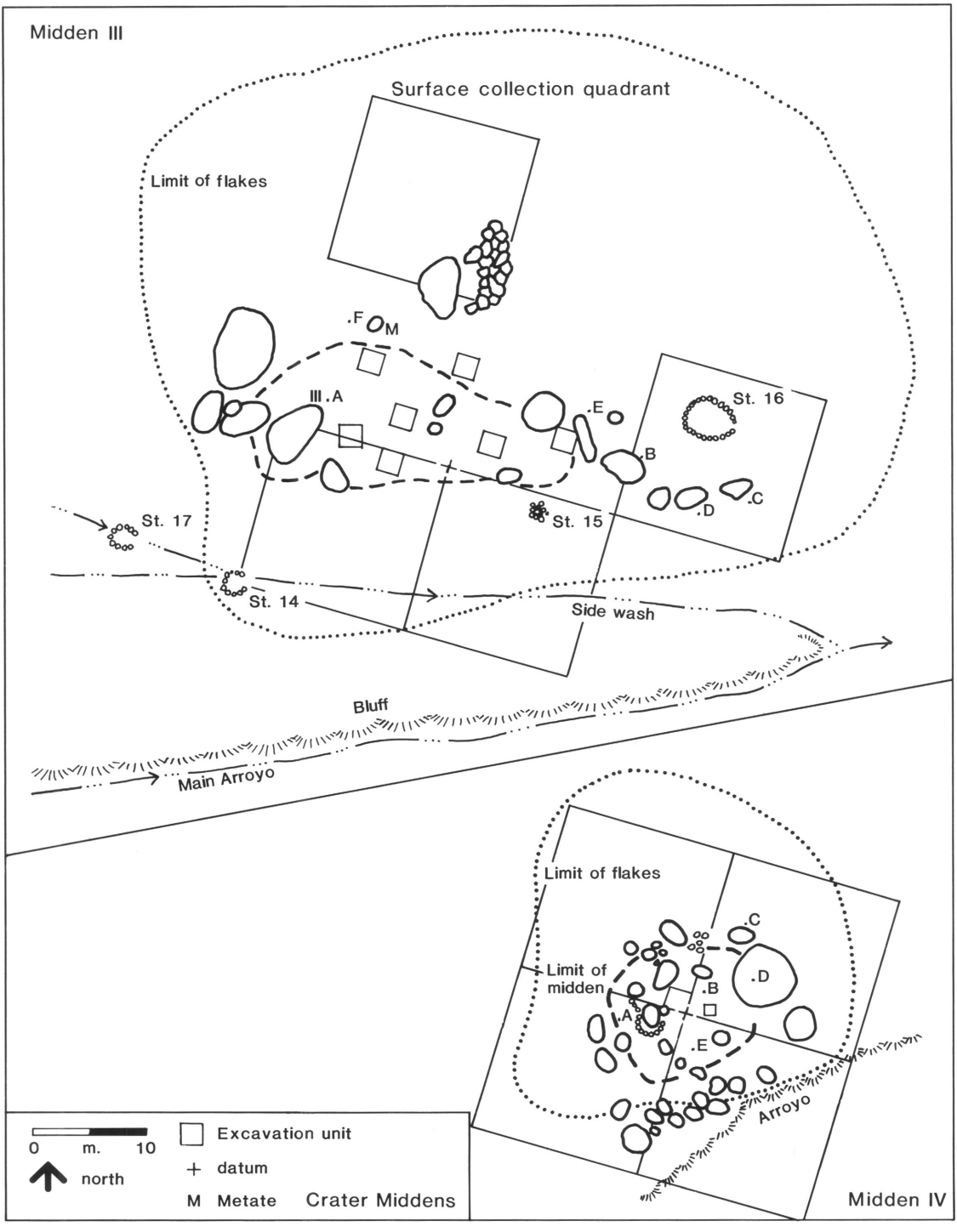

Fig. 8.5. Maps of Middens III and IV at Crater Middens.

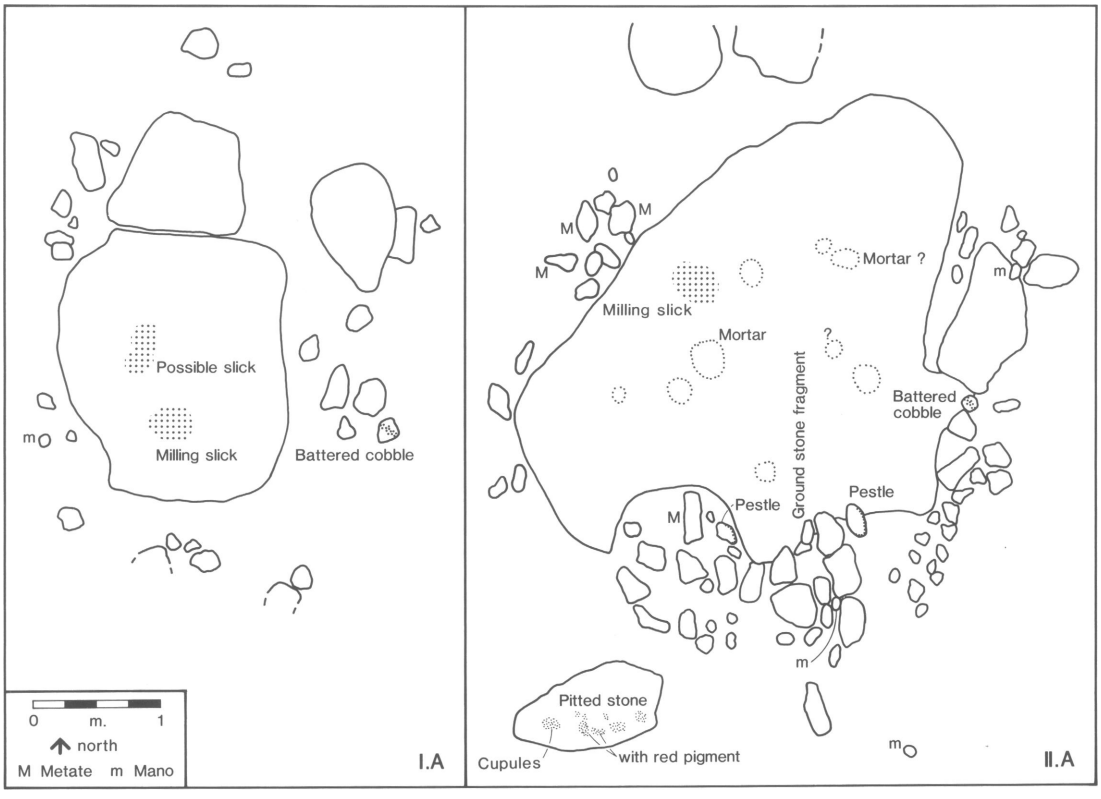

Fig. 8.6. Bedrock Milling Features I.A (Midden I) and II.A (Midden II) at Crater Middens.

but, as they do not generally shelter the northern and eastern sides of the grinding facilities, would be useful for this purpose only during the morning when the prevailing winds are from the south.

Most of the Crater Middens bedrock milling features are simple slicks or bedrock metates, flat or irregular in surface contour, showing no evidence of extensive use. Mortars are also present but considerably less common. Insofar as could be determined all of the latter were originally U-shaped in cross section.

Midden I. The bedrock milling assemblage at Midden I is limited to three slicks. Two of these, one measuring 25 × 35 cm, the other 20 × 40 cm, occur on a large granitic boulder near the southern edge of the midden. Designated Milling Feature I.A, this boulder is surrounded by a thin scatter of cobbles possibly placed there to support a sunshade (fig. 8.6). The remaining slick measures 30 × 55 cm and was executed on a small, flat boulder, about 80 cm in maximum diameter, located near the center of the midden area.

Midden II. Bedrock milling features are more abundant in number and diverse in kind at Midden II than at any other part of the Crater Middens site. There are two large boulder complexes (Milling Features II.A and II.B) with multiple working surfaces and several scattered examples occurring singly. Milling Feature II.A (fig. 8.6) located near the southwest margin of the midden, displays seven mortars ranging from about 1 to 9 cm in depth and 10 to 25 cm in diameter. Severe weathering has, however, clearly enlarged these mortars and they were undoubtedly somewhat smaller originally. On the same boulder, there are two very badly eroded depressions that may also be mortars and a single bedrock slick roughly oval in plan and measuring 30 × 40 cm. Cobbles line nearly the entire southern two-thirds of this feature.

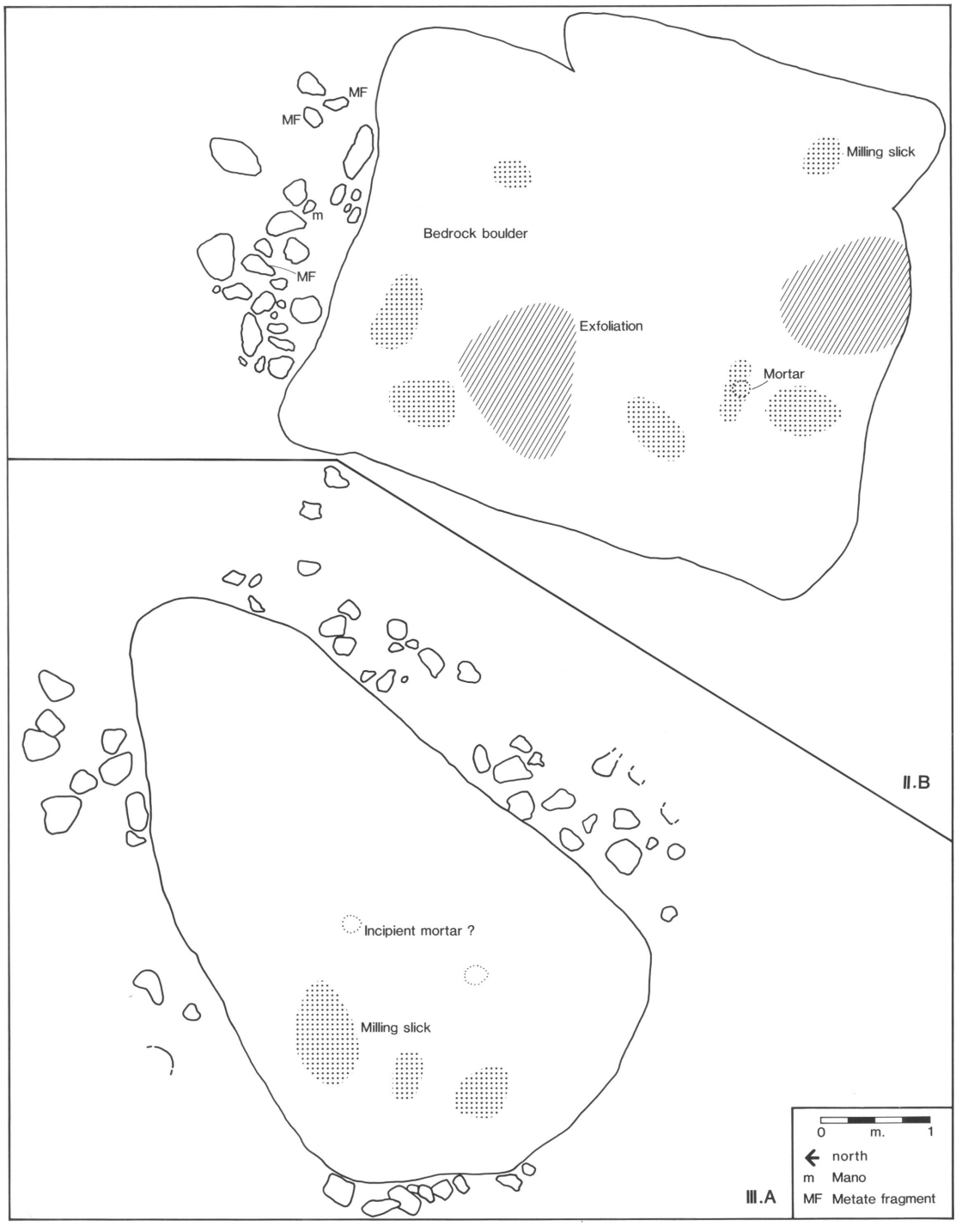

Fig. 8.7. Bedrock Milling Features II.B (Midden II) and III.A (Midden III) at Crater Middens.

Apparently these represent the footings of a sunshade although an enclosure of this size, if continuous, would also afford protection from the wind. Mixed among these cobbles were several groundstone implements including pestles, metates, manos, hammerstones, and unidentifiable groundstone fragments. A pitted petroglyph boulder is located directly south of the feature (fig. 8.6).

A flotation sample (F-69) recovered from deposits immediately adjacent to Milling Feature II.A yielded only a few seeds of *Artemisia ludoviciana,* but a second sample (F-117) from an excavation square (S3W3) less than a meter away produced abundant charred seeds of *Coleogyne ramosissima* and *Ephedra nevadensis* and somewhat smaller quantities of *Sphaeralcea ambigua, Oryzopsis hymenoides, Chenopodium fremontii,* and *Mentzelia congesta.*

Milling Feature II.B is a high, tablelike boulder outcrop centrally located within Midden II. It displays 6 milling slicks, the largest 20 × 30 cm, the smallest 15 × 20 cm, and a single mortar about 7 cm in diameter and 3 cm in depth (fig. 8.7). There is no evidence of a sunshade, but a small cistlike cairn on the northern edge of the boulder, well shaded even at midday, is interpreted as a storage cache for food or water. Among the cobbles incorporated in this cairn were three metate fragments and a mano.

The remaining five bedrock milling features at Midden II (Bedrock Milling Features II.C–G) are all single metates located on separate boulders.

Midden III. The bedrock milling facilities represented at Midden III are all slicks most of which are concentrated on two boulders (Milling Features III.A and III.B). Three of the slicks occur on a large boulder near the west end of the midden deposit (Milling Feature III.A; fig. 8.7). Two shallow pits on the same boulder may be mortars but cannot be identified as such with certainty. Cobbles concentrated near the northeast, southeast, and western edges of Milling Feature III. A may represent the foundation of a sunshade or windscreen, possibly consisting of three panels joined at the top to form a crude roofed structure.

Milling Feature III.B, a large granitic boulder with two slicks, is located just outside the eastern limit of the subsurface deposit of Midden III (fig. 8.8). A small group of cobbles along the southern edge of the boulder apparently marks the former presence of a sunshade. East of Milling Feature III.B, three bedrock metates (Milling Features III.C, III.D, and III.E) occur on separate boulders. The final bedrock milling feature, III.F, is a deep basin metate which in shape resembles portable basin metates at the site but which is so large that it cannot in any sense be considered portable, though it might be moved by rolling. Its grinding surface is 50 cm long, 38 cm wide, and 3.5 cm deep and the subspherical boulder on which it was executed is about 65 cm in diameter.

Midden IV. Although artifactual remains of other kinds were relatively sparse at Midden IV, the assemblage of bedrock milling facilites is extensive and includes three boulders (Milling Features IV.A, IV.B, and IV.D) with multiple milling surfaces. Milling Feature IV.A is located just west of the central midden deposit and consists of two adjacent mortars within a larger milling slick area 75 cm long and 45 cm wide (fig. 8.8). One of the mortars is about 12 cm in diameter and 2.7 cm in depth, the other 10 cm in diameter and 0.5 cm in depth. A well-defined curvilinear rock wall encircling the western and southern parts of the feature is thought to be a sunshade footing. A metate fragment and a mano were noted in association with the wall, possibly incorporated as building material. In addition, a mano was found adjacent to the northeastern margin of the boulder. A flotation sample (F-193) obtained from deposits adjacent to Milling Feature IV.A yielded several seeds of *Oryzopsis hymenoides.*

Milling Feature IV.B consists of a pair of mortars, both surrounded by milling slicks, on a low, oval granitic boulder about 4 m northeast of Milling Feature IV.A. The larger of these is roughly 15 cm in diameter and 7 cm in depth and the surrounding slick measures 30 × 40 cm. The smaller mortar is about 15 cm in diameter and 5.5 cm in depth and the surrounding slick is 20 × 25 cm.

The third complex of milling facilities, Milling Feature IV.D, is a large sloping granitic boulder that displays six very lightly ground slicks. The remaining two milling features, IV.C and IV.E, are individual slicks

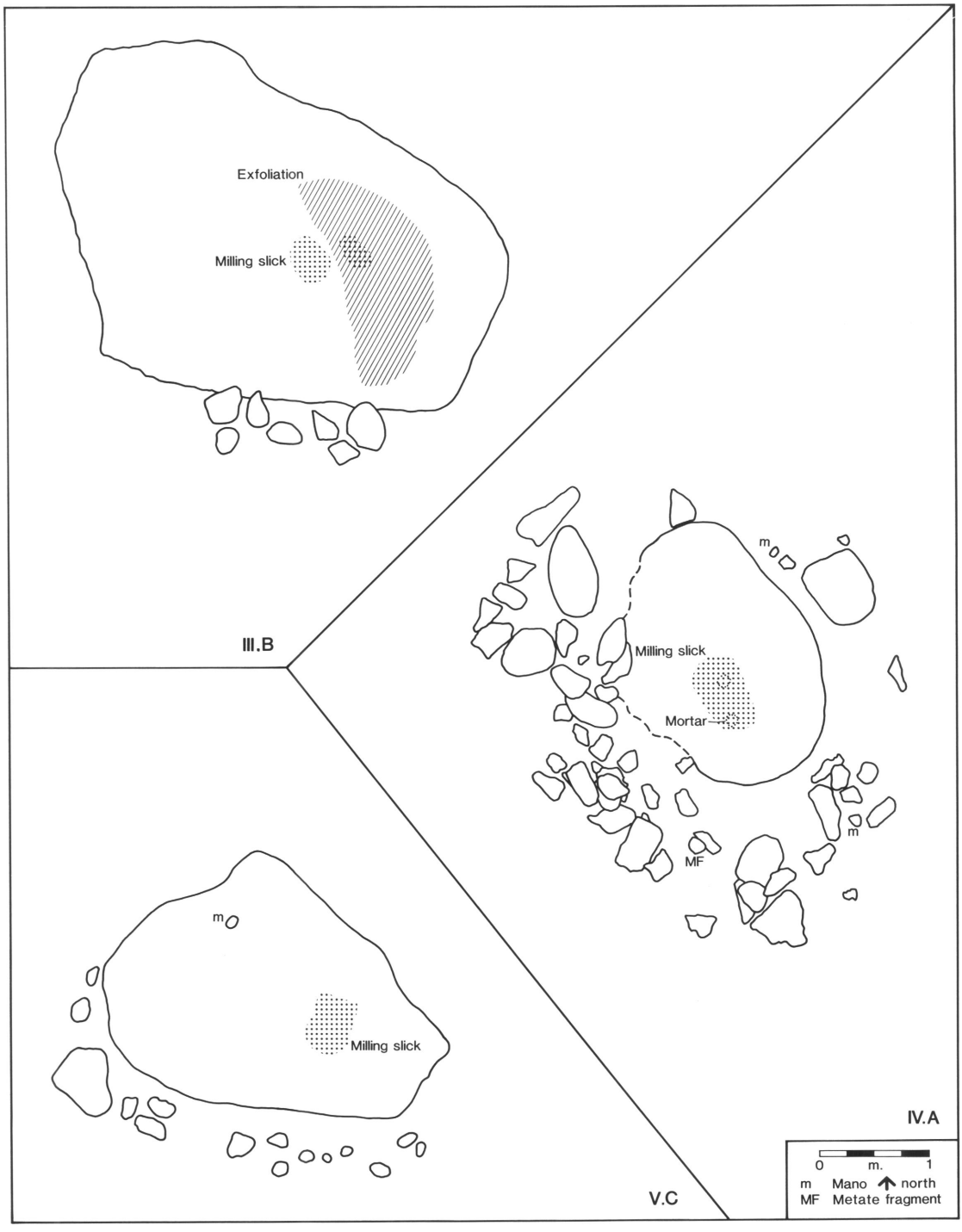

Fig. 8.8. Bedrock Milling Features III.B (Midden III), IV.A (Midden IV), and V.C (Midden V) at Crater Middens.

occurring separately on small boulders, one northwest of Milling Feature IV.D, the other southwest of it.

Midden V. Three slicks (Milling Features V.A, V.B, V.C) on three separate boulders constitute the entire bedrock milling assemblage at Midden V. Milling Features V.A and V.B were unaccompanied by features or artifacts of any sort. Milling Feature V.C, however, which is centrally located within the midden deposit, is partly encircled by a cobble alignment on its southern side, possibly the foundation of a pole and brush wall placed there to provide shade (fig. 8.8). A mano was found resting on the surface of this feature.

A few seeds of *Mentzelia congesta* and *Ephedra nevadensis* were found in a flotation sample (F-154) taken from deposits next to Milling Feature V.A.

PITTED BOULDER: Although rock art sites are common in the vicinity of Crater Middens, the only example noted on the site proper is a pitted boulder adjacent to a group of bedrock mortars, Milling Feature II.A, in Midden II. This boulder is 110 cm long, 60 cm wide, and 50 cm tall and exhibits nine shallow pits or cupules that resemble small mortars (fig. 8.6). Several are so badly weathered that their original dimensions cannot be determined. The better preserved examples are all about 4 cm in diameter and between 0.3 and 0.5 cm in depth. Three of the cupules are stained a faint red as though they had been at one time painted. Small pits might have been useful in any number of aboriginal tasks, e.g., nut cracking, but the location of these on a steeply slanting rock face precludes such use. They are more suitably interpreted as varieties of the Pit-and-Groove petroglyph style, which has a wide and ancient distribution in the western United States (Heizer and Baumhoff, 1962) and is common in Owens Valley (von Werlhof, 1965: 119–120).

One historic account is particularly helpful in interpreting the function of the pitted petroglyph at Crater Middens. In the summer of 1904, John W. Hudson, a retired physician commissioned by the Field Museum of Natural History, Chicago, to observe native lifeways and collect specimens of ethnographic material culture in California, visited Owens Valley. Somewhere near Independence, he noted the following concerning the native origin and use of pitted boulders that were occasionally observed near bedrock mortars in that vicinity.

> There are sometimes found several shallow pits around the mortar. These people say that when a barren woman wants children, she invites her husband to sit in front of her while she mills. She proceeds to dig and grind a small pit on the highest portion of the boulder near the mill. If well done this insures fecundity to the wife or potentiality to husband. New pits are added as other mouths are desired by the pair to consume the meal in the new pits. (Hudson, 1904: 41)

This account, recorded scarcely 30 years after Crater Middens is thought to have been abandoned and scarcely more than 25 mi away, describes perfectly the juxtaposition of its lone pitted boulder and its largest concentration of bedrock mortars. It is not unreasonable, therefore, to conclude that this pitted boulder denotes performance of rituals designed to insure the fertility of individuals living at this settlement. It is, further, reasonable to assume that similarly situated pitted boulders at other late prehistoric sites in Owens Valley indicate ritual activity of much the same kind.

STRATIGRAPHY AND SUBSURFACE FEATURES

STRATIGRAPHY: The cultural deposits of Middens II, III, IV, and V at Crater Middens extend in some places to more than a half a meter in depth. Yet except for the topmost few centimeters, which were loose, thoroughly mixed with organic debris, and excavated separately from the compacted material below, this midden deposit was in no place internally differentiated by color, texture, or composition to the extent that it could be removed in natural levels. Local stratification in the form of thin, discontinuous sand and gravel lenses was faintly visible in the sidewalls of most squares, however. Other than this and an observed increase with depth in the quantity of quartz and feldspar particles derived from the underlying parent granitic bedrock, the midden unit (designated Unit II) is a quite homogeneous friable, dark brown (10YR 4/3) sandy loam. Evidence of root and rodent disturbance is common throughout Unit II which, along with the slowness of soil

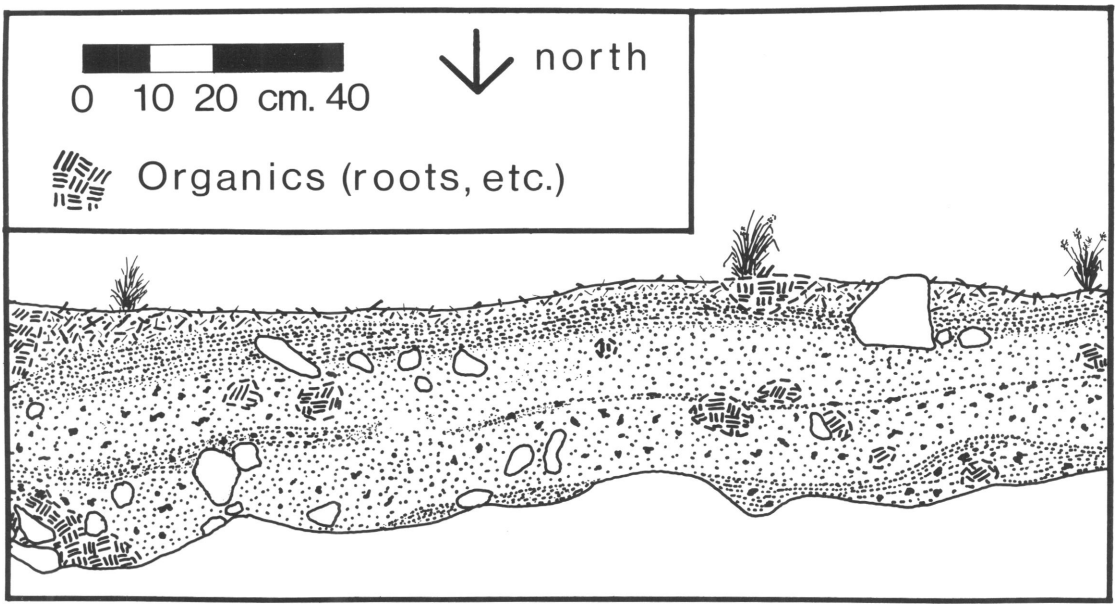

Fig. 8.9. Stratigraphic profile of south wall of square S1E10 (Midden II), which is representative of cultural deposits throughout Crater Middens.

formation and human disturbance occurring as the result of aboriginal occupation of the site, may account for the observed lack of stratigraphy. The loose surface material (Unit III) differs from Unit II to the extent that it is uncompacted, contains large quantities of organic material (e.g., twigs, chaff, etc.), and in some instances exhibits at the very surface more sand and gravel owing to the removal of finer particles by wind and water. Unit II, the midden, is underlain by granitic bedrock (Unit I) in varying states of decomposition but for the most part taking the form of a blocky, indurated, sandy clay that varies in color from light gray (10YR 7/2) to brownish yellow (10YR 6/8). A profile of the south wall of square S1E10, Midden II, representative of the midden deposit at Crater Middens as a whole, is illustrated in figure 8.9.

SUBSURFACE FEATURES: Apart from those noted within and described elsewhere in relation to excavated structures, only two subsurface features were encountered at Crater Middens, both in Midden II. The first is a relatively discrete concentration of rocks measuring 115 cm north–south and 120 cm east–west located at a depth of between 10 and 20 cm in excavation square S2E9. Included among these rocks were a flat slab millingstone fragment (O-3024) and an unclassified millingstone fragment (O-3025). Artifacts found in apparent association with this feature include one Rose Spring Side-notched fragment (O-3026) and one biface fragment (O-3027). No persuasive argument can be proffered with respect to the interpretation of this feature, but its configuration and the artifacts found with it suggest it may mark a location of refuse disposal, perhaps a spot where material from house cleaning or renovation was dumped.

The remaining subsurface feature consists of a pair of convex manos (O-2697, O-2698) found lying side-by-side at a depth of between 10 and 20 cm in square N4E5. Unlike most of the manos recovered at Crater Middens, both of these are complete, which would suggest that they were deliberately buried together, either as part of a ritual or, what seems more likely, as a cache of items to be retrieved at a later time. The latter interpretation suggests further that the owner of these manos stored them during a period of absence from the site, a winter spent in the Pinyon Woodland, for example, but through some circumstance was unable to return and reclaim them.

STRUCTURES

There were 17 cobble structures. Of these, 14 are circular rock rings interpreted as the foundations of free-standing roofed structures used as dwellings, cookhouses, workshops, or storehouses. Six of these were excavated. The remaining three cobble structures, none of which was excavated, are more difficult to interpret. One, Structure 13, appears to be a lean-to built against a large boulder, perhaps used as a work area or storage facility. Another, Structure 4, is rudely semicircular in outline and may represent either a shade or a partly dismantled circular, roofed structure. The third, Structure 15, is amorphous in outline and may be a simple cairn, a small sunshade or windbreak, or a storage facility. Each of these features, excavated or unexcavated, is described below.

Excavated Rock Rings

Midden I: *Structure 3.* Prior to excavation, Structure 3 was a discontinuous, rudely circular alignment of cobbles measuring roughly 4.0 × 3.5 m in inside diameter with a maximum floor space of 12.6 m^2 at least some of which was probably occupied by brush wall and thus not uable as living area (fig. 8.10). The area enclosed was relatively flat, uniformly sloping gently down to the east. Any of several breaks in the wall might be a doorway. One on the east, however, which is bounded on either side by concentrations of boulders that might have supported a pole door frame, and which occurs at the lowest point in the structure perimeter, seems most likely to have served this purpose.

Artifactual debris was sparse in and around the structure and there was no evidence of surface soil discoloration suggesting the presence of buried features. Nevertheless, excavation of Structure 3 revealed a well-preserved hearth and other features resting on what was apparently a single occupation floor barely covered by a sheet of colluvial slopewash about 4 to 6 cm thick.

The hearth was set slightly east of center within the structure, toward the opening tentatively interpreted as a doorway, which may have also been used as a smokehole. The hearth consists of two separate red oxidized patches that probably mark fire locations, and two thin deposits of gray ash, one larger and darker than the other, which are likely material that was intentionally removed from the fire area or that was naturally washed or blown away from the actual hearth area after the structure was abandoned. A flotation sample (F-60) taken from the ashy hearth deposits produced numerous seeds of *Mentzelia congesta* and, in lesser quantity, the seeds of *Oryzopsis hymenoides* and *Sporobolus airoides.*

Two small ash lenses noted between the hearth and the presumed doorway are similar in composition to the hearth ash and may be additional hearth residue or patches of roofing or flooring that burned during a fire that consumed the house. Additional evidence for such a fire is provided by a charcoal-filled hole—possibly a posthole—north of the hearth, a red oxidized stain, a concentration of charcoal, and a charcoal-stained depression, all situated near the southwestern margin of the structure.

Excavation in the wall area revealed no evidence that the structure had been rebuilt at any time and the disjointed configuration of the wall itself tends to support this notion.

Given the paucity of artifactual remains in the vicinity of Structure 3 and throughout Midden I generally, it is likely that the bulk of the material recovered from within the structure stems from its occupation or from ritual associated with its abandonment. Among the items found were several schist and granitic milling implements including both manos and metates, a drill, four bifaces, two unifaces, one Cottonwood Triangular point, two nondescript bits of worked bone, and small quantities of chipping debris and bone fragments. The assemblage is not especially large, and in view of this the recovery of seven beads, including examples made of shell, bone, stone, and glass, is noteworthy; with the single exception of Structure 12, beads are nowhere as proportionally abundant at Crater Middens.

Three obsidian hydration rim measurements made on small flakes obtained during the excavation of Structure 3 yielded apparent calendar dates of 500 B.C. (4.1 μ; OHL 922), A.D. 780 (2.5 μ; OHL 920), and A.D. 1341 (1.8 μ; OHL 921). The span of occupation indicated by these samples is certainly

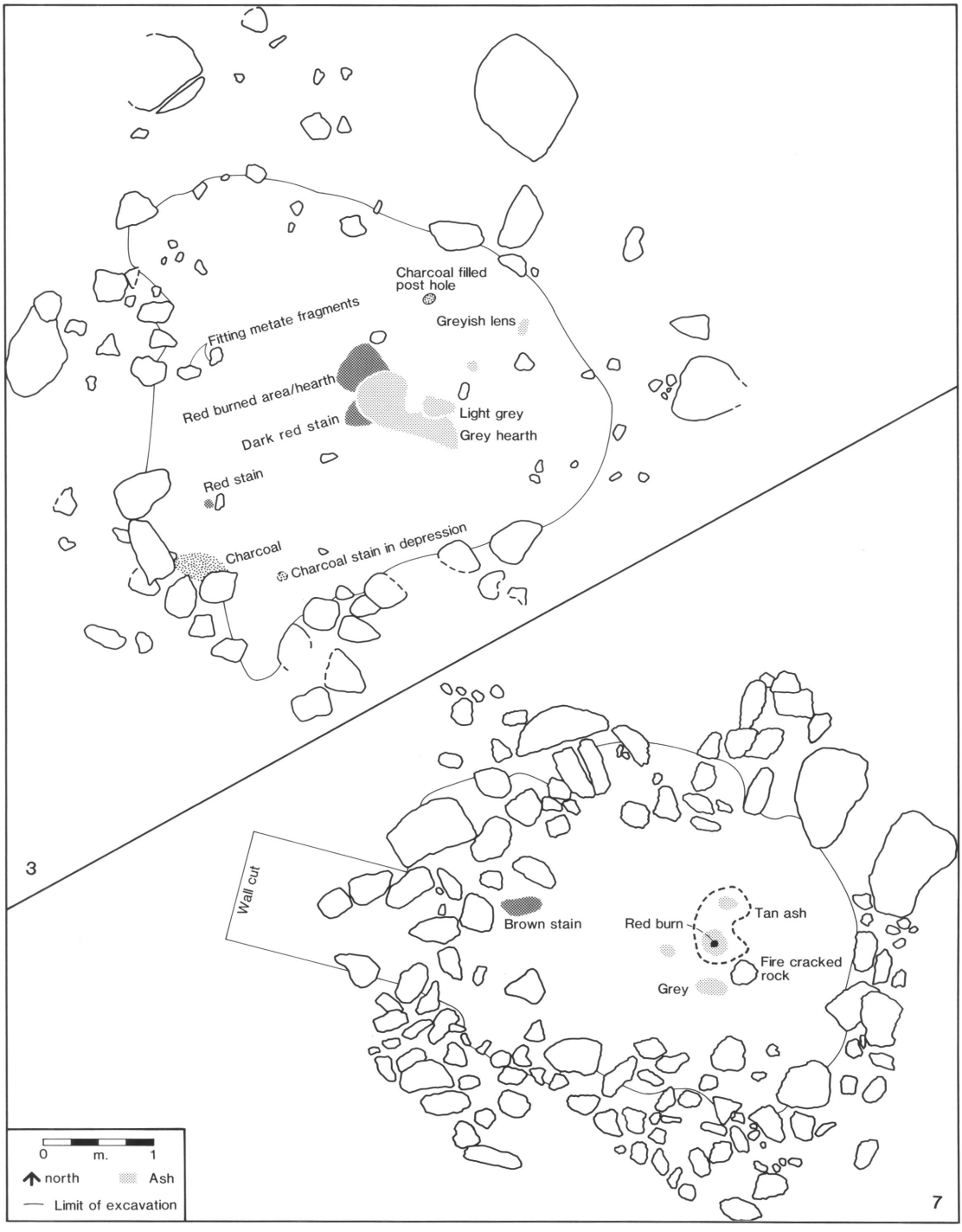

Fig. 8.10. Floor maps of Structures 3 (Midden I) and 7 (Midden II) at Crater Middens.

greater than hinted by the seven time-sensitive artifacts recovered in excavation, a Cottonwood point, four *Olivella* beads (Classes E1a, K2, K3), a steatite disk bead, and a glass bead, and by the insubstantial wall construction. In view of the possibility that the obsidian samples are earlier debris that washed into the structure following its abandonment, the Cottonwood point, the shell, stone, and glass beads, and the haphazard wall construction are in this case considered the more reliable indicators of the age and duration of the occupation of Structure 3. In combination they suggest occupation no earlier than A.D. 1300, and probably later, perhaps at late as A.D. 1800.

In comparison to the other structures excavated at Crater Middens, Structure 3 is anomalous in several respects. First among these is its location in Midden I, which shows no evidence of intensive occupation. Bedrock milling features are few, the scatter of surface debris and artifacts is sparse, and there is no midden development, all of which suggests casual and intermittent use. Added to this, Structure 3 appears to have been built with little effort and never rebuilt after it fell into disuse, possibly following a fire. Despite this, the structure was occupied for an interval of sufficient length to accumulate a reasonably diverse artifact assemblage and in particular a relatively large number of beads which, judging from the range of materials of which they are made, were lost at different times rather than all at once.

All of the above suggests that Structure 3 served a specialized function. It might be a dwelling, but its occupation probably was not closely related to the normal range of day-to-day activities occurring in the more intensively occupied parts of the site—such as Middens II and III—where all of the structures interpreted as everyday dwellings are located. Several explanations might account for this, but the one most promising is that Structure 3 was used by those in temporary isolation—for example, expectant families during ritual seclusion that accompanied childbirth (Steward, 1941: 314). This would account for the location of the structure away from the main site and the presence of milling equipment suggesting the preparation of food. It if is assumed that ritual prohibitions against certain male activities were in force (cf. Steward, 1933: 290) it might also explain the absence of abundant chipping debris, broken projectile points, roughouts, and cores.

There are other possibilities. One is that this is a menstrual seclusion hut; Steward (1933: 295), however, reports that the Owens Valley Paiute did not use a special structure for this purpose and this site and this particular structure are recent enough that his observation is relevant here and ought to be believed. It may also be that Structure 3 was used intermittently by individuals visiting Crater Middens from other villages either within or outside Owens Valley, perhaps during social or religious celebrations that occasioned the wearing and exchange of shell, stone, and glass bead ornaments and currency. The disadvantage of this proposition is that on most such occasions visiting celebrants camped in one large enclosure and food was provided by the local or host village (cf. Steward, 133: 320), which would seem to vitiate the need for isolated huts equipped with milling implements. Further, the list of other maintenance tools found in Structure 3, i.e., bifaces and unifaces, is more extensive than would be expected had it been occupied only by visitors to occasional festivals.

MIDDEN II: *Structure 7.* Structure 7 is the southern half of a joined pair of circular rock structures. Structure 6, described in a later section, is the northern half of this doubled feature which appears to open to the northeast. Structure 7 proper is oval in plan, its interior measuring 3.5 m east–west and 2.5 m north–south with a floor area of 6.8 m^2 (fig. 8.10). The wall of the structure is well-constructed, including the northern portion, which is shared with Structure 6. No metates are incorporated in the wall of either one. There is no opening in the walls of Structure 7 that clearly indicates the location of a doorway, but a narrow break between two large boulders in the northeastern wall may have served this purpose. The structure appears to have been built over a shallow, saucer-shaped basin scraped to a maximum depth of about 7 cm at its lowest point, which is in the east-central part of the interior.

Excavation within the structure disclosed

Fig. 8.11. Exposed floor of Structure 7 (Midden II) at Crater Middens. Trowel points to gray ash concentration marking location of central hearth. View is to west.

a cultural deposit varying between 10 and 16 cm in depth and resting on sterile decomposing granitic bedrock. The only feature of note found within the structure was a hearth area located at the center of the excavated depression and distinguished by a small area of red oxidized soil surrounded by several small patches of gray ash and a larger patch of tan ash (fig. 8.11). In three flotation samples (F-77, 81, 83) extracted from the hearth deposits, *Mentzelia congesta* was uniformly abundant. *Artemisia tridentata* and *Oryzopsis hymenoides* were also present in two, and *Artemisia ludoviciana, Atriplex polycarpa, Sporobolus airoides, Chenopodium fremontii,* and *Populus* sp. were each present in one.

There is a small oval brown stain toward the northwestern margin of the structure the explanation for which is unclear and that may be of natural origin.

A stratigraphic cut through the western wall of the structure revealed an upper unit consisting of boulders and cobbles in a matrix of charcoal-flecked silt. At the base of this was a thin, discontinuous band of ash and charcoal resting on oxidized, decomposing bedrock. Small bits of sagebrush bark were encountered beneath a few of the cobbles on the inside (interior) margin of the wall.

The simplest interpretation of these data is that two structures were built in this depression and that the charred debris of the first, which evidently burned, was removed from the interior and incorporated in the wall of the second. The charred sagebrush bark may be either flooring or roofing from either the first or second structure, more likely the second.

The artifact assemblage recovered from Structure 7 is limited. Milling equipment, an *Olivella* bead (Class E1b), 2 steatite disk beads, 13 Owens Valley Brown Ware sherds, 2 Cottonwood Triangular projectile points, 6 bifaces, and a core—items consistent with those expected of a dwelling—were, nevertheless, present. None of these, however, can be conclusively linked to the actual occupation of the structure rather than to the accumulation

of older or younger debris in this spot after it had fallen into disuse as a structure location.

A single radiocarbon date from the lower portion of the cultural deposit, the corresponding 95 percent confidence interval for which in calendar years is A.D. 920–1395 (800 ± 130 B.P.; UCR-1557), is in essential agreement with two obsidian hydration rim measurements from debitage samples originating in the stratigraphic unit immediately above; these indicate calendar dates of A.D. 1821 or 1581 (1.2 μ, 1.5 μ; OHL 924) and A.D. 1181 (2.0 μ; OHL 923). In combination these suggest that Structure 7 was occupied between A.D. 1200 and 1800, which is consistent with the 2 Cottonwood projectile points, 13 Owens Valley Brown Ware sherds, and shell and steatite beads found within it.

Structure 9. Structure 9 is subcircular in plan, its interior measuring 3.0 m north–south and 2.5 m east–west with a floor space of 6.0 m^2. The surrounding wall, which incorporates 10 millingstones and 7 manos, is thick and heavily built, standing nearly 40 cm high (fig. 8.12). The doorway is marked by an opening 1 m wide in the northeast wall of the structure. On the southern side of the opening, to the left when entering, a low rock partition extends for about a meter into the structure interior and forms a small alcove in the southeastern part of the structure. A circular patch of orange/brown oxidized soil, apparently a hearth approximately 0.5 m in diameter, is located immediately at the end of the partition, very nearly in the center of the structure interior. A flotation sample (F-86) from this hearth produced a small quantity of seeds of *Mentzelia congesta, Oryzopsis hymenoides, Sphaeralcea parviflora, Atriplex torreyi,* and *Artemisia ludoviciana.* The reason for the partition is unclear, but it may have reduced drafts within the structure and vented smoke from the hearth.

The cultural deposit enclosed by the rock wall was about 10 cm thick and rested on a unit of sterile, decomposing granitic bedrock of uneven contour, a relatively intact portion of which forms a slightly raised shelf that projects a short way into the feature on its western edge. Although there was no clear indication that the crumbly bedrock itself had been excavated by aboriginal house builders, the surface of the cultural deposit was slightly depressed toward the center of the structure where, at the deepest point, it is about 7 cm lower than at the margins. This may represent the excavation of cultural deposit from the center during successive phases of housebuilding (see below), the accumulation of wall material near the floor margins following the abandonment of the structure location, or the accumulation of wind-blown dust and debris at the relatively sheltered base of the high rock wall.

A narrow trench cut through the southwestern wall revealed what appear to be two different layers of cobbles and soil separated by a thin layer of charcoal and spotty ash. The upper wall unit is set slightly inside the lower unit, but the two overlap for the greater part of their widths. Presumably these two units correspond to two different phases of structure construction, the second occurring after the structure represented by the first had burned and its refuse—and perhaps additional material subsequently introduced—had been removed and the wall refurbished. More charred material, some of it in small lenses, is incorporated in the upper unit than the lower. This may be debris from the first structure, although the possibility exists that it is the remains of an additional phase of construction and burning between the destruction of the structure represented by the lower wall unit and the construction of the final structure, which is represented by the topmost portion of the upper wall unit. A charred seed of *Stipa speciosa* found in a flotation sample (F-91) extracted from a strata cut excavated through the southwestern structure wall may represent charred thatching or flooring.

The artifact assemblage recovered from Structure 9 is relatively extensive and includes 14 pieces of milling equipment, 29 Owens Valley Brown Ware sherds, 1 Cottonwood Triangular and 3 Desert Side-notched projectile points, 11 bifaces, 5 roughouts, a drill, 2 unifaces, 2 cores, and a Class E1a *Olivella* bead. Of all the material found, only a ceramic disc—possibly a potrest, a mano, and an obsidian core, all items likely to be found in dwellings, could be tentatively linked to the actual occupation of the structure. This tentative linkage rests entirely on the location

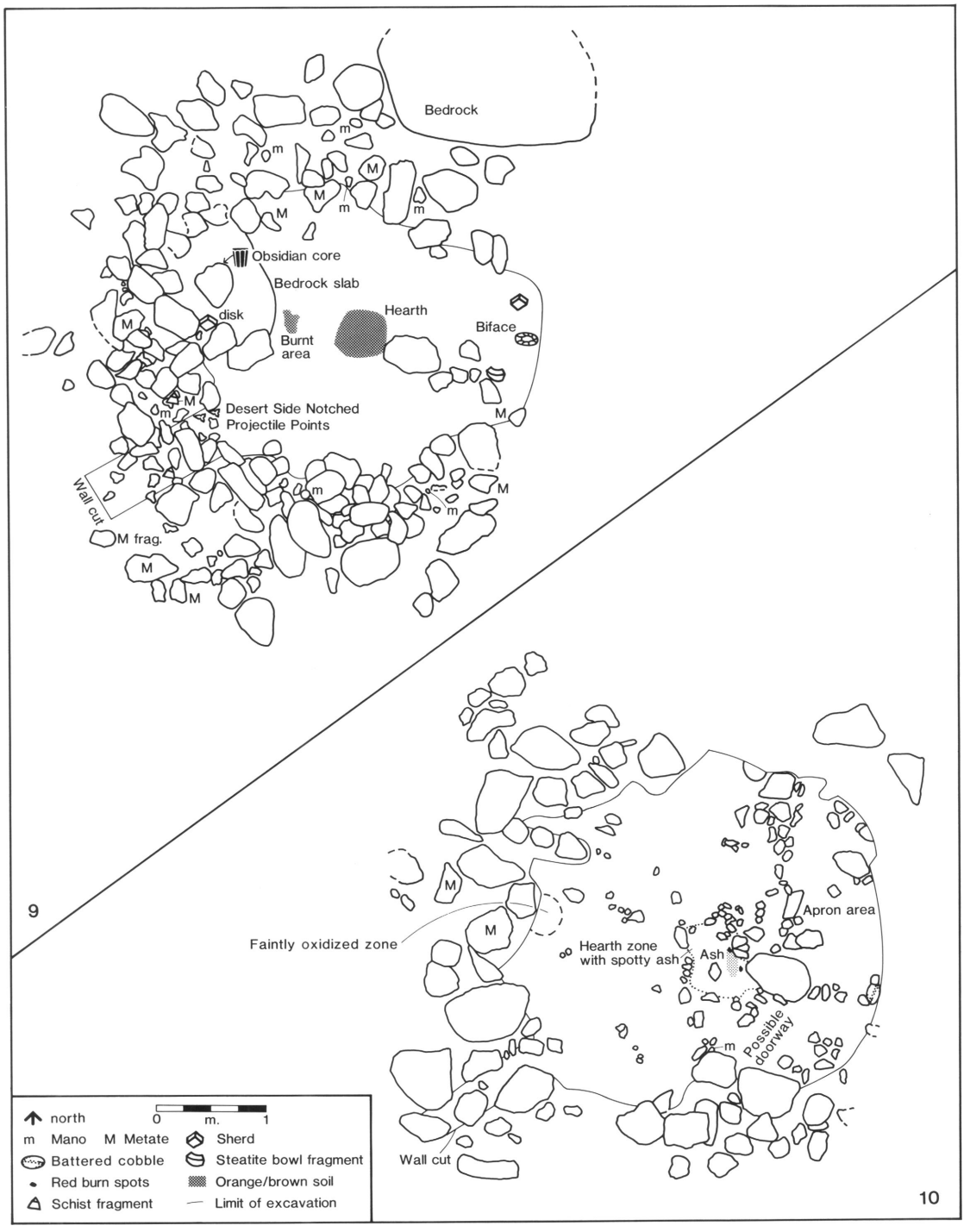

Fig. 8.12. Floor maps of Structures 9 and 10 (Midden II) at Crater Middens.

of those items at the floor periphery where they might have been stored. The remaining material, although potentially attributable to the structure occupation, might just as easily be earlier or later debris that washed or was thrown into the feature after it was finally abandoned as a house site.

Three Desert Side-notched and one Cottonwood Triangular projectile points, Owens Valley Brown Ware sherds, an E1a *Olivella* bead, and an obsidian hydration measurement suggesting a calendar date of A.D. 1501 (1.6 μ; OHL 925) on a flake from the lowest part of the cultural deposit, would tend to place the structure late in time, that is, after A.D. 1300. Again, in the absence of secure evidence associating any of these artifacts with the occupation of the structure, this dating is uncertain. An obsidian hydration rim measurement on a second flake recovered from the lowest part of the cultural deposit indicating a calendar date of either 2261 B.C. or A.D. 300 (6.3 μ, 3.1 μ; OHL 926—the piece was either broken or reworked) offers at least tenuous evidence of earlier use of the structure, but the presumption is strong that this is an older artifact that washed into the deposit after the structure was abandoned or was accidentally incorporated during its use. Even so, it might be that the younger of these two dates (A.D. 300) marks the point at which the flake entered the structure and was broken in the process.

Structure 10. Structure 10 is subrectangular in plan and measures 3.0 m north–south and 2.5 m east–west (fig. 8.12). Its cobble-and-boulder wall enclose an area of 5.6 m^2 but is well defined only to the southeast and west, where two millingstones were used as building stones. Nearly the entire northeastern third of the structure margin is open, marked only by a thin band of rocks. There is a break nearly 1 m across in the southern wall. The area just outside the rock band defining the northeastern outline of the structure seemed to be stratigraphically continuous with the adjacent floor interior and may have been an apron used as a work area. Both the surface of the enclosed cultural deposit, which was about 12 cm thick, and the subtending sterile decomposing granitic bedrock are essentially flat in overall contour, but tilt down to the northeast; the surface of the decomposing granite, however, is made somewhat uneven by localized protuberances and concavities. There is no well-defined doorway, but an opening at a low point between two boulders in the southeast wall may have served as such. An opening in the south wall seems less well suited to such use as it is higher and therefore would have been less convenient as an entryway. That the southeast opening is the doorway is made more likely by its location just south of a well-defined hearth, possibly placed there to make use of the doorway as a smokehole in a manner similar to that noted in Structure 9. The hearth itself is defined by two small patches of oxidized soil, presumably fire locations, between which is a small lens of gray ash. Surrounding these well-defined features are smaller, discontinuous patches of ash extending over an irregular area about 80 cm across. Two flotation samples (F-100, 102) were extracted from different parts of the hearth. Seeds of *Coleogyne ramosissima,* likely a source of firewood, were present in both but examples of other species were absent. A third flotation sample (F-101) taken from the lowest part of the deposit in the structure doorway, where hearth residue may have been swept during house-cleaning, likewise produced seeds of *Coleogyne ramosissima,* but also present were seeds of *Ephedra nevadensis,* another possible fuel source though it was occasionally used for food, and *Chenopodium fremontii* and *Oryzopsis hymenoides,* both food sources recorded ethnographically.

Other than the hearth, the only other evidence of fire noted in the structure was a faint, red, oxidized area toward the rear, adjacent to the rock wall and directly opposite the inferred doorway. This may be a spot where wall material, possibly a post or support, or floor-thatch burned, perhaps when ignited by a structure fire. No other evidence of such a fire was noted elsewhere in the feature, however. A stratigraphic trench through the southwestern wall of the structure, for instance, failed to disclose either charcoal or ash indicative of a structural burn. There was some evidence of successive building phases in that the rocks placed on the wall interior were stratigraphically superior to those on the exterior. This would tend to indicate the wall

was refurbished on its interior, since presumably the last course of rocks laid during structure construction would have been those placed along the exterior to anchor the roof thatching.

As is the case with most of the structures excavated at Crater Middens, it is difficult to associate the materials recovered from Structure 10 with its occupation. The only notable exceptions to this are a mano found at the southern edge of the inferred doorway, where it may have been stored, and a battered cobble (O-2426) found on the apron area just outside and north of this same doorway, where it may have been either used or stored. Among the items for which no definite association can be established are milling equipment, Owens Valley Brown Ware sherds, projectile points, bifaces, roughouts, and unifaces, all of them relatively well represented. The lack of certain association notwithstanding, these are consistent with the list of artifacts that might typify a dwelling.

The time-sensitive pieces recovered include two fragments of a blue glass bead, Owens Valley Brown Ware sherds, and one Cottonwood Triangular and three Desert Side-notched projectile points, all suggesting occupation of the structure—or alternatively, the deposition by either natural or cultural action of cultural debris—relatively late in time, certainly after A.D. 1300, and perhaps after A.D. 1860. A somewhat earlier date is suggested by two Rose Spring Corner-notched points and by two obsidian hydration rim measurements on flakes from the lowest part of the cultural deposit. These indicate apparent calendar dates of A.D. 780 (2.5 μ; OHL 927) and A.D. 1101 (2.1 μ; OHL 928). It is not clear, of course, that any of these items pertain to the occupation of the structure rather than to unrelated activities that produced refuse eventually incorporated in the structure deposit.

Structure 12. Of all the structures at Crater Middens, Structure 12 is the most carefully constructed. It is oval in plan, the interior measuring 3.0 m north–south and 2.5 m east–west with an enclosed floor of 7.4 m^2. The heavily built wall is nowhere less than 1 m thick and averages about 20 cm in height (fig. 8.13). Nine millingstones are incorporated in the wall, concentrated in its northwestern and eastern sections. A doorway 1.8 m in width opens to the northeast.

The surface of the enclosed cultural deposit, which extends to a maximum depth of about 15 cm, was essentially flat and level, although it is slightly raised at the margins, apparently owing to the deposition of soil and debris at the foot of the wall interior. This peripheral material might have built up naturally, for example, through the gradual erosion of the wall following the abandonment of the structure. Alternatively, it is possible that this represents the remains of material removed from the structure interior and thrown on its wall—or disposed of outside the structure, part inadvertently falling back into the interior—during construction of a new house built on the foundation of an earlier house that had become unsound or had been previously destroyed or abandoned.

A niche noted in the southeastern part of the structure might have served as a storage location, but excavation there produced no items in situ to support this notion.

The surface of the sterile decomposing granitic bedrock on which the interior cultural deposit rested was slightly, but distinctly, depressed toward the center, as though it had been excavated to form a shallow, saucer-shaped depression about 10 cm in maximum depth centered just southwest of the structure center. At the raised margins of the decomposing granitic bedrock surface were a series of 8 shallow depressions, the largest 20 cm across and about 6 cm in depth, the smallest 6 cm across and 3 cm in depth. The explanations for these are uncertain, but they might have been used to anchor individual structural members supporting the roof and walls that enclosed this structure; they would serve equally well as storage niches or seating places.

Excavation revealed no evidence of a hearth and although charcoal bits were common in the deposit, the only potential evidence of fire was a small red oxidized soil stain at the northwest edge of the floor. It is not clear that fire, rather than natural decomposition, was responsible for the oxidation noted here, but its location in the vicinity of an inferred brush-and-pole wall suggests that this might be so.

The list of items recovered from the cultural deposit is long, but it is likely that many

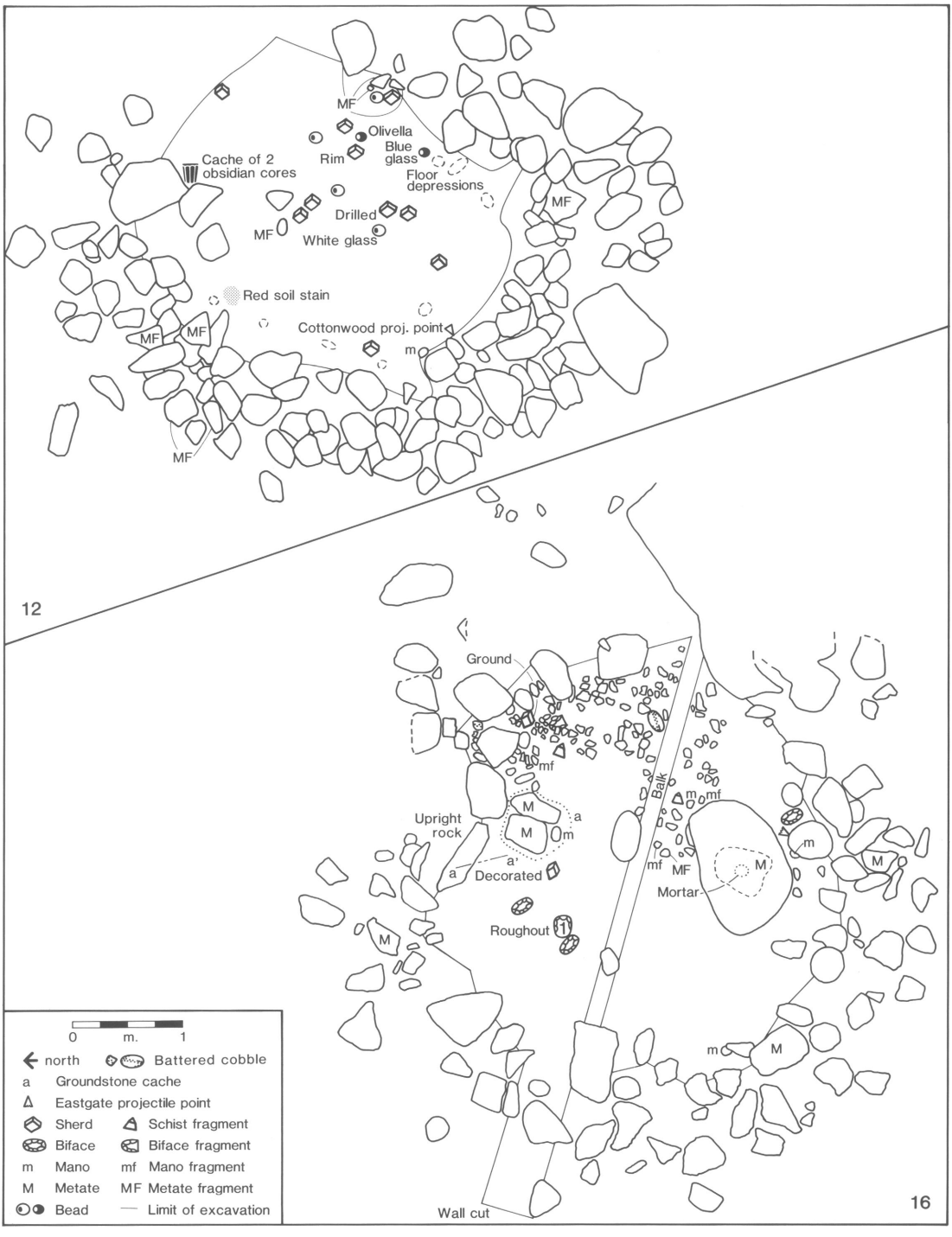

Fig. 8.13. Floor maps of Structures 12 (Midden II) and 16 (Midden III) at Crater Middens.

of these were introduced as refuse from activities occurring in the immediately adjacent central midden area of Midden II, which appears to have been the most intensively used part of Crater Middens. Such refuse disposal may account for the abundance of charcoal fragments in the cultural deposit, but, as noted above, a structure burn cannot be discounted. Well-represented among the items found are millingstones, beads, ceramics, projectile points, bifaces, roughouts, unifaces, and cores. Of these, the beads [42 of glass, 3 of shell (K1 *Olivella* and *Haliotis* Epidermis Disk), and three of stone (steatite disks)], two cores, and a mano seem most likely to be pieces linked with the occupation of the structure rather than extraneous debris that entered the structure following its abandonment. The beads are simply too numerous to be accounted for as refuse; their presence may reflect some sort of ritual, perhaps performed when the structure was abandoned or intentionally destroyed by fire, or the habitual use of beads for some purpose within the still-standing structure. The two cores, both of Fish Springs obsidian, neither of them exhausted, were found cached beneath the large boulder that defines the northern edge of the doorway of the structure. It is likely they had been placed there in anticipation of future use. The mano appears to have been similarly set aside for subsequent use, but at the rear of the structure, adjacent to the southwest wall.

Of the time-sensitive pieces found in the feature, the 42 glass beads, 3 shell beads, 3 steatite disk beads, 46 Owens Valley Brown Ware sherds, 4 Desert Side-notched points, and 3 Cottonwood Triangular points, all date the structure to protohistoric or historic times, a placement that seems relatively secure given that the glass beads are thought to be associated with the occupation of the structure or the act of its abandonment and not ambiguously associated debris.

A Humboldt series point and two Rose Spring series points were also found. These, along with two obsidian hydration rim measurements on flakes obtained from the bottom of the cultural deposit, raise the possibility of earlier use of the structure. One hydration measurement corresponds to a calendar date of A.D. 1181 (2.0 μ; OHL 898), the other to a date of A.D. 1101 or 860 (2.1 μ, 2.4 μ; OHL 897). Although these points and bits of debitage may be refuse from activities unrelated to the structure and its occupation, certain features of wall construction are consistent with the idea that the structure was inhabited over a period longer than is indicted by the bulk of its time-sensitive artifact assemblage.

There was no obvious evidence of sequential layers of wall material separated by discrete layers of ash that might suggest a succession of structural burns and reconstructions. Even so, the stones on the wall interior were clearly added last and, given the thickness and height of the wall and the care with which it was built, it is likely that a succession of houses was constructed within this foundation. It is not clear whether any of these were destroyed by fire but the presence of what may be some sort of ritual offering of beads left in the structure interior at least raises the possibility that this could have occurred once, perhaps at the time of its final abandonment.

MIDDEN III: *Structure 16.* One of the largest structures encountered at Crater Middens, Structure 16 is oval in plan, its interior measuring 4 m east–west and 3 m north–south with a floor space of 9.8 m^2 (fig. 8.14). Neither high nor heavily built, the rock wall is essentially continuous except for a narrow break, probably a doorway, about 50 cm across, in the northeast margin adjacent to which is a large granitic bedrock boulder that forms a short segment of the eastern structure wall. Three millingstones were found in association with the wall, apparently having been put there as construction material.

The cultural deposit within the structure varies between 20 and 35 cm in depth and exceeds by several times the volume found in any other structure. The surface of the deposit is essentially flat, tilting slightly down to the south where it reaches a maximum depth of nearly 7 cm below the highest part of the interior surface, the northern margin. The sterile decomposing granitic bedrock subtending the cultural deposit within the structure is essentially level, that is, unsloped and flat rather than saucer shaped or slanted, but is deeply fissured throughout, apparently as the result of intensive rodent burrowing

Fig. 8.14. Exposed floor of Structure 16 (Midden III) at Crater Middens. Note depth of deposit as shown by balk, lack of evident stratigraphy in balk, and pavementlike concentration of small rocks covering northeastern part of the floor, the upper portion, in this photograph. Pedestal of large, tilted wall slab appearing just to left of this pavement provided stratigraphic profile depicted in figure 8.14. Location of other artifacts and features may be ascertained with reference to figure 8.12. View is to northeast.

along natural fracture zones where advanced decomposition of the granitic bedrock facilitated tunneling. Some of these fissures are nearly half a meter in depth.

A stratigraphic trench excavated through the western portion of the structure wall revealed no obviously differentiated construction layers and no evidence of fire. Boulders placed on the inside of the wall, however, were stratigraphically superior to those on the exterior, raising the possibility that the wall was reconstructed at some time, perhaps more than once, the rebuilt wall being set on the inside of the old wall.

No evidence of a hearth or of a structural burn was noted during excavation of the interior cultural deposit but small charcoal fragments were common. Several subsurface features suggestive of the use of the structure were found, however. The most notable of these was a large bedrock milling feature, the surface of which was within 10 cm of the original ground surface and 25 cm above the sterile subsoil in which the boulder is embedded. This milling feature consists of a large, uneroded granitic boulder, 120 × 80 cm, modified by a relatively deep milling slick that is subtriangular in outline and measures 45 cm in length, 35 cm in width, and 3.5 cm in depth. In the center of this is a shallow cup-shaped mortar 10 cm in diameter and about 1.5 cm in depth (fig. 8.13).

A second feature, also clearly related to plant processing, is a cache consisting of a mano and two complete millingstones placed side by side face down near the northern margin of the structure interior. A flotation sample (F-162) recovered immediately beneath these millingstones yielded only the seeds of *Coleogyne ramosissima* and *Ephedra nevadensis,* both probable fuel sources. A second flotation sample (F-106A) taken from the

lower portion of the cultural deposit not far from the bedrock milling feature was likewise dominated by *Coleogyne ramosissima* and *Ephedra nevadensis,* although a single seed of *Mentzelia congesta* was also noted. There can be no doubt that both the portable and bedrock milling implements noted in Structure 16 were employed for seed processing, in the latter case within the confines of the structure itself; the virtual absence of charred seeds representing items of diet, therefore, presumably reflects the performance elsewhere of the steps of seed processing, most likely parching, that account for the presence of charred food seed in other flotation samples.

No other discrete features were noted, but a pavementlike concentration of small rocks covering the northeastern part of the floor appears to be the result of patterned behavior, though not necessarily a deliberate construction. This contained several associated tools and tool fragments, including a battered cobble, a ground sherd, a biface, and grinding implements; it may be a work area or, what seems as likely, an area into which was thrown refuse from activities occurring in the structure.

In addition to these features, several individual artifacts were found in locations that tend to associate them with the occupation of the structure rather than with the natural or cultural introduction of material after it was abandoned. Notable among these are three manos, two of them in close association with the bedrock milling feature, one in the central interior, where it may have been used, the other wedged under a wall boulder directly adjacent to the milling feature, where it may have been stored. The third mano, found under a wall boulder in the southwestern portion of the structure, may also have been stored there in anticipation of future use.

In contrast to these groundstone artifacts, which are clearly consistent with the milling features that distingush Structure 16 from other structures at Crater Middens, are three large chert bifaces—one complete and two fragmentary but still usable—that also appear to be something other than fortuitous refuse. The smallest of these is larger than any other biface recovered at the site and, given the lack of workable chert in the site vicinity as well as the apparent preference for this material in the manufacture of large bifaces, it is unlikely any of the three are discards. It is more probable they were left intentionally in the structure prior to an interval during which it was abandoned. The failure to retrieve them might have been deliberate, e.g., upon the death of an occupant, or inadvertent, e.g., as in the case where a family temporarily vacated the structure with the idea of returning but through unforseen circumstances was unable to do so. Either explanation would also account for the cache of portable milling equipment and the manos individually placed about the structure periphery.

An intact soil profile protected beneath an upright wall stone leaning south into the structure preserves an unusually clear picture of the occupational history of the structure and sheds some light on the plausibility of these alternatives. It shows a stratified sequence of four silty brown midden layers, each capped by a layer of wind-and-water-sorted material composed primarily of angular grains of quartz and feldspar (fig. 8.15). It is believed that each pair of midden and sand members corresponds to an interval in which the structure was occupied and then abandoned. The midden members either accumulated during each occupation or were emplaced at its outset as the result of wall building or floor clearing. The sand layers are thought to represent periods of abandonment during which the finer particles of the uppermost parts of the midden washed or blew away, leaving coarser material behind. Four occupations and abandonments are therefore represented.

Since there is no evidence in any part of this stratigraphic profile to suggest a structure fire, it seems unlikely that the material found within the structure represents a ritual offering that accompanied the abandonment of the structure and it is more likely that the items recovered in still usable condition were left there in anticipation of a reoccupation that for some reason never came to pass.

Taking all the above evidence into account, Structure 16 seems best interpreted not as a family dwelling but as a specialized structure used for plant processing or for storage, which would account for the absence of a hearth,

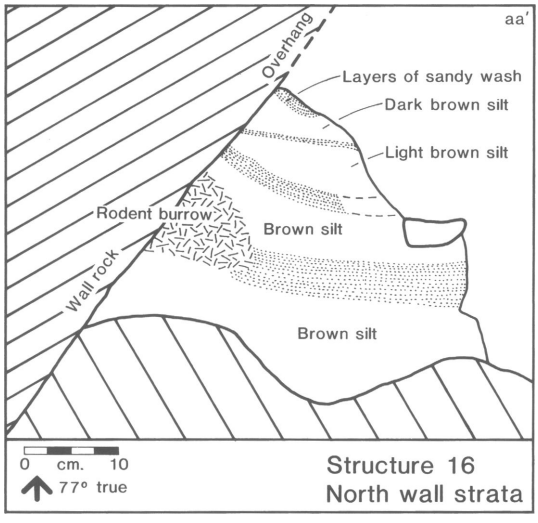

Fig. 8.15. Profile of strata preserved adjacent to north wall of Structure 16 (Midden III), Crater Middens.

the presence of a bedrock milling feature occupying a large fraction of the enclosed floor space that would be needed for sleeping and other activities in a family residence, and the presence of so many items in still useful condition, most notably milling equipment and bifaces.

The balance of the assemblage, though it is extensive, cannot be conclusively associated with the occupation of the structure to the exclusion of the possibility that it is extraneous debris that entered during one of the intervals in which it was abandoned. Every major artifact class is well represented in this collection, including milling equipment, battered cobbles, beads, ceramic sherds, projectile points, drills, bifaces, roughouts, unifaces, cores, and bone and chipped stone debitage. Given their lack of demonstrated association, the time-sensitive artifacts found in the structure cannot be regarded as necessarily indicative of its age. Nevertheless, the recovery of an Elko series projectile point at the very base of the cultural deposit is consistent with the notion that this structure was built and used very early during the occupation of Crater Middens, between 1200 B.C. and A.D. 600, or roughly coincident with the inception of occupation at the site. Subsequent use between A.D. 600 and 1300 is attested by the presence of projectile points of the Rose Spring series, of which there was one, and the Eastgate series, of which there were two. The most intensive period of occupation, however—provided we accept for the sake of argument that the items recovered represent the occupation of the structure—was between A.D. 1300 and historic times, this being represented by 15 Desert Sidenotched, 7 Cottonwood Triangular, and 1 Cottonwood leaf projectile points, 23 sherds of Owens Valley Brown Ware, 3 *Olivella* beads (Classes E1a and E2), a *Tivella* Thin Disk bead, and 3 steatite disk beads. A radio carbon assay on a carbon sample recovered from the lower part of the deposit yielded a radiocarbon age with a corresponding 95 percent confidence interval in calendar years of A.D. 1340–1645 (425 ± 100 B.P.; UCR-1560), which falls within the inferred interval of most intensive occupation. That the terminal occupation predated historic times is suggested by the absence of any Euro-American items in the collection save for a piece of lead shot, which is probably intrusive. The lack of any glass specimens among the 14 beads recovered is especially telling in this regard.

Unexcavated Rock Rings

Midden I: In addition to Structure 3, which was excavated and has been described above, there were two additional structures in the extreme western portion of the site defined as Midden I.

Structure 1. This is the westernmost structure at the site and is far removed from the main portion of Midden I, which centers on Structures 2 and 3, about 100 m downslope to the east. Structure 1 is U-shaped, measuring 4.0 × 2.7 m with an enclosed floor space of 5.1 m^2. It opens to the northeast, where a 2.0 m break in the wall clearly marks the location of a doorway (fig. 8.16). No millingstones are incorporated in the wall and artifacts of any kind are very sparse in the surrounding area. A chert core and a handful of chipping waste, however, were recovered in apparent association with this feature.

Structure 2. This feature is located in the central part of Midden I, a little more than 20 m from Structure 3. The structure is a semicircle of boulders and cobbles about 4

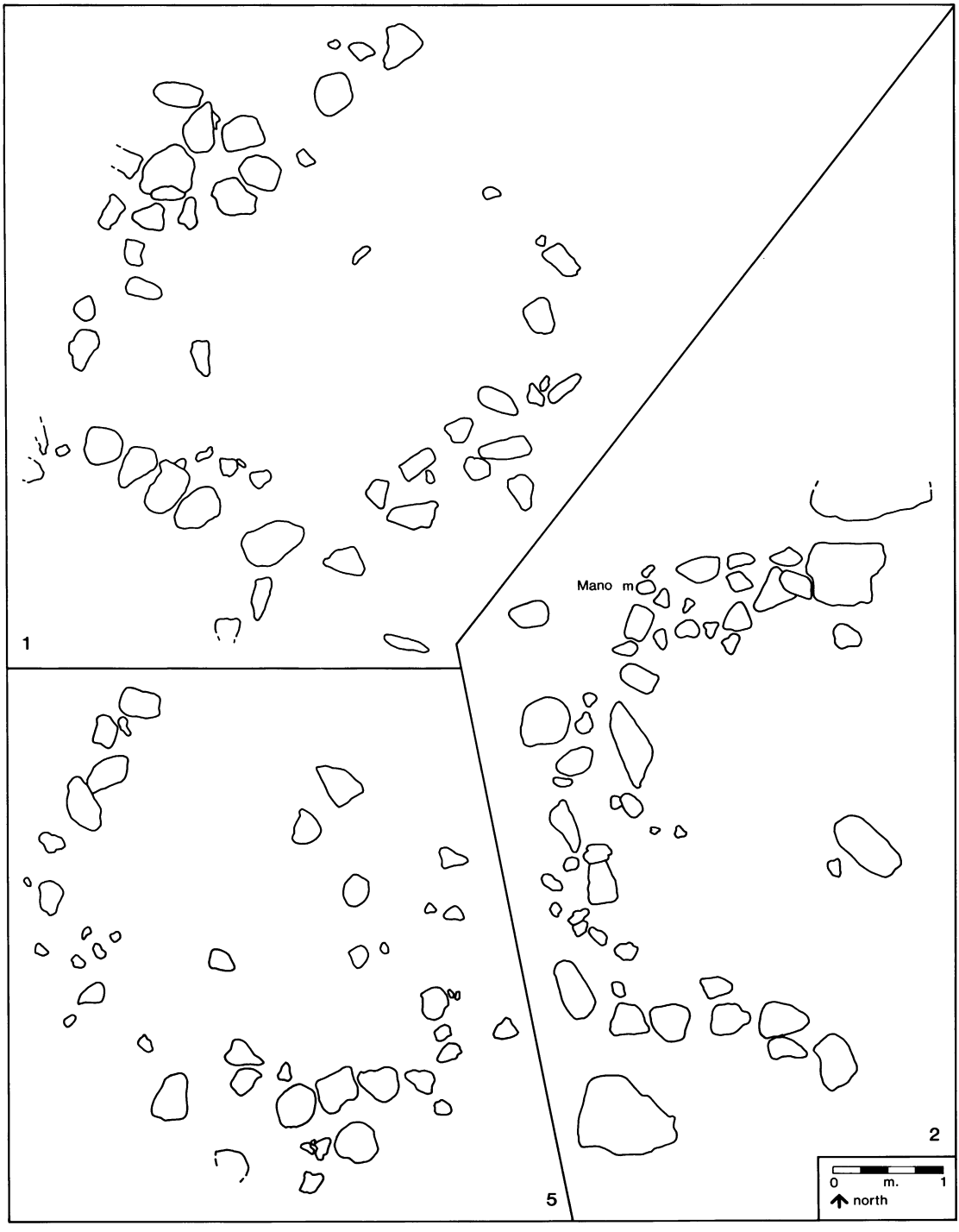

Fig. 8.16. Floor maps of Structures 1 (Midden I), 2 (Midden I), and 5 (Midden II) at Crater Middens.

m wide and 2.5 m deep, opening to the east (fig. 8.16). The enclosed floor occupies an area of 6.5 m^2. A large boulder located in line with and roughly midway between the ends of the structure wall may have provided footing for an upright pole or beam to which poles extending from the rock wall were attached. This would result in a roof in the shape of a half-cone. A mano was found in the exterior of the northern wall, but it is not clear whether this is building material or an item stored for later use.

MIDDEN II: Aside from Structures 7, 9, 10, and 12, which were excavated and have been described, there were four other rock rings in Midden II.

Structure 5. Structure 5 is a loose alignment of boulders and cobbles, roughly oval in plan and measuring about 3.5 × 2.0 m, enclosing an area of 6.9 m^2, the long dimension of which is oriented northwest–southeast (fig. 8.16). A break in the northern part of the wall, 1.5 m across, is apparently the doorway. There were no items of milling equipment in the wall itself.

Structure 6. The feature constitutes the northern half of a pair of structures joined along a common wall; Structure 7, which was excavated and has been described above, forms the remaining half, its northern wall being the southern wall of Structure 6. Structure 6 is essentially a gently curved wall about 4 m long and no more than 1 m deep (fig. 8.17). Being so shallow, the structure affords little shelter except at its southern end, where the wall shared with Structure 7 is perpendicular to the main wall of Structure 6. This provides an enclosed area about 1 m in diameter and 3.0 m^2 in area. No manos or metates were noted in the wall of Structure 6, which is probably a windbreak attached to Structure 7, rather than a separate dwelling.

Structure 8. This feature is located at the extreme western edge of Midden II, just outside the chippage scatter associated with this midden. It is large, oval in plan, and measures 4.5 × 2.0 m with a floor space of 10.0 m^2, its long axis oriented east–west (fig. 8.17). An opening 80 cm wide at the east end appears to be the doorway. The structure wall includes several large bedrock boulders, one of which displays a light grinding slick (Milling Feature II.G). A second bedrock grinding slick, again lightly ground, on a boulder of similar size is located 4 m to the north of the structure (Milling Feature II.F).

Structure 11. This is a small cobble-and-boulder alignment circular in plan, the interior of which measures 2.2 m north–south and 1.8 m east–west enclosing an area of only 2.8 m^2 (fig. 8.17). There is a break, 1 m across, in the west wall that apparently represents a door or entryway. No manos or millingstones were incorporated in the wall.

MIDDEN III: In addition to Structure 16, which has been described in the section dealing with excavated structures, there were two other rock rings in Midden III: Structures 14 and 17.

Structure 14. Structure 14 is oval in plan, measures 5.4 × 4.4 m, and exhibits two distinct floor spaces separated by a partition (fig. 8.18). It is somewhat similar in design to the feature formed jointly by Structures 6 and 7. In this case, however, the exterior wall is more heavily built than the partition and, except for a break 80 cm across in the east wall, which is apparently the doorway, seems to be a single, continuous foundation enclosing a large floorspace that has been divided by a low partition. Overall, the interior measures 4.0 × 2.2 m, the long axis oriented northwest–southeast. The interior partition is a single course of cobbles about 2 m long and oriented east–west. Two smaller areas are thus formed, the one on the south measuring 3.2 × 1.5 m, enclosing an area of 4.6 m^2, the one on the north 2.4 × 1.0 m, enclosing an area of 2.6 m^2. The long axis of each is oriented roughly east–west. It is possible that the northern area, which is quite narrow and includes the inferred doorway, is merely an entryway to the larger interior area, perhaps put there to provide protection from the wind. Three large metates were incorporated in the wall, but one of these, located on the wall exterior just south of the inferred doorway, may be an item stored there awaiting future use rather than building material.

Structure 17. This is a nearly circular alignment of cobbles and boulders that surround a shallow depression roughly 2.3 m in diameter with an enclosed floor area of 4.6 m^2 (fig. 8.18). The northeast one-quarter of the

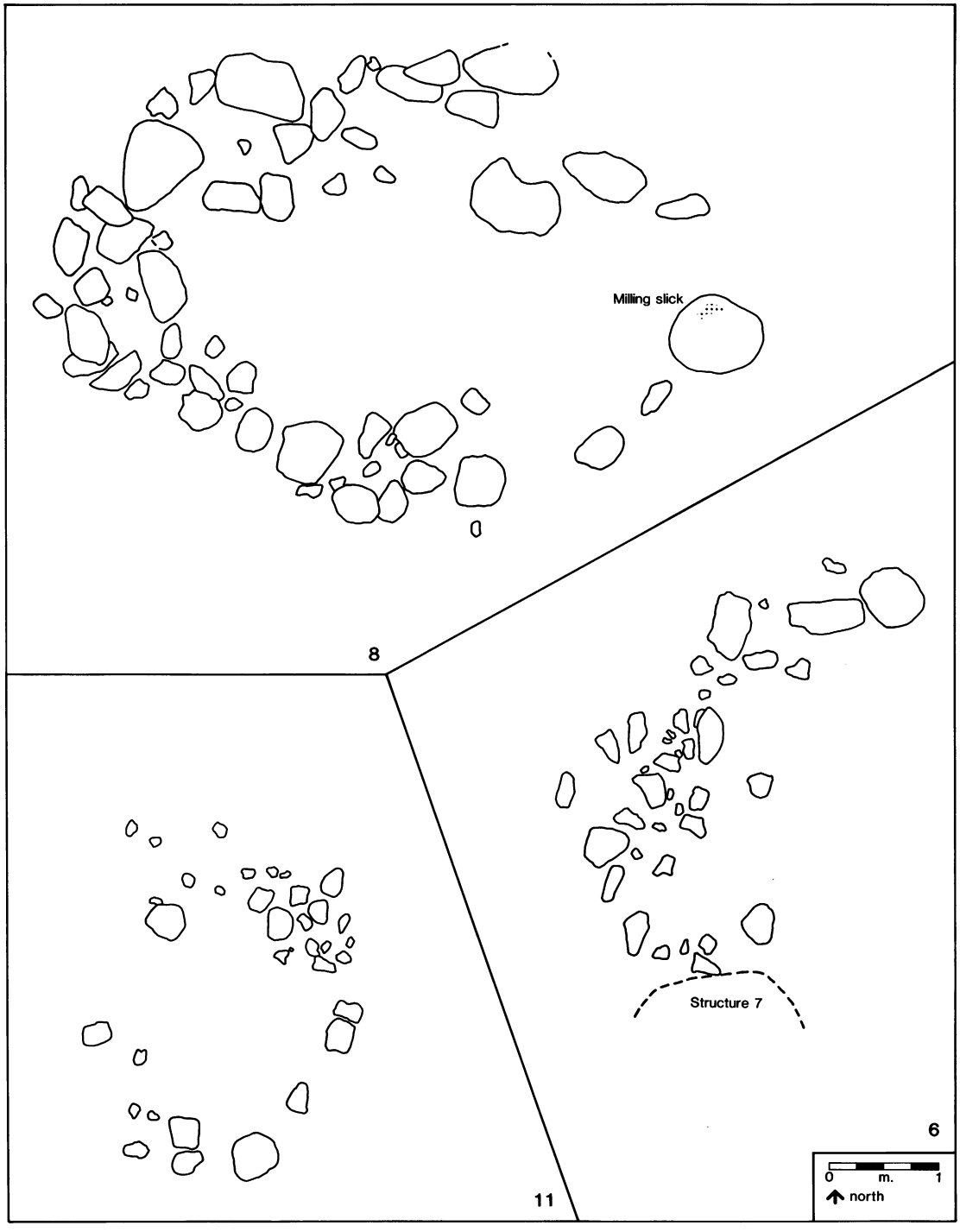

Fig. 8.17. Floor maps of Structures 6, 8, and 11 (Midden II) at Crater Middens.

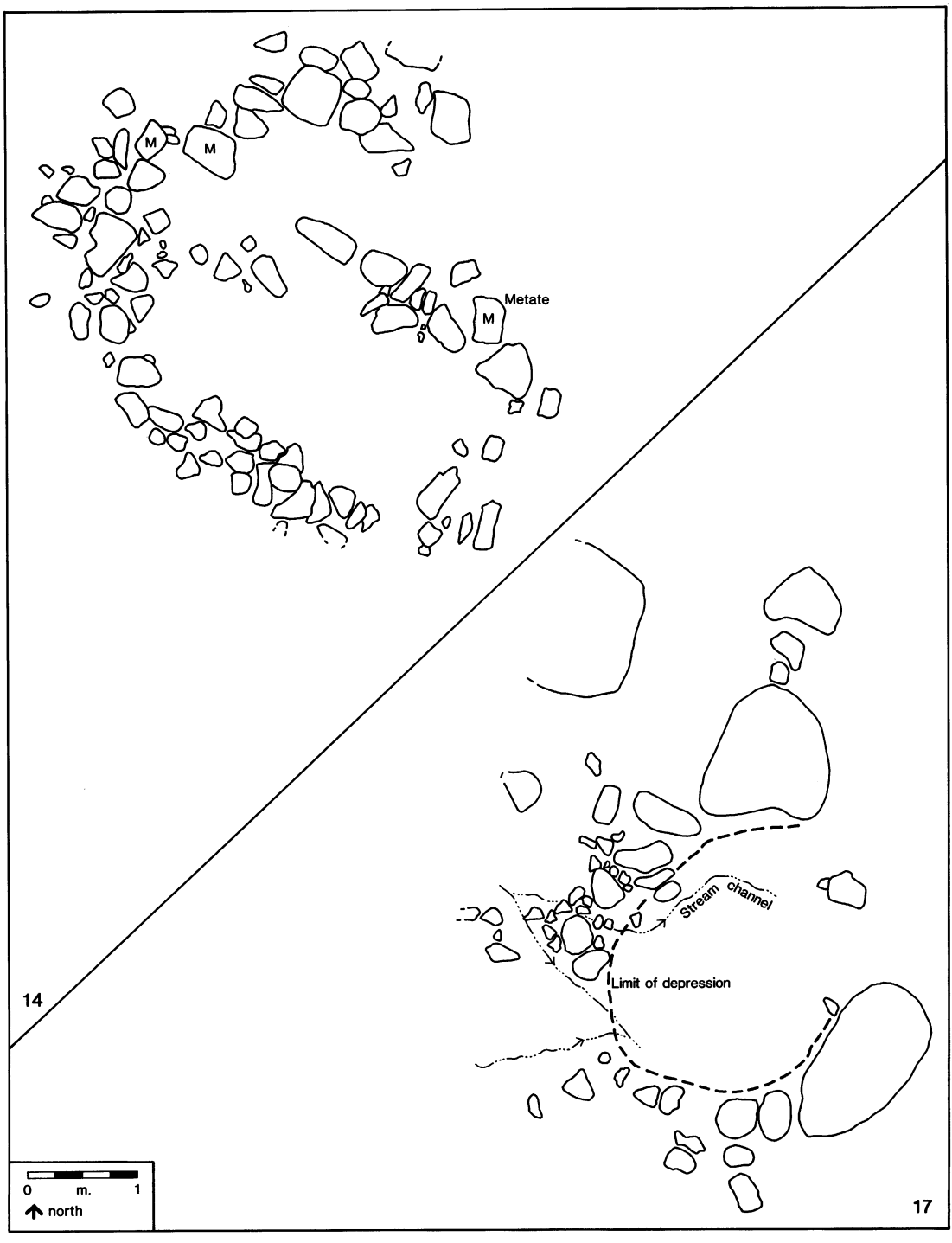

Fig. 8.18. Floor maps of Structures 14 and 17 (Midden III) at Crater Middens.

Fig. 8.19. Floor maps of Structures 4 (Midden II), 13 (Midden II), and 15 (Midden III) at Crater Middens.

structure is open for a distance of 1.6 m except for a large cobble set midway between two large bedrock boulders located on either side of this opening. No milling equipment was noted in the wall.

Miscellaneous Rock Structures

The remaining three rock structures at Crater Middens, Structure 4, Structure 13, and Structure 15, clearly represent something other than free-standing roofed buildings. With the exception of Structure 13, however, they admit of no clear interpretation.

Structure 4. Located just west of the chippage scatter that is associated with Midden II, Structure 4 is an amorphous patch of boulders and cobbles 5 m long and 3.5 m in maximum width (fig. 8.19). Among these rocks was noted a single millingstone. The function

of this feature, which is clearly cultural in origin, is not certain, but its northeastern margin is distinctly concave and it might be the remnants of a rock ring the eastern portion of which was dismantled and heaped on the western portion.

Structure 13. Structure 13 is not clearly associated with either Midden II or Midden III, but is somewhat closer to the former than the latter (fig. 8.3). It is a small semicircle of cobbles, the open end of which abuts the steep, east face of a large granitic bedrock boulder which stands 1.6 m above the ground surface and provides shade all day in the summer (fig. 8.19). The semicircle is 2.5 m long and 1.2 m deep, encloses an area of 2.1 m^2, and displays what would appear to be a doorway, 1 m across, on the northeast. A mano and metate were incorporated in the wall, possibly for storage rather than as building material, and a battered cobble (O-3715) was noted on the surface inside the structure at the foot of the steep boulder face. In addition, a pestle (O-3717), a mano (O-3716), and a metate were found around the western base of the boulder, that is, on the side away from Structure 13. This feature would appear to be too small for a house and the best explanation is that it is a storehouse or simply a small sunscreen that shaded a work area used for plant processing.

Structure 15. Structure 15 (fig. 8.19) is an amorphous cluster of cobbles and boulders 2.5 m in maximum width. It incorporates no milling equipment and, although almost certainly of cultural origin, suggests no definite interpretation. Perhaps it is the remains of a small cache that became misshaped upon being opened.

DISCUSSION

As at Two Eagles, the lack of evidence for substantial beams preserved in the excavated structures and the absence of large trees that might furnish such beams (except for a few Jeffrey pines along Big Pine Creek some distance away), would tend to suggest that the frames erected over the rock features at Crater Middens were fashioned of poles—probably willow or birch (*Betula occidentalis*). These may have been set in the form of a cone (the ethnographic winter house type: Steward, 1933: 264) or bent into a dome (the ethnographic summer house type: Steward, 1933: 265).

It is by no means certain, however, that all of the structures at Crater Middens were covered by such frameworks. During the same trip on which he visited the historic aboriginal village just below Crater Middens, Curtis photographed an unroofed brush surround or enclosure the rock foundation of which is similar in size to the rock structures at Crater Middens (Curtis, 1926: 66a). He identifies this as a summer kitchen, but as it does not seem to be furnished with a hearth, the identification may be in error. In any case, the similarity between the foundation of this roofless "summer kitchen" and the rock structures at Crater Middens is troubling because Steward (1933: 263–266, 1941: 282–286) does not report the presence of rock foundations in conjunction with any ethnographic Owens Valley dwelling type, roofed or unroofed, nor do the ethnographic photographs of Forbes show them in use with either the conical winter house (Bosak, 1975: figs. 14, 15) or the domed summer house (Bosak, 1975: fig. 16). The photographs of Curtis, however, clearly show a rock foundation at the base of a domed house (fig. 8.2) in the historic Owens Valley Paiute village below Crater Middens (Curtis, 1972: 151), yet not with a domed house photographed at Independence (Curtis, 1926: 58a), a town just south of Big Pine, or with a roofless circular summer enclosure, also evidently photographed at Independence (Curtis, 1926: 64a).

Despite the infrequency with which rock foundations were employed in the ethnographic roofed structures that have been reported, it seems likely that many, if not all, of the rock structures at Crater Middens were covered by either conical or domed frameworks. Certainly the idea that these foundations all represent open-air summer kitchens is implausible—even though scanty evidence suggests this type of feature may have commonly employed such foundations.

It is probably worth pointing out that both the utility and feasibility of constructing stone foundations as footings for roofed structures would likely vary with local conditions. Where the soil was deep, firm, and free of rocks, as for example along the Owens River

bottomlands, poles would have been more easily planted securely in the ground, thus eliminating the need for a rock footing. In addition, scarcity of portable rocks, particularly on the floodplain, might have made it difficult to obtain the material necessary to build one. In the rockier foothills, on the other hand, the shallow, cobble-strewn soils would provide little support for a pole framework—particularly for the domed form in which the poles were bent and lashed under tension. This would require the use of a rock foundation, the material for which was readily at hand. There is some support for this idea as nearly all of the photographed historical structures that lack foundations appear to have been built in locations where the soil would have been relatively firm and deep, while, on the other hand, a visit to the location of the historic structure with a rock wall photographed by Curtis (Mono Home) showed the soil there to be loose, shallow, and full of rocks. The latter conditions characterize Crater Middens and it is therefore likely that roofed houses there required stone foundations.

This explanation accounts for the absence of rock walls in association with the roofed structures at Pinyon House and other upland villages in eastern California: the mountain houses were all constructed of heavy beams that, once set in place and interlocked, supported themselves and did not have to be deeply implanted in the ground or buttressed by heavy stone footings.

Granting that houses built at Crater Middens would need stone foundations, it remains to define and interpret differences in the size, shape, and furnishings of these rock structures in terms of the purposes they might have served. As observed in their descriptions, Structures 4, 6, 13, and 15 are clearly abberant and can be set aside at the outset. Structures 4 and 15 are either disturbed or of such ambiguous form that no clear interpretation is possible, while Structure 13 is almost certainly a shaded work area. Structure 6 is best interpreted as a windscreen for Structure 7. Of the remaining structures, all of them rock rings, Structure 11 is so small that it can only be a cache or perhaps sleeping quarters for a single individual.

This leaves 12 rock rings that are large enough to have served any number of purposes including that of dwellings, seclusion huts, sweathouses, cookhouses, workshops, or storehouses. It has already been noted that Structure 3 may be a seclusion hut used by families during the period just prior to and just after childbirth. This inference was based on the isolation of the structure from the more intensively used parts of the site and its casual construction. These same characteristics apply to the other two structures in Midden I, Structures 1 and 2, although neither is as shodily built as Structure 3. It is probably not unreasonable, therefore, to attribute them tentatively with the same function, so long as it recognized that the interpretation of Structure 3 is in large part speculation and that this uncertainty is compounded in the cases of Structures 1 and 2 because they were not excavated.

With respect to the other structures, all located in Middens II and III, it is notable that only two of those excavated, Structures 12 and 16, lacked interior hearths and both were unusual in other respects. Structure 16 is very large and encloses a bedrock milling feature. This, along with shell bead refuse and caches of still-useful items found within it, would suggest use as a storehouse or workshop.

Structure 12, on the other hand, is not especially large, but it is very well built, easily being the most elaborate structure on the site. Like Structure 16, Structure 12 contained cached items, in this case two obsidian cores. It also yielded a substantial quantity of beads—most of them glass. Given the similarities to Structure 16, it may be that Structure 12 is a storehouse. The only other possibility would seem to be that it is a sweathouse, a notion that is consistent with its construction even though it would seem to be rather small for this purpose. This explanation conceivably also accounts for the numerous beads—which might be interpreted as items lost in gambling, and the cached cores—which might also be items of wager or perhaps raw material for craftwork done by males in or around such a sweathouse. The interpretation of Structure 12 as a sweathouse, however, appears contradicted by the absence of a hearth which, in the ethnographic Owens Valley sweathouse was used to generate steam (Steward, 1933: 265–266). Other

Great Basin groups, however, were known to have used water poured over heated rocks and this method could have been used in Structure 12 (cf. Steward, 1941: 285). At this point no strong case can be made for any specific function for Structure 12 but the available evidence weighs slightly in favor of its interpretation as a sweathouse.

Of the structures still remaining, all of which contained hearths, Structure 10 stands apart from the others in terms of its poor wall construction and adjacent cobble pavement. It may be that this merely reflects the normal variation within house construction. On the other hand, it may be of significance that the only other structure exhibiting an adjacent cobble pavement, Structure 16, is thought to be a workshop and storehouse rather than a dwelling. The idea that Structure 10 is a storehouse is improbable given the presence of a hearth, but this would not preclude its use as a workshop or an area of food preparation, perhaps similar to the roofed cookhouse reported by Steward (1933: 265) for the Owens Valley Paiute or, alternatively, a roofless summer kitchen of the kind photographed by Curtis (1926: 66a).

The elimination above of features that are unusual with respect to location, construction, or furniture leaves a more or less homogeneous group of rock features that are taken to be roofed dwellings. These are Structures 5, 7, 8, 9, 14, and 17. The excavated examples of this group, Structures 7 and 9, both exhibited hearths and northeast-facing doors. Door locations are less certain for the unexcavated examples except Structure 17, which also opens to the northeast. The floor areas are remarkably consistent among these six structures and range between 4.6 and 7.8 m^2, with a mean close to 5.4 m^2. Assuming that households comprised between four and eight individuals, which is about the size expected of nuclear families or small kin cliques, this would allow 1 m^2 of floor space per individual. The only notable structural elaborations represented within this gruop are the interior partitions and windscreens noted in Structures 7, 9, and 14. As discussed above, there is no indication as to the exact configuration of the frameworks covering these foundations or of those that covered Structures 1, 2, 3, 10, 12, and 16. Most likely these consisted of grass or brush thatching lashed by horizontal pole withes. If the ethnographic pattern applies to these dwellings, those used in summer were domed, those used in winter were conical. Unfortunately there is no sound basis at present for distinguishing the seasons in which individual structures were used although it is inferred from a variety of evidence that the site was occupied year-round (see below) in which case there would be some of each kind. It is entirely possible, however, that the ethnographic pattern does not apply here and that families occupied the same house, either conical or domed, year-round.

CHAPTER 9. CRATER MIDDENS: ARTIFACT ASSEMBLAGE

MILLING EQUIPMENT

MILLINGSTONES: As is true of the milling assemblage as a whole at this site, the collection of millingstones from Crater Middens is both large and diverse, consisting of 363 individual specimens, of which 261 could be assigned to one of the four basic millingstone types recognized in this study: graters, basin block, flat block, and flat slab (tables 9.1, 9.2). A total of 195–75 percent of all typable specimens—represents a distinctive kind of millingstone made of thin, shaped slabs of micaceous schist which was defined as a separate subtype of flat slab millingstone. As these are readily recognized even in very small fragments, both their numbers and the total millingstone count for the site are inflated. Between the three sites considered in this volume, examples of this particular schist millingstone subtype, as well as graters and basin block millingstones, were found only at Crater Middens. This suggests that a greater range of plant processing tasks was performed at this site than at either Pinyon House or Two Eagles and that, apart from plant procurement proper, Crater Middens played a more pivotal role in aboriginal settlement patterns than did these other two sites.

Before proceeding to the description of the various kinds of millingstones present, it should be noted that collection of surface milling equipment varied between the five middens that together constitute the site. At Middens I, III, and V, surface millingstones other than those made of schist were counted and, in most cases, assigned to a specific type, but were not collected, measured, or identified with regard to material. These artifacts are included in the totals given for different millingstone types but naturally do not contribute to the metric data or the range of materials recorded for these types, where appropriate being listed as *not applicable.* All portable milingstones, whole and fragmentary, were retrieved from the surfaces of Middens II and IV, often with great difficulty as they ranged up to 110 pounds in weight. These complete surface collections, in combination with the millingstones recovered in excavation, all of which were retrieved, are thought to provide a representative sample of the range of millingstones present at Crater Middens.

Further, to preserve the integrity of the site, millingstones and other grinding implements incorporated in the walls of structures were left in situ. They are described to the extent possible and contribute to the totals for grinding implement types to which they belonged. Specimens that could not be confidently assigned to a particular type of millingstone or mano or identified as having been made of a specific kind of stone without substantially disturbing a structure wall were left unclassified in these respects. As with the surface millingstones that were counted but not collected, metric data and material identifications for these specimens are, where appropriate, listed as *not applicable.*

To summarize, data obtained for surface millingstones are exhaustive with regard to the total number of specimens present and only slightly less exhaustive with regard to the total number for each type. Information is somewhat less complete for material than for counts. This attribute, however, is rather stable within the category of millingstones and is important only in the special case of schist millingstones—all of which were retrieved from the surface of all middens owing to this special importance. Accordingly the data obtained provide a reasonable assessment of the millingstone materials.

Graters (7 specimens; 1 granitic, 4 andesite, 2 metamorphic). Graters are distinguished from all other millingstone types by grinding surfaces that are irregular, uneven in contour, and lacking a single plane of wear. The working faces of most specimens exhibit minor ridges and promontories unobliterated by either pecking or grinding. As four of the seven specimens show evidence of having been roughly shaped by pecking along the margins, it would appear that the natural imperfections in the working faces were intentionally left unmodified except by use and may have been sought out when selecting stones to be used for this millingstone type. All seven examples exhibit a single working face. As is evident in table 9.3, with respect to general shape and size, these artifacts do not differ

TABLE 9.1
Distribution of Milling Equipment at Crater Middens

	Midden I			Midden II						Midden III			Midden IV		Midden V		
	St. 3	Surf.	Mid-den	St. 7	St. 9	St. 10	St. 12	Surf.	Mid-den	St. 16	Surf.	Mid-den	Surf.	Mid-den	Surf.	Mid-den	Total
Millingstones																	
Graters								7									7
Basin block								15	1		2	1					19
Flat block								16	2		1						19
Flat slab	3							2	5	2	5	3		1	1		22
Schist	2	1		3	11	3	20	22	67	19	12	7	9	19			195
Miscellaneous		4		1		1		19	40	7	12	12	1	4			101
Manos																	
Convex	1	1						11	20	6	3	10	3	5	2		62
Flat		1		1				4	4	1		3					14
Planoconvex								2			1	1					4
Rude	1	1			1	1		9	28	4	12	12	4	3	1	1	78
Miscellaneous		1					1	20	15	1	3	4	4	1			50
Miniature		1				1		1	2								5
Battered cobbles		2		1	2	1	1	26	33	6	29	15	9		3		128
Pestles								8	1		2		2				13

TABLE 9.2
Subsurface Distribution of Milling Equipment at Crater Middens

	Midden I	Midden II					Midden III						Midden IV					Midden V				
	0–10	0–10	10–20	20–30	30–40	40–50	0–10	10–20	20–30	30–40	40–50	50–60	0–10	10–20	20–30	30–40	40–50	0–10	10–20	20–30	30–40	Total
Millingstone																						
Basin block		1							1													2
Flat block		2																				2
Flat slab		2	3							3							1					9
Schist		31	23	10	3		3	1	1	2			5	6	6	1	1					93
Miscellaneous		9	21	8	2		2	1	6	3				3	1							56
Manos																						
Convex		7	6	5	2		2	2	5	1				1	3	1						35
Flat			1	3					2	1												7
Planoconvex										1												1
Rude		5	14	6	3		2	1	3	5	1				1	1	1				1	44
Miscellaneous		6	4	3	2		1	2	1					1								20
Miniature			2																			2
Battered cobbles		12	11	10			2	4	4	5												48
Pestles					1																	1

TABLE 9.3
Metrical Data for Millingstones from Crater Middens

		Length (cm)	Width (cm)	Thickness (cm)
Graters	$\bar{x}$	33.64	22.06	13.26
	S	8.74	6.48	1.81
	n	7	7	7
	Range	52.0–24.5	33.0–13.0	15.5–10.3
Basin block	$\bar{x}$		31.0	18.4
	S			5.69
	n		2	3
	Range		33.5–28.5	25.0–15.0
Flat block	$\bar{x}$	37.95	28.90	12.19
	S	12.09	7.96	2.53
	n	2	3	7
	Range	46.5–29.4	38.0–23.2	17.7–10.6
Flat slab	$\bar{x}$	46.80	29.15	5.61
	S	3.68	3.75	2.41
	n	2	2	14
	Range	49.4–44.2	31.8–26.5	10.1–2.2
Schist	$\bar{x}$			2.28
	S			0.94
	n			18
	Range			4.7–1.3

in any major way from the flat block millingstones described in a later section.

The grinding wear found on graters is distinctive from that of other millingstones in that the higher promontories are rounded rather than crisply faceted and the shallower depressions are worn rather than unworn. This implies differences between graters and millingstones of other kinds of terms of the hand tools used on them, the manner in which those hand tools were used, and the purposes of that use.

In particular, the configuration of the wear found on graters is unlike that which would result from habitual grinding with a broad, even-faced mano using a steady reciprocal or circular grinding stroke. Used in this manner, such a hand tool would ride across surface promontories in a single, continuous curvilinear or flat plane and leave the characteristic wear facets and unworn depressions found on most millingstones. The rounded promontories and worn depressions found on graters, on the other hand, suggest a less even grinding stroke and a hand tool with an irregular face or narrow working margin that was allowed to follow the uneven grater surface. As described in subsequent sections, the working portions of rude manos (with their irregular grinding faces) and battered cobbles (with their similarly irregular grinding faces and relatively sharp working edges and corners) lend themselves to the working patterns and use-wear observed on graters. It is these tools, rather than the more even-surfaced manos, that were probably used in conjunction with graters.

Given the irregular working portions of graters and those of the rude manos and battered cobbles we believe were employed in conjunction with them, it is inconceivable that they were used in the hulling or mealing of small seeds, which requires two closely matched grinding faces of relatively even contour. Probably graters, rude manos, and battered cobbles were used in the rough threshing of masses of seed-bearing inflorescences or pods and in the pulping of rootstalks. Both are tasks in which a smooth, regular working surface would serve no useful purpose. Indeed, it would be less efficient than an irregular or relatively narrow or pointed (though not jagged or sharp) surface, a form better adapted to work that is coarse and requires more splitting and pulverization than grinding as well as the processing of large, tough, fibrous masses.

As noted below in more detail, rude manos and battered cobbles may have been used to perform these same processing tasks in conjunction with other kinds of millingstones or with bedrock milling slicks, many of which display wear similar to that found on graters. In the former case, the more regular milling surfaces would seem to imply reduced efficiency in the initial stages of processing but may have allowed finer control in the final stages of root processing and, perhaps, threshing. In any event, rude manos and battered cobbles are more common at Crater Middens than would be expected had they been used only with graters—which were relatively rare (table 9.1), and with bedrock milling slicks—at least some of which seem to have been used with more conventional manos.

Basin Block Millingstones (19 specimens; 17 granitic, 2 not applicable). The basin block

millingstones recovered are all fragments, most of them quite small relative to the original from which they derive. That all specimens are granitic is readily explained by the relative ease with which this material is shaped in comparison to andesite and metamorphics, which were more frequently used for millingstones of other kinds. Only three examples are complete enough to permit tentative inferences as to their original size and shape (table 9.3). The largest (O-2081) is remarkable both with respect to size and degree of finish. It represents between a third and a half of a millingstone that in its original state exceeded half a meter in both length and width and was 25 cm thick. The original grinding depression was 8.1 cm deep, more than 31.0 cm long, 23.0 cm wide, and essentially oval in plan and bisigmoidal in both long and short cross sections, that is, approximating the shape of a normal curve in these sections. The entire grinding surface has been worn smooth almost to the point of being polished and the exterior margins of the piece have been trimmed by pecking. This fragment weighs approximately 110 pounds, the complete piece probably close to 250 pounds, and is unlikely to have been broken except by intention. As might be expected given the effort that would be needed to turn this millingstone over, there is no evidence of grinding on the opposite side.

The smallest of the three more complete fragments (O-2056) represents half a millingstone that was essentially oval in outline, tabular in short section, and suboval in long section. It measured 28.5 cm in width, 15.0 cm in thickness, and perhaps 60 cm in length, the fragment being half that long. The grinding surface, which is very smooth, is 18.0 cm wide, 3.5 cm deep, and was originally a little more than 30 cm long. It is convex in both long and short sections. It would appear that this millingstone was made from a rectangular block of granite that was carefully shaped by pecking to round the ends, giving it an oval shape in plan and suboval shape in long section. This left the middle portion essentially unmodified and thus tabular in cross section. As is true of the larger fragment, this piece shows no evidence of grinding on the face opposing the basin surface.

The third relatively complete basin millingstone fragment (O-2057; fig. 9.1) is a roughly dressed granitic slab that is subrectangular in plan view and in both long and short sections. It is 33.5 cm wide, 15.3 cm thick, and was originally about 67 cm long, the portion recovered being half that. The grinding depression is essentially convex in long and short sections and measures 7.5 cm in depth, 28.0 cm in width, and was, when still intact, perhaps 40 cm in length. Like the other two more complete fragments this piece exhibits grinding from use only on its basin surface.

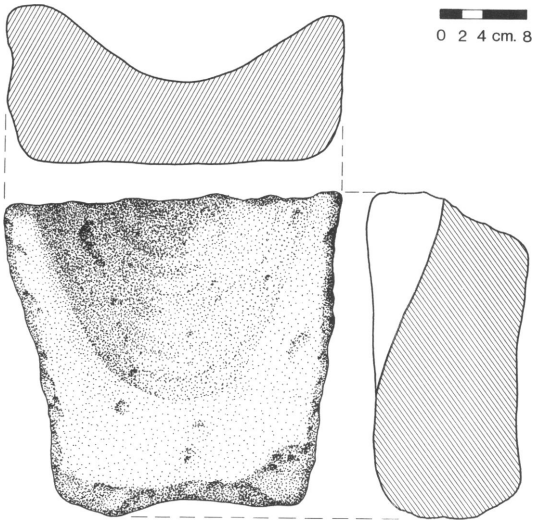

Fig. 9.1. Basin block millingstone (O-2057) from Crater Middens.

Of the remaining fragments very little can be said except to note that evidence of shaping was found on three of the four specimens that were complete enough to judge this characteristic and that in all four cases where a reasonably large portion of the face opposing the basin surface was present, it lacked evidence of grinding. Most of these fragments appeared to derive from millingstones of a size between that of the millingstones that produced the two more complete fragments.

It seems clear that basin millingstones are distinct in function from flat block and flat slab millingstones, but it is unclear precisely what the nature of that distinction is. Certainly, basin millingstones would be less suitable for seed hulling than flat millingstones.

On the other hand, because their concave grinding surfaces tend to concentrate material, rather than dispersing it as flat milling surfaces do, basin millingstones would afford greater efficiency in the milling of material that was tough or highly viscous, that was relatively bulky during the early stage of processing—thus tending to roll, or that contained juices that were in part the object of processing. In this sense, basin millingstones are more akin to mortars than to flat millingstones and the specific materials likely to have been processed in them are the same as those that are more effectively worked by mortar than flat metate: nuts and pits, berries, bone (for meal), meat, and rootstalks. In the special cases of rootstalks and berries, the containment of juices may have been of critical importance as a substantial fraction of the food content of both—sugars in the case of berries, starch in the case of roots—becomes liquid during processing. In addition, a recommended form of cattail root processing suggests that the roots be mashed, stirred, and allowed to stand overnight in water, and then decanted to recover the starch, which can then be dried and used as dough (Olsen, 1973: 53). Basin millingstones would be quite suitable for this purpose; flat millingstones would not.

Two circumstantial lines of evidence lend support to the argument that roots were among the more important items processed with basin millingstones. First, among the three sites considered in this volume, basin millingstones occur only at Crater Middens, which of the three provides the best access to riparian habitats along Owens River, where root-bearing plants are relatively common. Second, graters, battered cobbles, and rude manos (see below) all of which are thought to have been used in root processing, are also abundant only at Crater Middens. Only a few battered cobbles and no graters or rude manos were found at Two Eagles and all three are entirely absent at Pinyon House. To this might be added that both basin millingstones and battered cobbles are well represented at recently excavated village sites in the Alpine Tundra community of the White Mountains, a zone in which seed resources are exceedingly sparse and root resources relatively common, although berries are likewise common and were probably also procured and processed. The role of root procurement in the economy of Crater Middens is considered in subsequent summary chapters pertaining to this site and synthetic interpretation of all three sites in larger regional context.

The remaining point of interest is why, given the obvious effort and technical skill exhibited in the manufacture and the importance given them by the inhabitants of the site as inferred from this, there are so few basin millingstones, all fragmentary (table 9.1). At least four different explanations can be offered.

First, looting of the site by relic collectors—of which there is some evidence—no doubt extended to the removal of the more complete specimens, which are highly prized as bird baths and hearth pieces. Second, that the ones found are all fragmentary and that some of these fragments derive from millingstones that scarcely can have been broken by accident suggests that basin millingstones—and, as noted below, other kinds of grinding implements including flat millingstones and manos—were deliberately "killed," probably upon the deaths of their owners. These fragments may have been intentionally scattered in locations where they are hard to find, the cobble-choked arroyo channel next to the site, for example. Third, many of the fragments were incorporated in structure walls where they are, again, difficult to locate. This use might merely represent a shortage of suitable cobbles at the site. Nevertheless, the ritual burning of dwellings—and presumably the construction of replacements—was a practice observed ethnographically by the Owens Valley Paiute, so the possibility that these "killed" millingstone fragments were purposely incorporated in structures built to replace those ritually destroyed cannot be excluded. Finally, the more complete basin millingstones may have been removed from Crater Middens by its occupants when they evidently abandoned the site in favor of a location closer to the modern town of Big Pine. As noted in the description of the site this move may have responded to a disruption of the local water supply occasioned by the 1872 earthquake. Alternatively, the inhabitants may have simply moved to be in closer proximity to the town of Big Pine and the opportunities

of employment, gleaning, and scavenging offered by the town and nearby ranches. Either way, it was only a short move and it seems unlikely that an item so valuable as a basin millingstone would have been abandoned when its transport would have been relatively simple.

Flat Block Millingstones (19 specimens; 11 granitic, 3 andesite, 2 metamorphic, 1 volcanic, 1 unidentified, 1 not applicable). Of the 19 flat block millingstones found at Crater Middens (tables 9.1, 9.2), only 8, 2 of them complete, were collected for analysis (table 9.3); 10 others were incorporated as building material in the walls of structures and one more occurred on the surface of Midden IV, from which millingstones were counted and typed but not collected.

Among the seven analyzed specimens that were complete enough to ascertain the number of grinding faces present, five are unifacial and two are bifacial. Shaping in the form of marginal percussion trimming or pecking is evident on three of the five pieces that were sufficiently intact for this characteristic to be judged. In one specimen (O-2082), this percussion trimming produces a steep undercut that would have permitted placement of a flat tray, one of basketry for example, directly beneath the edge of the grinding surface, where it would serve to catch meal intentionally swept or accidentally spilled from the working face. Two other examples (O-2169, O-1910) exhibit similar undercuts, evidently natural, that might have been used in the same way.

In general, the grinding wear on these millingstones is less advanced than that which characterizes basin block, flat slab, and schist millingstones. In only one instance (O-2058) is the working face entirely smoothed from use, this same specimen being the only one that exhibits pecking on the working surface, presumably to rejuvenate it. The remaining pieces display more isolated wear, most notably as well-defined, highly polished facets.

Flat Slab Millingstones (22 specimens; 12 granitic; 2 andesite, 2 metamorphic, 1 sandstone, 1 unidentified, 4 not applicable). Flat slab millingstones are only slightly more common at Crater Middens than flat block millingstones (tables 9.1, 9.2), but as only two were used as building material and only four were found on the surfaces of middens where millingstones were counted but not collected, the sample retrieved for analysis is substantially larger (table 9.3). There are 16 specimens, including 2 that are complete. Of the 14 specimens for which the number of grinding faces could be determined, 13 are unifacial and 1 is bifacial. That bifacial specimens are so rare and unifacial specimens are so common is apparently an intended element of design, not a reflection of casual use, because most specimens exhibit well-worn grinding surfaces or evidence of shaping other than by use. In seven intances the grinding surface has become completely smoothed by wear; three of these have been pecked, probably to roughen the milling surface, thereby increasing its efficiency in grinding. Marginal percussion trimming and pecking is present on 8 of the 11 pieces that could be judged for the presence of this attribute.

The two complete flat slab millingstones, both shaped unifacial specimens, were found cached with a mano in Structure 16. One (O-3885) is 44.2 cm long, 26.5 cm wide, 8.7 cm thick, and exhibits a well-worn grinding surface that has become moderately concave through prolonged use, measuring 27.0 cm long, 23.0 cm wide, and 0.9 cm deep. The other (O-3884) is 49.4 cm long, 31.8 cm wide, and 10.1 cm in maximum thickness, though is is throughout most of its length less than 10.0 cm thick and was on this basis classified as a slab rather than block millingstone. The grinding surface of this specimen measures 41.0 cm long and 26.0 cm wide and is (like that of its mate) well used but (unlike it) entirely flat.

Schist Millingstones (195 specimens; all micaceous schist). Schist millingstones are among the most common items of groundstone found at Crater Middens (tables 9.1, 9.2). All except four found in structure walls were collected. As in the case of vesicular basalt manos, their superiority in numbers to millingstones of other kinds is in part an artifact of the material of which they are made, which is at once highly visible and not local to the site, making them easier to recognize than millingstones made of other materials. At the same time, schist is more prone to break than other materials used for millingstones and as a consequence schist milling-

stones are more fragmented than those of other materials. The effects of these properties are readily evident in the sample from Crater Middens. Out of 195 individual fragments, only about one-third exceed 4.0 cm in length and of these the largest is only 18.0 cm long. Under these circumstances it is difficult to make quantitative comparisons between schist millingstones and other kinds. Perhaps the most that can be said is that schist millingstones appear to have been used as frequently as other types—probably more frequently.

Schist millingstones are distinctive in both shape and size. There are no complete specimens but the larger fragments indicate that most were rectangular to subrectangular, tabular in both long and short cross-sections, and exceptionally thin. The mean for the 18 specimens that could be measured is 2.28 cm (table 9.3). All 23 pieces that were complete enough to disclose evidence of intentional shaping have been smoothed, pecked, or percussion trimmed along one or more margins. In combination, these attributes suggest that these millingstones were carefully manufactured from thin slabs of micaceous schist probably obtained from the Inyo Mountains, where metamorphic outcrops are more common than in the Sierra Nevada. The surface survey of the Big Pine transect located one large outcrop of micaceous schist suitable for use as millingstones at the edge of Papoose Flat, in the Inyo Mountain uplands about 20 km southeast of Crater Middens. This may or may not be the source for the schist millingstones at Crater Middens.

The working surfaces on the larger specimens in the collection are uniformly well worn, exceptionally smooth, and either essentially flat (26 examples) or moderately concave (29 examples). Most of these surfaces appear to have been pecked, presumably to increase their efficiency in grinding. Among the 36 specimens for which the number of grinding faces could be ascertained, 24 (66%) are bifacial; of these, 4 are flat on both sides, 1 is concave on both sides, 12 are flat on one side and concave on the other, 1 is flat on one side and of undetermined configuration on the other, and 6 are of undetermined configuration on either side. There are 12 unifacial specimens, on which the working face was in 1 case flat, 8 cases concave, and in 3 cases of undetermined configuration. Finally, of the 11 specimens that exhibited grinding on one face but lacked an intact surface on the opposing face and thus could not be classified as either bifacial or unifacial, 4 displayed flat faces and 7 displayed concave faces.

It is uncertain whether the difference between flat and concave working faces is one of function or duration of use. The latter, however, seems the more likely given that the stone is relatively soft, the specimens tend to grade in degree of concavity, and even the deepest examples are much more shallow than basin millingstones.

As flat millingstones of other kinds are less prone to breakage and sufficiently portable to be readily moved from spot to spot within a site and occasionally transported from site to site in residential moves, it must be presumed that schist millingstones served a more specialized purpose. Most likely they were routinely carried on short expeditions to locations that were not repeatedly revisited and thus could not be equipped in advance with caches of milling equipment. Being light, they are well suited for such use. In addition, at least one specimen (O-2171) bears an abraded groove that would facilitate attachment of a cord by which it might have been carried; several others exhibit incipient notches made by percussion, evidently for the same purpose (fig. 9.2).

If this interpretation is accepted—and there is little to refute it, at least in a general sense—then the presence of schist millingstones at Crater Middens but not Pinyon House and Two Eagles is the result of functional differences between these sites not directly related to plant procurement and processing.

Evidently designed to be carried rather than cached, schist millingstones would only rarely be found where they were used. Rather, they are most likely to be found where they were discarded after ritual destruction or abortive attempts at rejuvenation, after storage during seasons in which they were not needed—at winter camps, or where when excessively worn, they were set aside against the possibility of future need when replacements might not be readily at hand. Thus, it cannot be concluded that because schist mill-

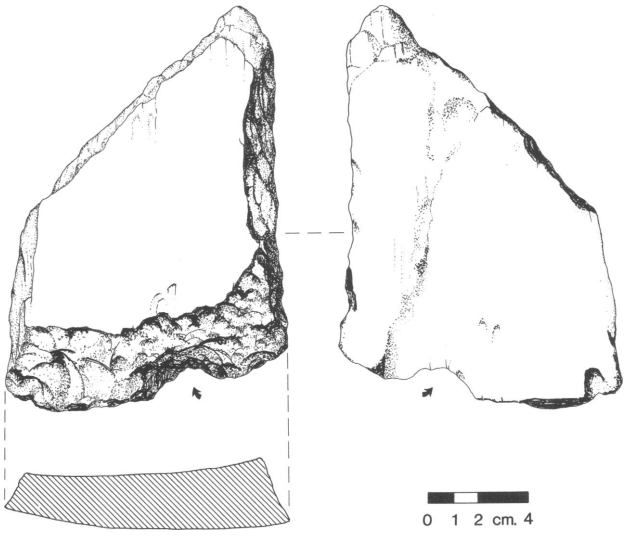

Fig. 9.2. Notched schist millingstone fragment (O-2217) from Crater Middens.

ingstones were not found at Pinyon House or Two Eagles they were not used there; to the contrary, given the range of plant procurement and processing activities inferred for those sites, they very likely were. Their absence, however, indicates that these sites were used more for resource procurement than was Crater Middens, which in addition to its role in resource procurement served as a strategic base for resource storage, social activities, and raw material acquisition—in short, a nucleus for the aboriginal subsistence-settlement system as a whole.

Two other points are worthy of note in regard to this millingstone type. Firstly, the vertical and horizontal distribution of schist millingstones at Crater Middens tends to place them late in time (tables 9.1, 9.2); they are conspicuously rare in the buried deposit of Midden III, which represents the earlier occupation of the site, and substantially more common in the upper 20 cm of Midden II and throughout the deposit of Midden IV, both of which represent later occupation. The appearance of these distinctive grinding tools at Crater Middens might be accounted for as the result of either: (1) a shift in relations of trade that made them or the material of which they are made more readily available, or (2) a change in exploitative patterns that placed greater emphasis on short-term plant procurement stations which, because they were too numerous or too infrequently reoccupied, could not be individually stocked with milling equipment. These alternatives and their implications are explored more fully in the concluding chapters of this volume.

The second point is that despite the impression given in the general literature (Riddell and Riddell, 1956: 31), micaceous schist millingstones are not common in the Inyo-Mono region. Meighan (1955), Enfield and Enfield (1964), and E. Davis (1964) fail to report any examples from Mono County, perhaps because volcanics and not metamorphics dominate the geology of that region. Even so, micaceous schist millingstones seem only slightly more common at the southern end of the region, where the necessary raw material is more readily available. Iny-2, the late prehistoric village site of Cottonwood Creek, yielded none at all (Riddell, 1951) and there are only 4 micaceous schist specimens among the 120 whole and fragmentary millingstones from the Stahl site at Little Lake (Harrington, 1957: 42). They are present at the Rose Spring site, but Lanning (1963: 247), fails to specifiy in what number. Hunt (1960) is similarly unforthcoming in regard to the abundance of micaceous schist millingstones in Death Valley, but they are evidently rare and tend to occur primarily in

late prehistoric contexts (Hunt, 1960: 246). Other than this, there is no mention of such specimens by Wallace and Taylor (1955), and Meighan (1953) for Death Valley, by Hillebrand (1974) or Panlaqui (1974) for the Coso area, or by Wilke (1983) for the Owens Lake area. It seems clear then that intuitive impressions to the contrary, micaceous schist millingstones are of relatively limited distribution in this part of eastern California. If they are indeed as common in Owens Valley proper as Riddell and Riddell (1956) aver, their distribution might well be a reflection of the centralized settlement systems thought to have characterized this particular area in late prehistoric times (Bettinger, 1978a; Steward, 1933).

Unclassified Millingstones (101 specimens; 33 granitic, 20 andesite, 1 metasediment, 5 basalt, 1 vesicular basalt, 15 metamorphic, 1 volcanic, 3 quartzite, 4 unidentified, 18 not applicable). Among the 101 millingstones (tables 9.1, 9.2) that could not be typed were 73 fragments recovered in controlled surface collections or in excavation, 19 specimens found and left in situ in structure walls, and 9 specimens counted but not collected from the surfaces of Middens I and III. Very little data can be provided for any of these. Of those collected for analysis, the number of grinding faces present could be determined for only 10, of which 9 were unifacial and 1 bifacial. Similarly, in this same group only 13 specimens could be judged for the presence of intentional shaping, 11 of which showed some form of marginal trimming by pecking or percussion flaking. All nine of the millingstones counted but not collected from the surfaces of Middens I and III exhibited flat working surfaces but none can be reliably identified as being of block or slab form. No data can be provided for the unclassified millingstones used as building material in structure walls, the bulk of which could not be readily moved for observation.

MANOS: A total of 213 whole and fragmentary manos was found (tables 9.1, 9.2, 9.4). Of these, 158 are sufficiently complete to be classified into one of the four mano types recognized here: convex (figs. 9.3a, c, d, 9.4a, c), flat (fig. 9.3b), planoconvex, and rude. Among the remainder are five specimens that resemble the recognized mano types in shape but are diminutive in size and, to judge from this, clearly distinct from them in function; for want of a better term these were designated *miniature manos* (fig. 9.4b). The balance of the collection consists of small fragments that could not be confidently attributed to any particular mano type or that were incorporated in structure walls and accordingly were not collected.

All types of manos occasionally exhibit a hard, greasy deposit on one face—in the case of at least one unifacial example, on the side opposite the working surface. It is possible that this is hand soil or the residue of processing but without a definitive test to establish its composition might as easily be a natural encrustation. The stain is difficult to recognize in the field and in any case we were at first not aware of its presence and made no attempt to ascertain whether the stained surfaces consistently faced up or down when in situ. The explanation that it resulted from contact with plant material is difficult to reconcile with the notion that the primary function of manos is to grind, which would seem to preclude formation of any coating or film on the working surface.

Convex Manos (62 specimens; 38 granitic, 3 andesite, 9 vesicular basalt, 2 basalt, 6 sandstone, 3 metamorphic, 1 limestone). Convex manos, which are characterized by grinding surfaces that extend onto the leading and trailing edges of the tool but not the lateral edges at opposite ends of the axis perpendicular to the direction of the working stroke, are well represented at Crater Middens. They are the second most common type found at the site and account for the majority of the manos intentionally shaped. Most of them (61%) are made of granitic stone, which is readily available as stream rounded cobbles in the dry arroyo directly adjacent to the site. This does not preclude the possibility that some of them were imported, as similar cobbles are to be found in every channel and wash along the entire eastern Sierra Nevada front. Vesicular basalt, which accounts for roughly 15 percent of these manos, was almost certainly obtained from the lava fields of Crater Mountain less than 300 m due south of the site. The source of material for the six sandstone and one limestone manos is unknown, but limestone outcrops are common

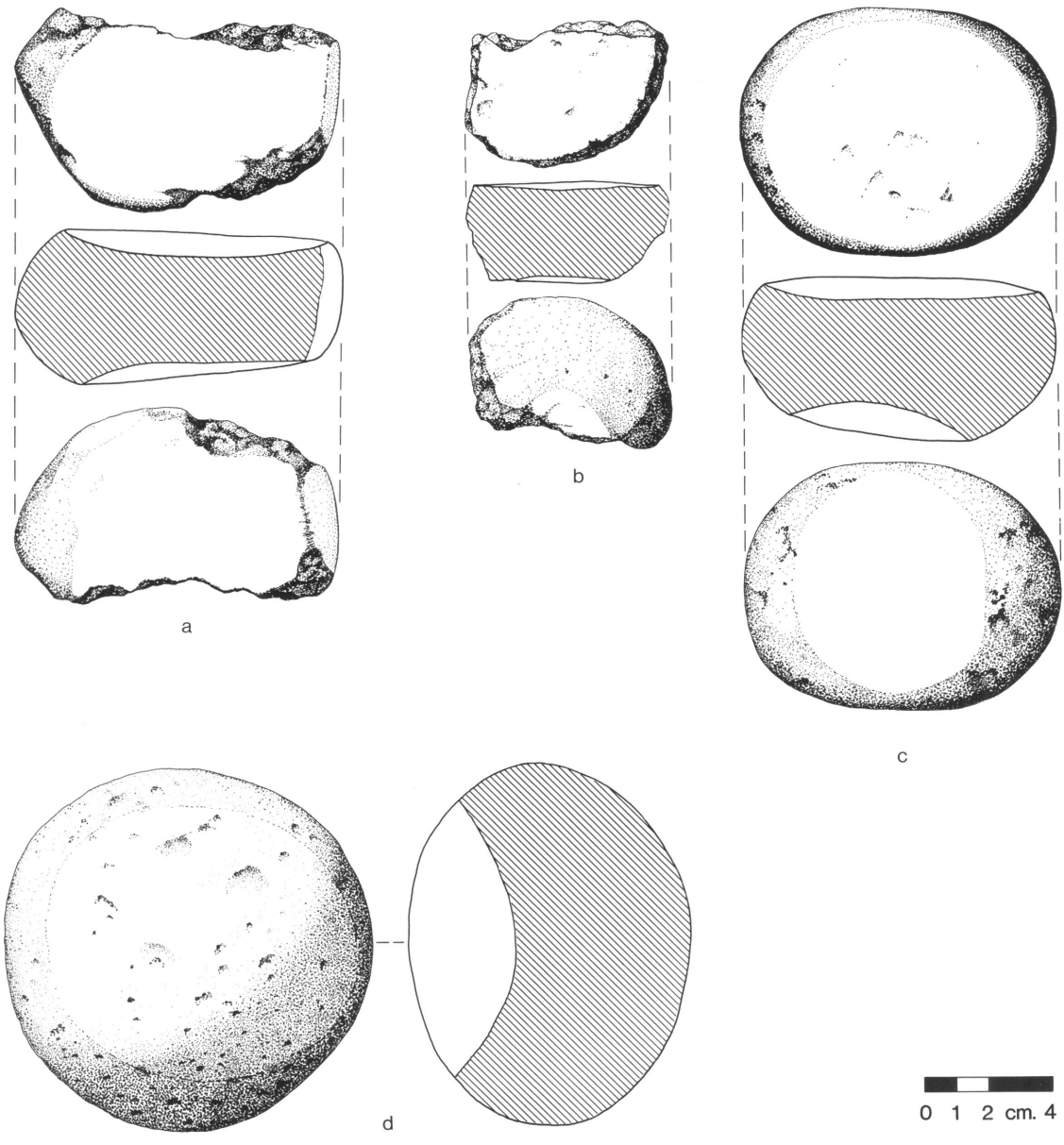

Fig. 9.3. Manos from Crater Middens. **a, c, d.** convex manos; **b.** flat mano. a. O-584; b. O-585; c. O-2698; d. O-2697.

in the White Mountains east of the site and one of them in all probability furnished the stone for the one specimen in the Crater Middens collection. Local stream cobbles were probably used for the examples made of andesite.

Most of these manos are oval in plan, but there is substantial variation in this regard and a few are subrectangular. The bulk of their working surfaces are planar in the section perpendicular to the working stroke, which suggests use on an essentially flat mill-

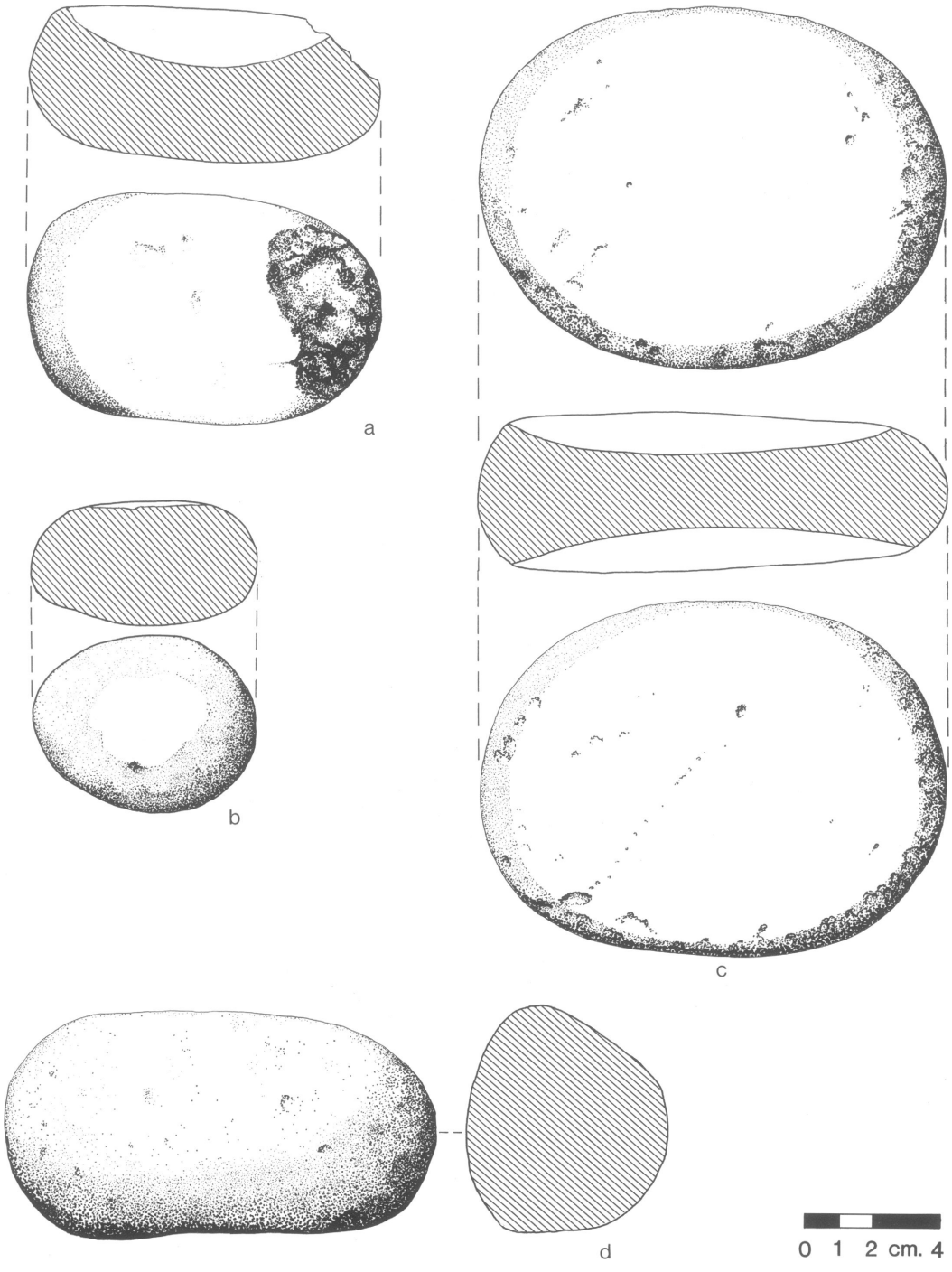

Fig. 9.4. Manos and pestle from Crater Middens. **a.** convex mano with battered end suggesting secondary use as pestle (O-3444); **b.** miniature mano (O-2411); **c.** convex mano (O-3991); **d.** pestle (O-2207).

ing surface. A few, however, are convex along this section, whch suggests use on a basin-shaped—rather than flat—millingstone.

Of the 49 specimens that retain both faces in whole or part, 32 (65%) are bifacial, exhibiting working surfaces on both faces, and 17 (35%) are unifacial. The other 13 are too fragmentary for this attribute to be evaluated. Most of the bifacial specimens are essentially tabular or lenticular in cross section (i.e., parallel to the working stroke) but a few are wedge- or teardrop-shaped in this respect.

Out of 58 specimens that could be judged for the presence of modification other than by use, 35 (60%) exhibited evidence of intentional shaping, in each case by pecking along the edges of the tool. Some of this modification, however, may be the result of use as a pestle or hammerstone (e.g., fig. 9.4a). No examples of central pitting on the working surface were noted. It is possible that some of these manos were rejuvenated or made ready for initial use by pecking the working surface but as they are uniformly well-worn, this could not be determined.

Flat Manos (14 specimens; 7 granitic, 4 vesicular basalt, 1 sandstone, 1 metasediment, 1 metamorphic). Flat manos, those on which the working surface is planar and does not anywhere extend onto the edges of the tool, constitute only 9 percent of the typable manos found at Crater Middens. At the same time, they account for 19 percent of the intentionally shaped manos, which suggests they may have been more important than their number would indicate. With respect to the range and proportion of materials represented, these flat manos conform to the distribution noted for convex manos.

Out of 13 specimens that could be judged for the presence of grinding on both faces, 5 (38%) were bifacial, which is substantially lower than was noted for convex manos (65%), possibly owing to functional differences between these two types. On the other hand, of the 11 flat manos that were complete enough to be evaluated for intentional shaping, 10 (91%) exhibited edges shaped by pecking, a proportion much greater than is noted for convex manos (60%), again possibly owing to functional differences between these categories.

This sample is quite small, but it is evident that in comparison to convex manos, flat manos are shorter, wider, and thinner, which is to say lighter and less elongate than convex manos (table 9.4). The difference in morphology is entirely consistent with the inferred use of these two mano types. Convex manos were presumably employed for mealing with a back-and-forth milling stroke, which would seem to demand a heavy stone with a long transverse axis; flat manos, on the other hand, were probably used for seed hulling with a circular grinding stoke, which would demand a stone that was relatively

TABLE 9.4
Metrical Data for Manos, Battered Cobbles, and Pestles from Crater Middens

		Length (cm)	Width (cm)	Thickness (cm)
Manos				
Convex	$\bar{x}$	11.01	8.61	5.16
	S	1.84	1.57	1.29
	n	17	19	32
	Range	14.6–7.1	11.1–5.5	8.8–3.2
Flat	$\bar{x}$	9.70	9.18	3.96
	S	1.87	1.84	1.38
	n	2	4	9
	Range	10.8–8.6	11.3–6.9	6.9–1.9
Plano-convex	$\bar{x}$	12.9	11.0	4.90
	S			1.70
	n	1	1	2
	Range			6.1–3.7
Rude	$\bar{x}$	11.89	9.16	5.70
	S	2.66	2.85	2.01
	n	60	62	64
	Range	27.0–6.5	17.8–5.1	10.2–1.3
Miniature	$\bar{x}$	5.25	4.18	2.78
	S	0.84	0.64	0.84
	n	4	4	4
	Range	6.5–4.7	5.1–3.7	3.6–2.0
Battered cobbles	$\bar{x}^a$	10.78	8.33	5.84
	S^b	2.95	2.61	2.02
	n^c	112	112	113
	Range[d]	18.9–5.5	18.6–3.4	12.3–2.3
Pestles	$\bar{x}$	21.52	13.33	9.18
	S	5.66	3.12	2.17
	n	10	10	12
	Range	29.0–12.6	16.4–6.5	12.4–5.9

[a] Number of edges, 2.79; number of faces, 1.65.
[b] Number of edges, 1.59; number of faces, 1.05.
[c] Number of specimens furnishing edge and face counts.
[d] Number of edges, 8-1; number of faces 5-0.

light, in order not to crush the kernels, and lacked a pronounced linear bias, which would interfere with the circular grinding motion.

Planoconvex Manos (4 specimens; 3 granitic, 1 vesicular basalt). Planoconvex manos, which are by definition bifacial with one convex working surface and an opposing flat working surface, are scarce in the Crater Middens collection, constituting but 2 percent of the manos recovered. Given the differences in sample size, they do not differ appreciably from either convex or flat manos in terms of raw material. All four were intentionally shaped by pecking along the edges. Two of the four specimens were too fragmentary to be measured at all and a third (O-643) yielded measurement only of thickness: 3.7 cm. The remaining example (O-2066), made of granitic stone, is complete and measures 12.9 cm long, 11.0 cm wide, and 6.1 cm thick.

The joint presence of convex and flat working faces on planoconvex manos suggests a composite function, the flat surfaces for hulling, the convex surfaces for mealing. It may be of significance in this regard that the one complete piece in the collection resembles convex manos in its size and flat manos in its lack of a pronounced linear bias (table 9.4). The ubiquitous shaping noted for this mano type is perhaps attributable to the presence of the flat working face and the special requirements of seed hulling since it has previously been noted that shaping is nearly always present on flat manos (91%). All the same, it seems equally possible that such careful manufacture is a reflection that planoconvex manos, though numerically unimportant to the normal routine of aboriginal activity, might have served a critical purpose in circumstances that precluded the use of two different manos for mealing and hulling, on long trips for instance.

Rude Manos (78 specimens; 43 granitic, 2 vesicular basalt, 3 basalt, 2 quartzite, 12 andesite, 3 metasediment, 3 metamorphic, 1 chert, 2 schist, 2 gneiss, 5 metagranitic). A total of 78 cobbles that exhibit incipient grinding insufficient to disrupt the natural contour of the faces on which it occurs were classified as rude manos. As summarized below, these tools do not differ appreciably from convex manos in their principal dimensions. They are, however, more variable in size owing in part to a few very large pieces (table 9.4).

Rude manos differ substantially from the other mano types in material, preparation and shaping, and degree of use. Most (55%) are made of granitic stone that was very likely obtained in the arroyo at the edge of the site. The same source probably furnished the material for those made of andesite (15%), quartzite (3%), metamorphics (4%), metagranitics (6%), and metasediments (4%). The pieces made of basalt (4%), vesicular basalt (3%), chert (1%), gneiss (3%), and schist (3%) may have been obtained in raw form from more distant locations, but the source of the basalt is almost certainly the lava fields of Crater Mountain no more than 300 m to the south; indeed, this material might easily have been obtained from the arroyo channel itself where it occasionally occurs, albeit in poorer quality. The chert and schist examples may have been recycled from exhausted tools or rejected blanks rather than imported to the site in raw form.

For a sample so large, sandstone, which was employed for both reciprocal and flat manos, is conspicuously absent and vesicular basalt substantially less well represented than in the other mano types. This, along with the presence in some number of materials that were evidently avoided as unsuitable for use in other manos types—quartzite, schist, gneiss, and chert—suggests that rude manos were employed for tasks other than routine seed hulling and mealing. The lack of consistent form and uneven grinding surfaces, both dictated by the vagaries of cobble shape, is further evidence in this regard: the irregular working faces preclude effective use in either seed hulling or mealing.

There is little evidence of any attempt to correct these deficiencies. Of 72 specimens that were complete enough to disclose evidence of shaping, only 5 (7%) showed edge modification by pecking and none showed pecking on the working faces, all of which lack sufficient wear to obscure such preparation. Added to this, the grinding wear noted on rude manos is less even and the wear facets more rounded than on convex or flat manos. On both of the latter the plane of wear, whether linear or curvilinear, is both uniform and continuous across the entire working face and

the wear facets are flatter and more distinct as the result of contact with a correspondingly even milling surface. Further, rude manos are more frequently complete than manos of other types, 77 percent being sufficiently intact to be measured for all basic dimensions.

Despite all of the above, which seems to imply casual use, rude manos are the most common type at Crater Middens and the collection gives at least some indication that they were saved and reused; of 68 specimens retaining enough of both faces to evaluate the presence of wear on each, 32 (47%) were bifacial. On this basis it would seem inappropriate to regard distinctions between rude manos and those of other types as resulting merely from duration of use. Of course a few rude manos are, no doubt, simply convex manos in the earliest stages of use—perhaps discards that proved unsuitable as tools. For the vast majority, however, the shape and working surfaces suggest use in rough pulverizing and crushing that would have disfigured the working surfaces of the more formal mano types or that could not be done as efficiently with them. The threshing of seed heads and the mashing of rootstalks are two likely possibilities. Both were probably routine tasks at Crater Middens and neither could have as effectively been performed with convex or flat manos. Bone mealing, and sinew and fiber separation—and perhaps many other tasks akin to these—are alternative possibilities. With the possible exception of bone mealing, however, these tasks are unlikely to have been of sufficient importance to explain the large numbers of rude manos found and were probably secondary applications for these tools.

It is worth noting that owing to their inferred function, rude manos may occur in numbers that exaggerate their importance in the milling assemblage. With advanced wear, the serviceability of these tools in rough grinding and pulverizing diminishes significantly. This might cause them to be discarded more quickly than either convex or flat manos, where well-worn surfaces, if kept slightly roughened, are desirable. A relatively short lifespan for rude manos might explain why so few are broken, why so many are present at the site, and why local—as opposed to exotic—materials were selected for use.

If it is accepted that rude manos are distinct in function from convex, flat, and planoconvex manos, being of service primarily in rough grinding, threshing, and pulverizing, and to that end being intentionally less regular with respect to working surface, it follows that the milling surface with which they would work most efficiently would be of similar kind, that is, rough and irregular rather than smooth and even. Two kinds of milling surfaces present at Crater Middens fit this description: bedrock milling slicks—many of which exhibit poorly developed grinding wear similar in configuration to that observed on rude manos, and graters—which resemble more formal basin and flat millingstones in shape but exhibit the same irregular grinding surfaces that characterize rude manos. Rude manos, graters, and rough bedrock milling slicks, then, may constitute a plant processing assemblage distinct in function from that represented by convex, flat, and planoconvex manos and flat and basin millingstones, which served primarily in seed hulling and mealing. By contrast, the assemblage that included rude manos was probably employed in heavier, rougher plant processing, most likely preparing roots and threshing large masses of plant stalks with seed-bearing inflorescences, perhaps as a first step in a long sequence of processing. It is likely that the category of battered cobbles, described subsequently, was also employed in this early processing stage and should be considered part of this rough plant processing assemblage. It is worth noting here that both rude manos and battered cobbles could have been used for pulping and threshing in conjunction with either flat or basin millingstones or the smoother bedrock milling slicks though not as effectively as with graters and rough bedrock milling slicks. That such use did occur is suggested by the larger numbers of these tools relative to the numbers of graters and rough bedrock milling slicks at the site.

Miniature Manos (5 specimens; 3 granitic, 2 metasedimentary). As noted at the outset, miniature manos resemble other manos in shape but are much smaller. The largest (O-2411) is 6.5 cm long (fig. 9.4b), the smallest (O-1841) 4.8 cm long. Summary metrical data for all five are furnished in table 9.4.

Three of the four (75%) that could be judged

for the presence of grinding on both faces are bifacial. None exhibited any attempt at edge modification but one specimen (O-2184) appears to have been used as a hammerstone. In no case is grinding wear advanced and in some instances it is barely perceptible. Despite their formal similarity to other mano types, the size of these artifacts precludes use in seed processing and the most likely explanation is that they were used to smooth ceramic vessels, or as child's toys, or paint grinders, though none retains any trace of pigment.

Unclassified Mano Fragments (50 specimens; 16 granitic, 21 vesicular basalt, 7 andesite, 1 metamorphic, 1 unidentified, 4 not applicable). The collection of 50 unclassified manos includes 40 specimens that were too fragmentary to be assigned to any particular type and 10 specimens that were counted but left in situ in the walls of structures and for this reason cannot be typed even though descriptive data regarding material and number of grinding faces were obtained for some.

The group of fragments is remarkable with regard to both material and degree of finish. Half (50%) are vesicular basalt, a fraction much greater than that characterizing the typable specimens collectively or by individual type. In addition, all 5 of the fragments that were complete enough to ascertain the number of grinding faces were bifacial and all 12 that could be judged for intentional shaping exhibited edges modified by pecking. The frequency of basalt in this residual collection is hard to explain because this material is no more likely to break—and perhaps less likely—than other materials favored for manos. The frequency of bifacial and shaped specimens is equally difficult to explain as these tools might reasonably have been expected to be more carefully attended to and less frequently subjected to hard use than less formal manos. It is possible that this pattern of breakage is the result of the ritual "killing" of possessions belonging to a person recently deceased, particularly if the more favored items of personal gear featured prominently in such rituals. In more general terms, ritual killing may explain why complete manos of nearly all kinds are so rare at Crater Middens. As previously noted, it is almost certainly the cause for many of the broken millingstones at the site.

With respect to the 10 specimens counted in the walls of structures or features, very little can be said except that among the cases where the number of grinding faces was recorded there is an unusually high frequency of bifacial specimens (80%). It seems likely, however, that this is an artifact of the ease with which bifacial specimens are recognized, less well-worn unifacial pieces being more readily overlooked in coarse wall rubble.

OTHER MILLING EQUIPMENT: *Battered Cobbles* (128 specimens; 82 andesite, 20 metamorphic, 15 quartzite, 4 granitic, 3 basalt, 3 chert, 1 volcanic). Battered cobbles are readily identified by the presence of at least one steep working edge or corner, generally prepared by percussion flaking and almost invariably exhibiting severe use-wear in the form of battering, crushing, abrasion, or polish, and, normally, at least one working face, which is generally rough and irregular rather than smooth, but nevertheless exhibits evidence of use in grinding (table 9.4). These grinding faces vary in configuration from convex to concave and may display glossy polish and linear scratches or striations in addition to the more common grinding wear, which takes the form of use-rounded prominences and smoothed depressions similar to those found on rude manos (fig. 9.5). The steep working edges and grinding faces sometimes occur separately, but in many instances they are joined and there is evidence of continuous use-wear, generally striations and polish, between them. These indicate a working stroke in which the tool was initially held so that only the steep working edge was in contact with the material being processed and that as the stroke progressed the trailing margin of the tool was lowered, thus bringing the grinding face to bear on the same material through which the working edge of the tool had just passed. Where they occur in such juxtaposition, therefore, these edges and faces indicate a mode of processing that combined planing, scraping, or shaving with grinding or pulping. Isolated edges and faces, on the other hand, indicate the same set of activities done individually rather than in the same motion.

The polish frequently found on these tools is almost certainly the result of plant processing. As previously argued in reference to the similar working surfaces that typify rude manos, however, it is inconceivable that the grinding faces of battered cobbles were used in the hulling and mealing of small seeds. The pulping and grinding of roots, the heavy threshing of seed-bearing inflorescences and pods, and perhaps the mashing of berries, bone, and meat are more suited to the rough configurations of these working faces. With all these materials, planing, shaving, scraping, or simply chopping with a narrow, blunt edge would seem a likely first step of processing, which would explain the percussion-flaked edges and corners of these tools.

The rounded wear facets and gouged striations found on many specmens make it clear that battered cobbles were at least occasionally used on milling surfaces that were as rough and irregular as their own grinding faces. As noted earlier, the graters and rougher bedrock milling slicks found at Crater Middens fit this description and were likely used exclusively in conjunction with battered cobbles and rude manos. At the same time, smooth edges and faces found on some battered cobbles suggest use on flat or basin millingstones, perhaps in the final stages of root processing or threshing where a more even milling surface was required.

In addition to those resulting from use on rough surfaces, at least some of the striations found on the edges and faces of these battered cobbles were probably caused by small fragments of stone detached from the working edges and faces of these tools and perhaps the milling implements with which they were used. Evidently, the raw material from which these tools were made was deliberately selected to minimize such attrition, there being a marked preference for tough, fine-grained materials including andesite, quartzite, chert, and metamorphics. Given the functional link inferred between battered cobbles on the one hand and rude manos and graters on the other, it is not surprising that the latter two are similarly distinguished by preference for these same materials.

Apart from the careful selection of raw materials, battered cobbles show evidence of extensive use and curation in the characteristic presence of multiple working edges and faces (table 9.4). This, in combination with the numbers in which they occur, suggests the basic importance of processing tasks that took place at Crater Middens. Their distribution between middens and within buried deposits tends further to suggest that this importance persisted for nearly the entire period during which the site was occupied (tables 9.1, 9.2). Battered cobbles are, however, lacking in the buried deposit of Midden IV, which is relatively recent. If it is not an artifact of sam-

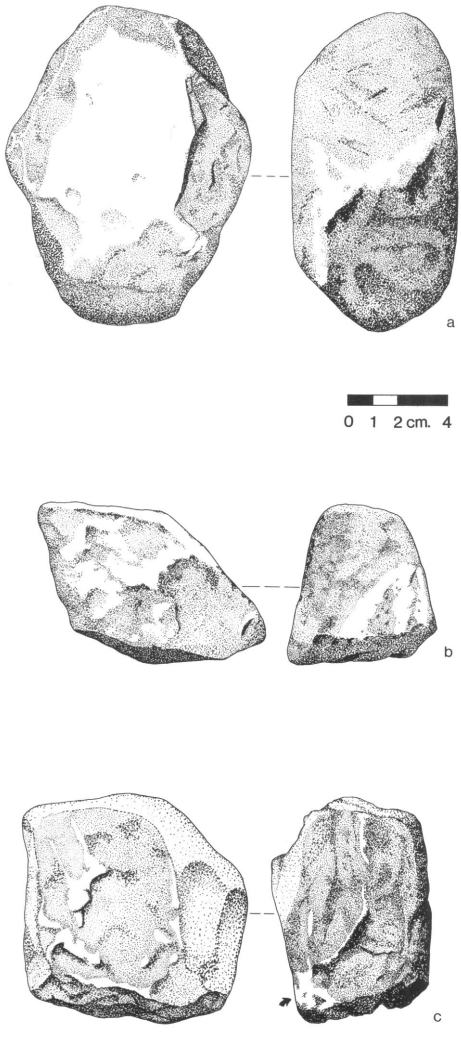

Fig. 9.5. Battered cobbles from Crater Middens. a. O-4232; b. O-1915; c. O-2206.

pling error, this may indicate diminished use of such tools toward the end of occupation of Crater Middens.

Artifacts similar to these battered cobbles were relatively abundant at the Stahl site, Little Lake, where Harrington (1957: 47–49) took them to be hammerstones for percussion flaking (cf. thin-edged, thick disc, and reused scrapers; Harrington, 1957: 48). The materials out of which those specimens were made, however—chert, quartz, granite, basalt—are too hard for percussion work. The description of these hammerstones provided by Harrington (1957) matches that of the battered cobbles from Crater Middens with respect to the presence of heavily worn, percussion-flaked edges, but not with respect to evidence of grinding, of which there is no mention. As this attribute is not pronounced on many of the specimens from Crater Middens it is possible that it was present on the Little Lake specimens but went unrecognized. In any case, it seems likely that at least some of the Little Lake hammerstones are what have been termed here battered cobbles.

Elsewhere in the Inyo-Mono region, battered cobbles are either very rare or have simply been overlooked. None are reported by Riddell (1951), Wilke (1983), or, with the exception of two possible core tools from Rose Spring, by Lanning (1963: 258) for the southern part of the region. Meighan (1955) reports none and E. Davis (1964: 272) only a few possible examples from surveys in Long Valley and the Mono Basin. They appear to be entirely lacking at the Long Valley sites excavated by E. Davis (1964), Enfield and Enfield (1964), Basgall (1983), Bettinger (1980b), and Hall (1983); these particular sites, however, should perhaps be ignored owing to the specialized uses they served. In the Death Valley area, none are reported by Wallace and Taylor (1955) but at least some of the scraper planes and hammerstones found by Hunt (1960) might be classified as battered cobbles.

In regard to the scarcity of these tools in the Inyo-Mono region generally, it is worth reiterating that in the course of the research reported here, none were found at Pinyon House and only a few specimens—odd ones at that—were found at Two Eagles. Indeed, the only other relatively well-studied sites at which they occur in great abundance are the alpine villages at elevations in excess of 3200 m that have recently been found and partially excavated in the White Mountains (Bettinger, 1984). It is of some significance that in tems of the plant procurement and processing that occurred at these highland sites, roots are believed to have been at least as important as seeds. Thus, the abundance of battered cobbles they exhibit tends to support the notion that these tools were used in the processing of roots. It is equally noteworthy that among the three sites reported in this volume and the alpine village sites in the White Mountains, basin block millingstones appear only at Crater Middens and the alpine villages (that is, in very nearly the same distribution as battered cobbles). This tends to support the idea of some functional connection between battered cobbles and basin millingstones, perhaps in some special form of root and rhizome processing that required containment of liquid, either produced during processing or added to aid in that process.

Pestles (13 specimens; all granitic). The bulk of the pestles found at Crater Middens are simply elongate granitic stream cobbles that are flattened on one or both ends as the result of use in pounding (table 9.4; fig. 9.4d). Eight of the 10 complete pieces showed evidence of such use at only one end. At least three specimens (O-2175, O-2219, O-3488) show some attempt at trimming and shaping in the form of pecking along the margins. In addition, among the 12 pestles that were sufficiently intact to judge the presence of secondary use, 10 had been used as manos, 5 on one face, and 5 on both faces.

Pestles and mortars occur in small quantity throughout the Inyo-Mono region. Lanning (1963: 247, 268) concluded that the distribution of pestles at the Stahl site (Harrington, 1957), Rose Spring (Lanning, 1963), and Cottonwood Creek, Iny-2 (Riddell, 1951) implied a recent introduction, sometime around A.D. 500. That only one specimen was found in the buried deposit at Crater Middens implies an even more recent introduction, perhaps as late as A.D. 1300 (table 9.1). That bedrock mortars are confined to Middens II and IV, which date to the later occupation of Crater Middens, is consistent with this idea.

As at Stahl, Rose Spring, and Iny-2, port-

able mortars are lacking at Crater Middens. Presumably this implies use of pestles with wooden mortars (cf. Steward, 1933: 246; Lanning, 1963: 247) or bedrock mortars, the latter being present at Rose Spring, Iny-2, and Crater Middens, but evidently not Stahl. They might also have been used with basin millingstones, which are found at Rose Spring and Crater Middens. Further north, pestles and bedrock mortars, but again not portable mortars, are reported for northern Owens Valley, Long Valley, and the Mono Basin (Meighan, 1955: 13, table 1; Cowan and Wallof, 1974: table 6; Hall, 1980: Appendix D, 1983: 153; Bettinger, 1980b: 7, 1978d: 4–5, 1981c: 9; Basgall, 1984: 17; E. Davis, 1964: table 2, table 18, 280). Pestles and portable mortars of stone and wood are much more common in Death Valley (Hunt, 1960: 104–106, 257–263; Wallace and Taylor, 1955: 362), where they may date as early as 1200 B.C.

It is almost certain that the greater frequency of mortars and pestles noted for Death Valley can be attributed to their use in the processing of a major resource, mesquite (*Prosopis* spp.), that occurs there but not in Owens Valley, Long Valley, or the Mono Basin. The last three areas lack mesquite, have few acorns to speak of, support only small relict stands, and never enjoyed more than occasional access to them by trade with groups living on the west slope of the Sierra Nevada. In these cases there is greater use of the mortar and pestle than can be readily explained as resulting from the preparation of plant foods not yielding readily to the more common mano and millingstone (Meighan, 1955: 12).

The possibility cannot be excluded, of course, that in the Inyo-Mono region, mortars and pestles were used as specialized processing tools for such exotics as acorns. Nevertheless, the appearance of these tools in relatively late prehistoric times seems more readily attributed, albeit indirectly, to the westward spread of Mono speakers (Western Mono) across the Sierra Nevada perhaps 500 years ago. This was followed by an increase in contact through trade, marriage, and seasonal visitation between groups living in Owens Valley, Long Valley, and the Mono Basin and those living on the west slope of the Sierra Nevada (e.g., J. T. Davis, 1961: 24–26). The latter people traditionally used the mortar and pestle to process small, hard seeds and roots as well as acorns (Barrett and Gifford, 1933: 151, 157) and interaction with them is the likely source of this technology in the northern Inyo-Mono region. It is possible that the diminished use of battered cobbles tentatively inferred for the terminal occupation of Crater Middens may in part stem from this late introduction of mortar and pestle technology, which is well-suited to the same set of heavy processing tasks thought to have been performed with battered cobbles.

In broader terms, the mortar and pestle might be tentatively added to the list of practices borrowed in whole or part by the Owens Valley Paiute from groups living on the west slope of the Sierra Nevada, possibly as the direct result of intensified social and economic intercourse between these groups following the westard migration of the Western Mono and the establishment of a Mono-speaking corridor across the Sierra Nevada. These borrowings include kinship terms and observances (cf. Steward, 1933: 294–295), the mourning ceremony (cf. Steward, 1933: 296–299; Bettinger and King, 1971), and perhaps the sweathouse and practices relating to its use (C. Fowler, personal commun.). The role of these exotic elements in the prehistoric development of patterns of subsistence, settlement, and sociopolitical organization in Owens Valley is discussed in the concluding chapters of this volume.

CERAMICS

A total of 593 ceramic artifacts was found (tables 9.5, 9.6). Of these, 524 are Owens Valley Brown Ware vessel fragments, 29 are unidentified gray ware vessel fragments, 1 is an unidentified red ware vessel fragment, and 39 are clay objects of other than vessel form: worked sherds, pipes, modeled plates, discs, rolls, lumps, and impressed sherds.

OWENS VALLEY BROWN WARE (524 specimens; 472 undecorated body, 33 undecorated rim, 5 base, 7 decorated body, 7 decorated rim): All Owens Valley Brown Ware sherds in the collection appear to be made of residual clays shaped by coiling and scraping.

TABLE 9.5
Distribution of Ceramic Artifacts at Crater Middens

	Midden I			Midden II						Midden III			Midden IV		Midden V		
	St. 3	Surf.	Mid-den	St. 7	St. 9	St. 10	St. 12	Surf.	Midden	St. 16	Surf.	Mid-den	Surf.	Mid-den	Surf.	Mid-den	Total
Owens Valley																	
Brown Ware																	
Undec. body		8		12	28	8	44	126	132	19	48	19	17	11			472
Undec. rim				1	1		2	9	11	3	1	1	2	2			33
Dec. body						1		2	2			2					7
Dec. rim								3	1	1		1		1			7
Bases								3			2						5
Gray ware																	
Undec. body								13	2				2	2			19
Undec. rim								2									2
Dec. body								8									8
Red ware									1								1
Modeled plates		1							3								4
Discs					1					1							2
Pipes					1				2								3
Rolls										2							2
Lumps									1				1				2
Impressed sherd														1			1
Worked sherds																	
Owens Valley																	
Brown Ware						1		8	9	2	2		1				23
Gray Ware								1	1								2

TABLE 9.6
Subsurface Distribution of Ceramic Artifacts at Crater Middens

	Midden I	Midden II					Midden III						Midden IV					Midden V				
	0–10	0–10	10–20	20–30	30–40	40–50	0–10	10–20	20–30	30–40	40–50	50–60	0–10	10–20	20–30	30–40	40–50	0–10	10–20	20–30	30–40	Total
Owens Valley Brown Ware																						
Undec. body		87	35	8	2		11		5		3		6	4	1							162
Undec. rim		6	3	2						1			1	1								14
Dec. body		1	1				1			1												4
Dec. rim			1				1						1									3
Gray ware																						
Undec. body		2											2									4
Red ware			1																			1
Modeled plates		2	1																			1
Pipes		2																				3
Lumps		1																				2
Impressed sherd																	1					1
Worked sherds																						1
Owens Valley Brown Ware		3	2	3	1																	9
Gray ware			1																			1

TABLE 9.7
Characteristics of Owens Valley Brown Ware Sherds from Crater Middens

Interior surface treatment	Exterior surface treatment				Total
	Smooth	Rough	Random brushed	Parallel brushed	
Smooth	33	47	2	1	83 (26%)
Rough	2	65	2	1	70 (22%)
Random brushed		11	7	5	23 (7%)
Parallel brushed	5	60	42	29	136 (43%)
Tooled	—	5	—	1	6 (2%)
	40 (13%)	188 (59%)	53 (17%)	37 (12%)	318

The quantity and size of aplastic inclusion vary without clear gradation. Hollow interstices left by plant parts carbonized in firing are common. Exterior surface residues are lacking altogether and interior surface residue was observed on only one sherd, where it occurred as a very thin, dark crust. The same sherd (O-481) also exhibited the only case of modification by drilling—probably to permit crack lacing. The single biconical perforation in this piece is 0.7 cm at the widest but narrows to about 0.2 cm in diameter midway through the sherd.

For convenience, the balance of ceramic assemblage is best described by subcategories defined on the basis of morphology and decoration.

Undecorated Body Sherds. The 472 undecorated body sherds from Crater Middens display the full range of exterior and interior modes of surface treatment. Those large enough to be reliably classified exhibited the composition shown in table 9.7 with respect to these modes.

For this same group of sherds, measurements of wall thickness yielded the following summary statistics.

Wall Thickness (cm)	$\bar{x}$	S	Max.	Min.	n
	0.64	0.14	1.1	0.4	318

In terms of surface treatment it is apparent that the assemblage of body sherds from Crater Middens is in all respects more heterogeneous than the assemblages previously described from Pinyon House and Two Eagles. Sherds in the Crater Middens collection are more evenly distributed between the different modes of exterior, interior, and joint exterior–interior surface treatment. Robinson's index of similarity (table 9.8), however, indicates that the differences between these three assemblages are not unduly large—especially given the differences in the nature and size of these three samples—nor are they of uniform magnitude for all attributes.

It is evident firstly that irrespective of the nature of the ceramic samples from these sites, the distribution of exterior surface treatment in the Crater Middens assemblage is comparable to that observed in both the Pinyon House and Two Eagles assemblages, which are themselves virtually identical in this respect. As noted earlier, this suggests that exterior surface treatment is rather stable both between vessels and between assemblages of Owens Valley Brown Ware in central Owens Valley.

Secondly, there are strong similarities of interior and joint exterior–interior surface treatment between the Crater Middens assemblage and the Pinyon House assemblage, even though the Pinyon House collection is substantially smaller. The Two Eagles assemblage, on the other hand, shows no strong resemblance to that of Crater Middens in these respects, just as was shown earlier it does not bear much resemblance to the assemblage from Pinyon House. This makes sense if it is understood that the body sherds from Two Eagles probably represent a single shattered vessel. Thus the close similarity between Crater Middens and Pinyon House in terms of interior and joint exterior–interior

TABLE 9.8
Robinson's Indices of Agreement Between Owens Valley Brown Ware Sherds from Crater Middens and Owens Valley Brown Ware from Pinyon House and Two Eagles

	Crater Middens/Pinyon House	Crater Middens/Two Eagles
	IA	IA
Exterior surface treatment	175	175
Interior surface treatment	169	127
Exterior–interior surface treatment	150	101

surface treatment of body sherds is one between assemblages consisting of multiple vessels; conversely, the differences in these respects between both these sites and Two Eagles is one between assemblages consisting of multiple vessels and an assemblage consisting of one vessel. It seems reasonable to propose on this basis that interior and joint exterior–interior surface treatments vary between individual vessels of Owens Valley Brown Ware—either as the result of functional differences between vessels or the stylistic predilections of their makers—but at the same time these attributes are stable with respect to distribution and diversity between assemblages.

Comparison between the Crater Middens and Pinyon House assemblages, both consisting of multiple vessels, shows that the two differ most markedly in the more frequent presence at Crater Middens of sherds with smooth exteriors and sherds with smooth interiors, frequently but not exclusively in combination, and the less frequent presence of sherds with random brushed exteriors and sherds with random brushed and parallel brushed interiors; sherds with rough exteriors and sherds with rough interiors occur in about the same proportion at both sites. On this basis it might be suggested that these differences reflect alternative methods of surface treatment in the sense that the modes in question seem to vary inversely: smooth exteriors increase at the expense of random brushed exteriors and smooth interiors increase at the expense of random brushed and parallel brushed interiors, and conversely. This might represent stylistic preference but given the differences in settlement type between Pinyon House—an upland pinyon camp—and Crater Middens—a lowland occupation site—there is also the possibility that the differences are functional. Whatever they are, it is clear that they do not affect the frequency with which rough exteriors and rough interiors are represented. Again, however, it is not clear whether the observed stability in these attributes is a matter of function or style.

The summary statistics for sherd wall thickness from the three sites indicate essentially the same relationships as are indicated by comparisons of surface treatment. Sherds from Crater Middens are distinctly thicker than those from Pinyon House; the differences between these two sites in terms of this attribute, however, are less than the differences that separate either one from Two Eagles. Further, in standard deviation of wall thickness, Crater Middens and Pinyon House are virtually identical, both being more variable than the Two Eagles sherd assemblage. This also suggests that, like interior and joint exterior–interior surface treatment, wall thickness is more variable between than within individual vessels—a conclusion not intuitively obvious by casual inspection of complete Owens Valley Brown Ware vessels, which often appear excessively lumpy and irregular.

Undecorated Rim Sherds. The 33 undecorated rim sherds in the Crater Middens collection exhibit a broad range of form (fig. 9.6). Eight are recurved, that is, outflaring, but this is pronounced in only four cases. With the possible exception of one sherd that may be slightly incurved (O-4753), the balance are direct. A plurality of the lips (n = 13) are rounded, formed by smoothing a terminal vessel coil. Among the more common departures from this basic pattern are lips that have been distinctly flattened, of which there are five, including one that has been

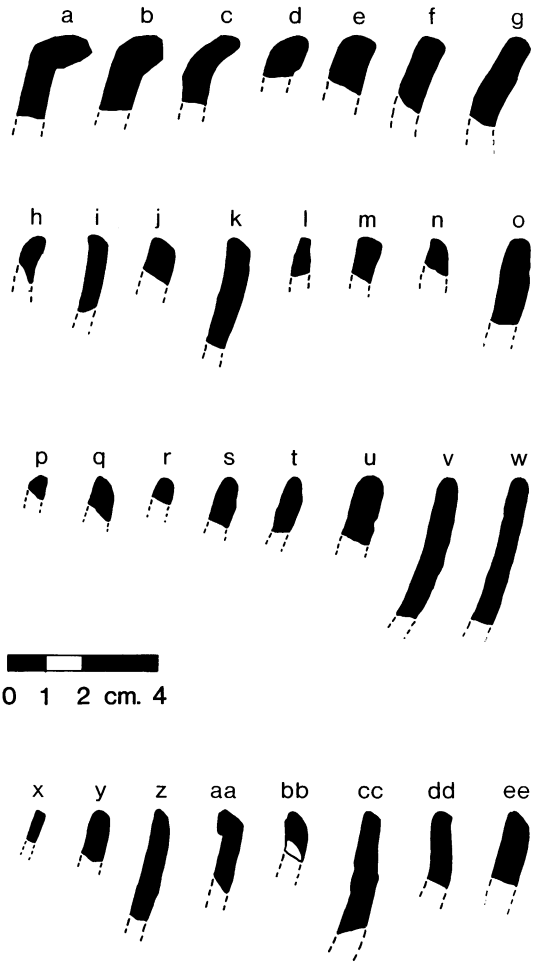

Fig. 9.6. Undecorated Owens Valley Brown Ware rim sherds from Crater Middens. a. O-2190; b. O-1921; c. O-3096; d. O-3254; e. O-3318; f. O-2306; g. O-2316; h. O-3255; i. O-2189; j. O-2290; k. O-2112A/C; l. O-2954; m. O-3130; n. O-3319; o. O-2307; p. O-2149; q. O-2996; r. O-2308; s. O-3446; t. O-3220; u. O-407/O-482; v. O-2953; w. O-3958; x. O-649; y. O-3505; z. O-3999; aa. O-4000; bb. O-4753; cc. O-4714; dd. O-4645; ee. O-4852.

tapered, one that has been thickened, and one in which material displaced during flattening protrudes as a thin shelf on either side of the rim. The remaining lips have been bevelled in varying degree by the removal of more material from one side than the other. In most cases, the bevel is on the exterior (10 cases); in one extreme example (O-4000) this resulted in the displacement of material toward the vesssel interior where, after being flattened and smoothed, it forms a raised band or collar running around the rim interior. In five cases the asymmetry of the lip cross section indicates finishing principally by the removal of material from the inside of the lip, in all but one case in association with recurved rims.

Bases. The five bases all exhibit substantial use abrasion on their exterior surfaces. Four of the five are round-bottomed. The three largest and most complete of these show substantial thickening at the base which tapers rapidly to form the vessel wall. This thickening is accomplished without raising the contour of the interior surface and stems from the presence of additional material on the vessel exterior, which forms a well-defined bump at that point. The fifth base is likewise thickened at the very bottom but is distinctly flatter in contour and exhibits a distinct shoulder at the point of contact between it and the vessel wall. The thickened flange present on some flat-bottomed Owens Valley Brown Ware vessels (e.g., Riddell and Riddell, 1956: fig. 1) is, however, lacking on this piece. Together these five sherds range in thickness from 1.0 to 1.3 cm, with a mean of 1.12 cm, which is well in excess of the mean thickness noted for body sherds (0.64). Although this thickening clearly serves to reinforce vessel bottoms, it is very likely in the main the incidental result of manufacture by the ethnographic method in which a clay lump is molded to form a thick basal disc and the vessel walls are built by adding coils to this foundation (Steward, 1933: 267).

Decorated Body Sherds. All seven decorated body sherds exhibit designs made by punctation. In all cases the tool was finely tipped but the precise configuration evidently varied (fig. 9.7h–n). In three instances the bit was spatulate in cross section (O-2416, O-2115, O-3474), in two cases it was round (O-1920, O-3253), and in two cases semilunate (O-561, O-4260). The decorated pieces in this sample are so small that no pattern or design can be inferred. Lines and areas filled with multiple punctations are evidently component elements of these designs, however. The scarcity of body decoration in Owens Valley Brown Ware can be made clear by

noting that the ratio of decorated to undecorated body sherds in the Crater Middens collection is about 1:68 (table 9.5).

Decorated Rim Sherds. In comparison with decorated body sherds, the seven decorated rim sherds exhibit a broader range of decorative techniques although the observed range is still limited (fig. 9.7a–g).

Five of the rims exhibit finger- or thumbnail punctations oriented vertically and running in a band just below the very top of the vessel. In three of the five (O-773, O-2995, O-2305), the nail marks are oriented to open exclusively to the right when the sherd is held in the proper position, that is, with the rim at the top; one of these (O-2305) is incised below the punctations. In the other two sherds (O-2148, O-4787), the nail marks open both to the right and left, occurring as a juxtaposed series of marks opening first in one direction and then shifting to the opposite direction. By coincidence, in both these cases the marks on the left part of the sherd open to the left and those on the right part open to the right.

Two sherds were incised while the vessels on which they appear were still wet. In one of these (O-3869), the incision is in the form of a large zig-zag running on the concave portion of a sharply recurved rim. In the other (O-2305), which also exhibits thumbnail punctations, the design is that of two lines that converge without joining toward the rim. On either side of these are semicircle designs that intersect the converging lines but do not pass into the area intervening between them. The rim itself curves sharply inward.

The final decorated rim (O-560) exhibits a horizontal line of punctations executed with a fine, round-pointed tool. As this fragment is small, the possibility that this line was part of a larger stippled area cannot be excluded.

Although the sample of decorated rim and body sherds is small, a clear pattern is suggested. First, rim sherds are more commonly (18%) decorated than body sherds (1%). This is consistent with ethnographic accounts that specify only decoration of rims (Steward, 1933: 268; but see Steward, 1933: fig. 1i). The technique of decoration is likewise indicated to be predominantly that of thumbnail punctation (Steward, 1933: 268, fig. 1b, i), but zigzags and chevrons are also noted. Second, if the sample from Crater Middens is considered representative, at least for the sake of argument, then it seems clear that the technique of decoration differed according to vessel portion. Thumbnail punctation and incision are confined to rims and adjoining portions of the wall; tool punctations are largely, though not exclusively, confined to the lower portions of the vessel wall. It is unclear whether these standards of design are among the defining characteristics of Owens Valley Brown Ware or whether they reflect the ritual, social, or political affiliations of individual makers within broader traditions of this ware.

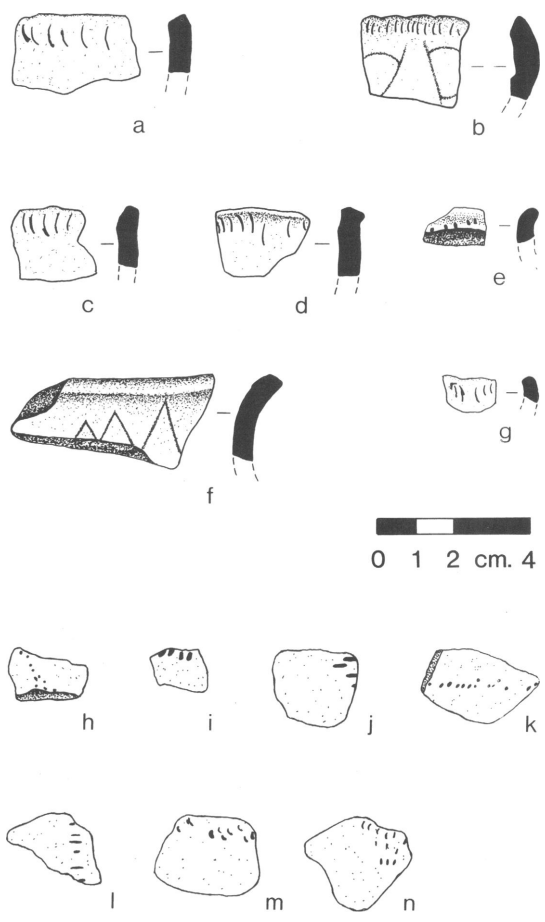

Fig. 9.7. Decorated Owens Valley Brown Ware rim sherds and body sherds from Crater Middens. **a–g.** rim sherds; **h–n.** body sherds. a. O-773; b. O-2305; c. O-2995; d. O-2148; e. O-560; f. O-3869; g. O-4787; h. O-1920; i. O-2416; j. O-2115; k. O-3253; l. O-3474; m. O-4260; n. O-561.

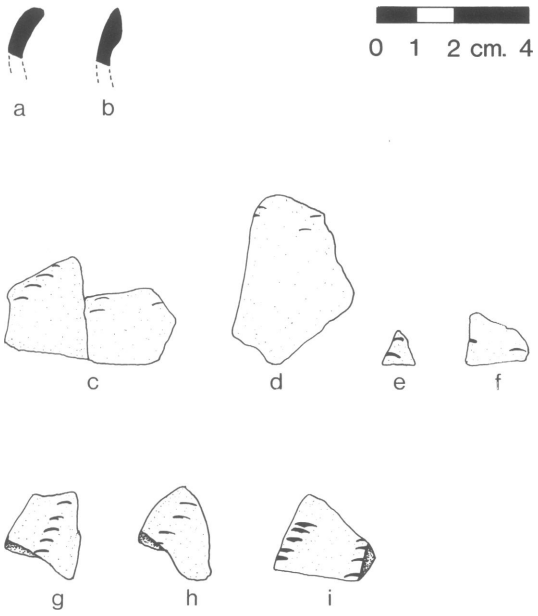

Fig. 9.8. Gray ware rim sherds and decorated body sherds from Crater Middens. **a, b.** rim sherds; **c–i.** decorated body sherds. a. O-2212; b. O-2208; c. O-2193/O-774; d. O-2114; e. O-2191; f. O-2192; g. O-2209; h. O-2210; i. O-2224.

GRAY WARE (29 specimens; 19 undecorated body, 2 undecorated rim, 8 decorated body): Twenty-nine sherds of an as yet unidentified gray ware were found. The term *gray ware* refers here only to the distinctive color of these sherds and is not meant to imply affinities to named gray wares from the Southwest or Great Basin. These pieces are uniformly thin as indicated by the following summary statistics for wall thickness.

Wall Thickness (cm)	$\bar{x}$	S	Max.	Min.	n
	0.52	0.04	0.6	0.5	27

From their hardness, it would appear that these sherds were fired at temperatures higher than Owens Valley Brown Ware vessels. The presence of fire clouds indicates that this was done in an uncontrolled atmosphere. The method of construction cannot be confidently ascertained from this small sample but the absence of obvious anvil marks suggests shaping by coiling and scraping. Aplastic inconclusions are sparse and fine, consisting of quartz, mica (which is most evident on sherd surfaces), and possibly feldspar.

In nearly all cases, the exterior color (2.5YR 5/2) sharply contrasts with the core and interior color (2.5YR 4/0). It would appear that this is the result of a deliberate finishing technique, either puddling to bring finer particles to the surface or, less probably, application of a fine clay slip. Both interiors and exteriors are smooth and appear to have been lightly burnished when partially dry with a stone or ground sherd. Both of the rims are recurved although this is more pronounced in one specimen (O-2212) than the other (O-2208) (fig. 9.8a, b).

Surface decoration, exclusively horizontal thumbnail punctations, is present on nearly a third (32%) of the body sherds (fig. 9.8c–i). These punctations were evidently arrayed in a series of parallel diagonal lines running from somewhere in the vicinity of the neck down to the left. The point of termination for these is uncertain. It is unclear whether the individual punctations opened toward the top or bottom of the vessel, but it seems more probable that it was toward the bottom, which would be the more natural method if it is assumed that the piece was decorated while standing upright, that is, rim up. In comparison to Owens Valley Brown Ware, gray ware decoration is more frequent and consists exclusively of thumbnail punctations that are horizontal rather than vertical and appear on the vessel body rather than the rim.

Although the number of gray ware sherds is relatively substantial, constituting about 5 percent of the Crater Middens collection, those from Midden II are so similar in color, thickness, and design that it is improbable they represent more than one vessel. However, that four specimens were also found at Midden IV (tables 9.5, 9.6) suggests that at least two different gray ware vessels were present at the site.

This gray ware does not resemble any ware traditionally made in southern California nor does it exhibit the olivine temper that distinguishes the gray wares made in the vicinity of Las Vegas. Comparison with type collections suggests some similarity to Snake Valley Gray, a Fremont ware made in southern Utah (R. Madsen, 1977).

RED WARE (1 undecorated body sherd): One

very small red ware sherd was found. Again, the term *red ware* refers to its distinctive color and should not be construed as a typological designation. The sherd is very thin, 0.3 cm. The color (10R 5/6) is uniform throughout the sherd. The clay would appear to be sedimentary, rather than residual, and fine aplastic inclusions in the form of quartz and feldspar are abundant. Both the interior and exterior surfaces appear to have been polished or burnished. The method of construction cannot be ascertained but the concentration of more quartz and feldspar particles on the exterior than the interior implies that the latter was manipulated by puddling, drawing the finer clay constituents to that surface.

This sherd resembles no ware indigenous to the Great Basin or Southern California and the most likely possibility is that it is from a vessel that in whole or part found its way to the site from the Southwest.

OTHER CERAMIC ARTIFACTS: *Modeled Plates.* Four fragments of what appear to be modeled plates were recovered. From their shape it would appear that these plates were made by hand pinching and punching lumps of residual clay into shallow saucer or dish-shaped forms. Two are quite crude and exhibit irregular cross sections that taper to thin, uneven rims. One of these (O-1838) is rough on both the interior and exterior; the other (O-3393) shows what may be described as light parallel brushing on both surfaces although this does not obscure the cavities and nicks made during construction.

The two remaining specimens (O-3284, O-3256), which appear to derive from the same plate, are more carefully finished but irregularities in cross section are still present. Both interior and exterior surfaces are smooth and may have been finished by puddling. The tapered rim is even.

There is no previous ethnographic or archaeological mention of artifacts resembling these pieces. It may be, however, that they served many of the same uses attributed to the ceramic discs described below, that is, as pot or basket rests or as serving dishes or scoops.

Ceramic Discs. Two ceramic discs, both of them recycled body sherds from Owens Valley Brown Ware vessels, were found. One (O-3998) is a basal sherd consisting of the molded lump and first wall coil—a segment of which is missing—of what would appear to be a globular vessel (fig. 9.9b). This specimen is 7.6 cm in diameter, 0.6 cm thick, and lacks evidence of obvious modification except for smoothing around the edges, evidently as the result of use rather than intentional grinding. The other specimen (O-2361A/B/C/D) is a thick body sherd that has been roughly ground into subcircular form (fig. 9.9a). The base of this piece, the original vessel exterior, is also ground, but this appears to be the result of use. Both specimens were recovered from structure deposits.

There is no ethnographic or archaeological record of similar discs in central eastern California. Such objects are relatively more common in southern California, where they are regarded as vessel lids (cf. Campbell, 1931: 59–60, pl. 34f, h). As almost none of the rim sherds recovered at Crater Middens suggests a vessel with a mouth sufficiently narrow in diameter to be covered by either of the discs that were found, this interpretation is unlikely in the present case. It is more probable that these sherd discs were used as pot or basket rests or as serving dishes or scoops. That both were found in structure deposits (table 9.5) lends some credence to the notion that their presence in this context stems from use in these locations rather than the subsequent dumping of unrelated trash.

Pipe Fragments. One well-finished rim sherd from the bowl of a ceramic clay pipe and two more crudely fashioned pieces that may be pipe fragments were found. The better-made fragment (O-2360) is 0.3 cm thick and exhibits a very slight taper toward its rim, which is flattened (fig. 9.9g). When complete the bowl would have been closer to 2.4 cm in outside diameter and 1.8 cm in inside diameter. The exterior is smooth and may have been finished by puddling; the interior is rough. The paste is similar to that which characterizes Owens Valley Brown Ware vessels and contains in moderate quantity relatively fine-grained particles of quartz, feldspar, and mica. The two cruder examples—one a bowl rim, the other a body sherd—are rough on both the interior and exterior. The rim is (O-537) 0.4 cm thick at the maximum but owing to irregularities in construction, it is

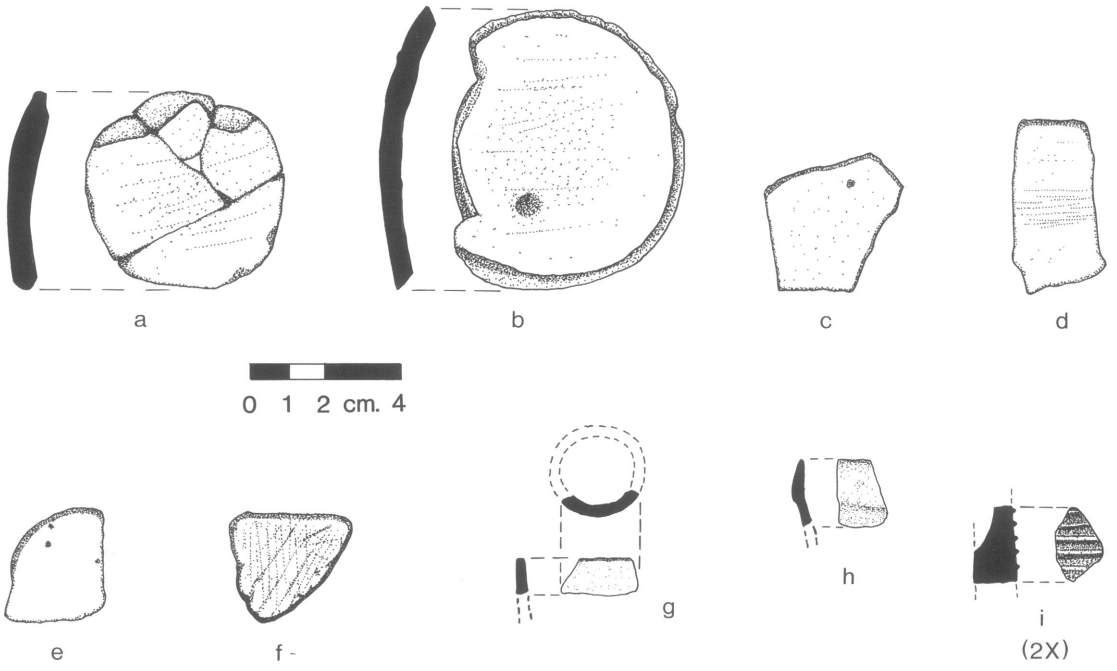

Fig. 9.9. Miscellaneous ceramic artifacts from Crater Middens. **a, b.** ceramic discs; **c–f.** worked sherds; **g, h.** ceramic pipe fragments; **i.** impressed sherd. a. O-2361A/B/C/D; b. O-3998; c. O-2147; d. O-2113; e. O-3131; f. O-2194; g. O-2360; h. O-537; i. O-4945.

in places as thin as 0.2 cm (fig. 9.9h). This piece tapers markedly toward the rim, which is straight but not smooth. The remaining fragment (O-2546) is very small and exceptionally thin, 0.2 cm. There are on the interior of this piece impressions that indicate it was molded around a twig or grass stem, which is the ethnographic manner of forming pipe bores. It is on this basis that this fragment is tentatively identified as belonging to a pipe. Both this specimen and the cruder bowl rim were fashioned of clay similar to that from which the more carefully made fragment was made.

In surface finish the two cruder fragments are reminiscent of ethnographic Owens Valley Paiute ceramic pipes, which are elongate cones shaped by hand with a U- or V-shaped bowl and a long bore formed when a twig or grass stem around which the pipe is molded burns away in firing (Steward, 1933: 268, pl. 4a–c, 5c, e). The better-made specimen appears to be of the same basic shape but its fine exterior surface finish distinguishes it from the examples Steward observed being made in historic times.

Ceramic clay pipes are less frequently encountered in eastern California than stone pipes, which they resemble (cf. Riddell, 1951: 16). Two specimens, however, are reported from the Rose Spring site (Lanning, 1963: 246). Hunt (1960: 270) reports a clay pipe from Death Valley, but unlike the specimens reported here or those made by the Owens Valley Paiute, the bore and bowl are drilled rather than modeled by hand or around a twig core.

Clay Rolls. Two fired clay rolls may represent fragments of figurines (cf. Hunt, 1960: figs. 58, 59, 60, cf. unbaked clay figurines) or parts of unused coils intended for vessel construction. The larger (O-3765) is 2.6 cm long and 0.7 cm in diameter. The smaller (O-4001) is 0.8 cm long and only 0.4 cm in diameter. Both are fragmentary and both were found in Structure 16, which is thought to be a storehouse or workshop. This tends to favor the interpretation that they are related to the ac-

tivities occurring in that structure—possibly the manufacture of ceramic vessels or the preparation of clay for use in vessel manufacture—and not extraneous debris.

Clay Lumps. Two amorphous lumps of residual clay containing abundant quartz and feldspar were recovered. One (O-4677) is 2.0 cm in diameter and lacks any distinctive surface markings. The other (O-3392), also 2.0 cm in diameter, exhibits multiple striations reminiscent of but deeper than those observed on brushed sherds of Owens Valley Brown Ware. It is believed that both are by-products of ceramic manufacture and that the striated specimen is excess material removed from a brush used in finishing Owens Valley Brown Ware vessels.

Impressed Sherd. A single Owens Valley Brown Ware sherd (O-4945), 0.6 cm thick, exhibits five parallel channels separated by raised ridges as though it had been impressed with some textile, presumably a basket, while still wet (fig. 9.9i). A positive impression taken from this piece, however, suggests no particular basket form.

Worked Sherds (25 specimens; 23 Owens Valley Brown Ware, 2 gray ware). A total of 25 vessel sherds exhibiting evidence of grinding on one or more edges are thought to represent scrapers used in the manufacture of ceramic vessels (cf. Riddell, 1951: 23). There is, however, no ethographic record of this practice (e.g., Steward, 1933, 1941). It is possible that some of them were used for some other scraping task—the separation of fiber, for instance—or are parts of ground discs similar to the two described above. Most of the worked edges are straight or slightly convex in plan but a few are round or oval (fig. 9.9c–f). The abrasion is almost invariably perpendicular to the plane of the sherd, which would indicate the tool was held in an upright position, at right angles to the material being worked. The frequent appearance of more severe wear on the exterior edge of the sherd tends to suggest that it was the leading edge in the scraping motion.

Worked sherds similar to the ones from Crater Middens are of relatively common occurrence at archaeological sites in eastern California although not in the numbers noted here (Riddell, 1951: 23; Lanning, 1963: 245).

PROJECTILE POINTS

A total of 223 artifacts was identified as projectile points (tables 9.9, 9.10). Of these, 184 can be placed in well-defined Great Basin projectile points series. The remaining 39 specimens were too fragmentary to be so typed.

HUMBOLDT SERIES: Three projectile points, all three basal fragments of obsidian, were tentatively placed in the Humboldt series (fig. 9.10a–c). The blades of two appear to have been crudely reworked by percussion flaking, perhaps in an attempt to resharpen points broken in the field. The larger of the two (OV-285) is 1.8 cm wide at the base, 1.8 cm thick, exhibits a shallow basal concavity, and tapers from its maximum width somewhere near the midpoint (now missing) toward the stem. There is just above the base on one side of this piece a shallow constriction, which gives the appearance of a flaring or eared stem; the other side is straight. The other reworked specimen (O-2122) is 0.6 cm thick, 1.3 cm wide at the base, and likewise exhibits a shallow basal concavity and tapers from a maximum width somewhere in the vicinity of what would have been its midpoint toward the base. The third piece (O-484C), provisionally classified within the Humboldt series, consists of the basal concavity, one basal corner, and part of the blade of what appears to have been a thin, parallel-sided point with a relatively deep basal concavity. It bears some resemblance to the Humboldt Basal-notched biface type but is thinner (0.3 cm) and shows no evidence of the use-wear resulting from cutting and sawing that is common for that type.

ELKO SERIES: As is the case for both Pinyon House and Two Eagles, the Elko series is not well represented in the Crater Middens collections. Only eight specimens belonging to this series were recovered and all of these are quite fragmentary (fig. 9.10d–k).

Elko Eared (5 specimens; all obsidian). The basal portions of five Elko Eared projectile points were found. Three of these retain small portions of the blade, which in each case has been reworked to permit reuse as a point or an altogether different tool form. The other two pieces are smaller fragments, each con-

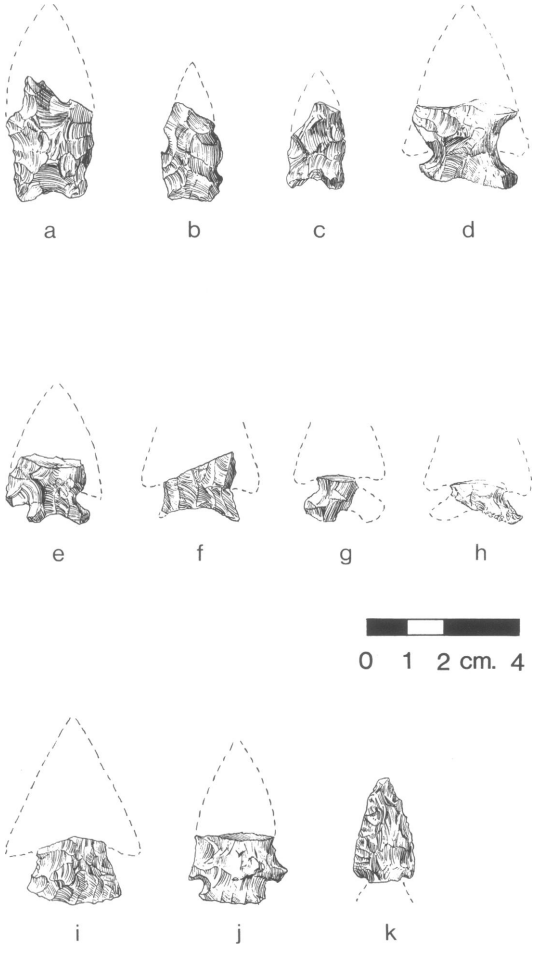

Fig. 9.10. Humboldt and Elko series projectile points from Crater Middens. **a–c.** Humboldt series; **d–h.** Elko Eared; **i–j.** Elko Corner-notched; **k.** unclassified Elko series fragment. a. OV-285; b. O-2122; c. O-484C; d. O-4985; e. O-4395; f. O-3509; g. O-4415; h. O-4060; i. O-2922; j. O-2998; k. O-3508.

sisting of the neck and one ear of a point. Owing to their fragmentary condition, length, width, and weight could not be measured for any of the five and thickness could be measured on only the two largest specimens that retained portions of the blade; one of these (O-4395) was 0.8 cm thick, the other (O-4985) 0.7 cm thick.

Elko Corner-notched (2 specimens; 1 obsidian, 1 chert). The more complete (O-2998) of the two Elko Corner-notched points consists of the base and lower blade of what appears to have been an essentially triangular point with straight sides, a straight base, and relatively shallow corner notches. This piece, which is made of gray-green chert, exhibits unifacial edge retouch just above one shoulder which may reflect either resharpening or recycling. The width is 2.4 cm, the thickness 0.5 cm; neither length nor weight could be determined.

The other Elko Corner-notched point (O-2922) is represented by an expanding basal section that snapped across the neck. The notches are relatively deep and the base is convex. The material is obsidian. Length, maximum width, thickness, and weight cannot be estimated from this small fragment, but the basal width is 2.4 cm, so the complete piece must have been quite large.

Unclassified Elko Series Fragment. The blade of a notched obsidian point (O-3508), broken at the neck, was identified as belonging to the Elko series on the basis of size but, lacking the stem, could not be more specifically classified. The orientation and position of the notches, however, suggest that it was either corner-notched or eared. The same attribute (notching) would appear to preclude the possibility that the point belonged to the Little Lake series. The blade itself is triangular in outline, with straight sides and a lenticular cross section. The maximum width is 1.6 cm, thickness is 0.4 cm, and the neck width is 0.8 cm.

ROSE SPRING SERIES: The Rose Spring series is represented by 54 specimens at Crater Middens. Of these, 48 belong to formal types with the series and six are either too oddly shaped or too fragmentary to be classified.

Rose Spring Corner-notched (42 specimens; 38 obsidian, 2 chert, 2 chalcedony). The Rose Spring Corner-notched points exhibit a marked dichotomy with respect to pattern of breakage (fig. 9.11). None of the 42 specimens is complete but 22 retain, in addition to the base, a large portion of the blade; the other 20 are bases that snapped across the neck at, or slightly above, the notches.

Among the fragments with blades there is a good deal of variation in both size and shape; workmanship is uniformly good. The bases and blade sides vary from straight to convex;

TABLE 9.9
Distribution of Projectile Points at Crater Middens

	Midden I			Midden II						Midden III			Midden IV		Midden V		
	St. 3	Surf.	Mid-den	St. 7	St. 9	St. 10	St. 12	Surf.	Mid-den	St. 16	Surf.	Mid-den	Surf.	Mid-den	Surf.	Mid-den	Total
Humboldt series							1	1									3[a]
Elko series																	
Eared										1	2	2					5
Corner-notched									2								2
Unclassified											1						1
Rose Spring series																	
Corner-notched						2		6	17	1	1	15					42
Side-notched							1	1	1		1			1			5
Contracting stem									1								1
Unclassified							1	1	1			3					6
Eastgate series								1	2	2		1					6
Cottonwood series																	
Triangular	1			2	1	1	3	3	7	7	6	1	5	4			43[b]
Leaf									1	1	2						4
Bipoint									1			1					2
Desert Side-notched																	
Sierra		1				2	2			7	1	2	2	3			20
General					1		1	3	2	6	2		2	3			21[c]
Delta					2	1		1			2						7[d]
Unclassified			1				1	2	4	2	1		1	4			16
Untypable																	
Large		1			1				2		3	1					8
Small							1	5	4		2	1	1	1			15
Indeterminate									6	1	2	7					16

[a] One surface specimen collected in 1972 lacks spatial provenience with site.
[b] Two surface specimens collected in 1972 lack spatial provenience within site.
[c] One surface specimen collected in 1972 lacks spatial provenience with site.
[d] One surface specimen collected in 1972 lacks spatial provenience within site.

those with straight sides generally have straight bases, those with convex sides, convex bases. Cross sections are typically lenticular but a few are planoconvex. One piece exhibits shallow serration.

The basal fragments appear to duplicate the more complete pieces in both size and shape, the basal form varying between straight and convex except for one example with a moderately concave base.

As mentioned earlier with regard to a Rose Spring Corner-notched base in the Pinyon House collection, it is unclear why this type should be so prone to breakage across the neck; nearly half of this type—more than a third of all Rose Spring points found at Crater Middens—are fragments of this kind. No other point type in any of these collections displays this kind of breakage in similar degree.

It is thinkable that underlying this pattern is a flaw in the design of some Rose Spring Corner-notched points. The notion is intuitively attractive because, along with the Eastgate series, the Rose Spring series is believed to mark the introduction of the bow and arrow into the Great Basin and, as with the establishment of any new technology, some evidence of trial and error mght reasonably be expected. Data presented and discussed elsewhere (Bettinger, in press) suggest that the appearance of the bow and arrow in central eastern California was accompanied by two distinct changes in point morphology that are relevant here. There was initially a reduction in point weight below a threshold

TABLE 9.10
Subsurface Distribution of Projectile Points at Crater Middens

	Midden I	Midden II					Midden III						Midden IV					Midden V				
	0–10	0–10	10–20	20–30	30–40	40–50	0–10	10–20	20–30	30–40	40–50	50–60	0–10	10–20	20–30	30–40	40–50	0–10	10–20	20–30	30–40	Total
Elko series																						
Eared							1	1														2
Corner-notched			1		1																	2
Rose Spring series																						
Corner-notched		5	5	7			6	4	3	2												32
Side-notched			1										1									2
Contracting stem			1																			1
Unclassified		1						2		1												4
Eastgate series			1	1				1														3
Cottonwood series																						
Triangular		4	1	2			1						3	1								12
Leaf		1																				1
Bipoint			1								1											2
Desert Side-notched																						
Sierra							1				1			3								5
General		2											1	1	1							5
Miscellaneous	1	3	1											2	1		1					9
Untypable																						
Large				1	1		1															3
Small		3		1			1							1								6
Indeterminate		2	2	2			5	1	1													13

Fig. 9.11. Rose Spring Corner-notched projectile points from Crater Middens. **a-v.** fragments with blades; **w-pp.** basal fragments. a. O-2834; b. O-4518; c. O-2673; d. O-650; e. O-3037; f. O-3767; g. O-593; h. O-775; i. O-2121; j. O-4397; k. O-4155; l. O-4854; m. O-2938; n. O-2833; o. O-2873; p. O-4194; q. O-1954; r. O-4147; s. O-2903; t. O-2470; u. O-2610; v. O-1923; w. O-737; x. O-594; y. O-1960; z. O-2772; aa. O-3633; bb. O-4317; cc. O-2836; dd. O-3163; ee. O-4303; ff. O-4462; gg. O-4463; hh. O-4493; ii. O-2837; jj. O-4196; kk. O-2427; ll. O-2401; mm. O-2939; nn. O-3164; oo. O-1951; pp. O-2646.

of 3.0 g and subsequently a reduction in basal width below a threshold of about 1.0 cm. Either one of these changes might have been attended by a flurry of point breakage during the search for proper balance in critical point dimensions, but it is the reduction in basal width that appears to be responsible for most of the cases of neck breakage observed in the Crater Middens collection. Out of 34 Rose Spring Corner-notched points that could be measured for basal width, 71 percent of those with basal widths of less than 1.0 cm had broken at or just above the neck; only 30 percent of the points with basal widths equal to or greater than 1.0 cm had broken in this manner. The simplest interpretation of these data is that the high incidence of neck breakage in Rose Spring Corner-notched points reflects early failed attempts to create a narrow-based point shape that would fit narrow-shafted arrows being developed concurrently to take better advantage of the bow or to better accommodate the lighter arrow points used in conjunction with the bow.

An alternative possibility is that the narrow bases are an early arrow point design introduced with bow and arrow but, proving too susceptible to breakage, were subsequently replaced with wider bases. This seems unlikely in view of evidence from the rest of the Great Basin, where Rose Spring points almost invariably exhibit basal widths of less than or equal to 1.0 cm, indicating that the narrow-based form was broadly successful given the correct combination of neck width and thickness and blade size.

There are other possibilities. For one, it might be that this breakage pattern has nothing at all to do with point design but rather with the behavior related to point repair. Perhaps hunters accustomed to resharpening dart points while still mounted in the foreshaft or shaft attempted the same act with the smaller arrow points, often with the result that the point snapped at the neck. Later points, for example those of the Cottonwood and Desert Side-notched series, may have been replaced without attempts at resharpening or, being thinner, were more easily retouched without breaking.

Finally, these snapped bases may only reflect greater propensity to carry shafts with broken points to lowland occupation sites for repair rather than attempting removal and replacement in the field. By comparison, one would not expect to find as many bases of the Elko series, as there is abundant evidence that these dart points were either repaired or discarded when broken in the field (cf. Bettinger, 1975a). This explanation, however, does not by itself explain the relative lack of corresponding forms in the Cottonwood and Desert Side-notched series; both must have been removed at lowland occupation sites, as temporary hunting camps are lacking in Klondike phase settlement systems in central Owens Valley (Bettinger, 1977a: table 8). As just noted, however, perhaps Desert Side-notched and Cottonwood points were seldom repaired at all and simply removed from the shaft and discarded in the field.

Of all the above explanations, and these by no means exhaust the possibilities, the first is the most likely: that these bases represent a design flaw inherent in early narrow-based point forms developed in conjunction with narrow arrow shafts.

A summary of the metric data for Rose Spring Corner-notched projectile points is given in table 9.11. Note that these measurements are for the specimens that have retained some portion of the blade, the basal fragments being too incomplete to provide any of the standard measurements.

Rose Spring Side-notched (5 specimens, all obsidian). Two of these points, both of them basal fragments retaining a small portion of the lower blade, are well made and exhibit deep, narrow notches and convex bases (fig. 9.12b, c). The other three are more crude (fig. 9.12a, d, e). One has been unifacially flaked to produce a relatively thick, narrow point that is triangular in cross section with straight sides and a moderately convex base. The remaining two points are relatively short and stubby, perhaps as the result of resharpening. Both lack all or part of their bases and are classified as Rose Spring Side-notched, rather than Desert Side-notched, because their blades are thicker and their notches are shallower than those of Desert Side-notched points. Metric data obtained from this small and fragmentary sample are summarized in table 9.11.

Rose Spring Contracting Stem (1 specimen; obsidian). The only point typed as Rose

TABLE 9.11
Metrical Data for Certain Projectile Point Types from Crater Middens

		Length (cm)	Width (cm)	Thickness (cm)	Weight (g)
Rose Spring					
Corner-notched	$\bar{x}$		1.61	0.41	
	S		0.27	0.08	
	n		12	17	
	Range		2.1–1.3	0.6–0.3	
Side-notched	$\bar{x}$	1.80	1.10	0.40	
	S		0.14	0.10	
	n	1	2	3	
	Range		1.2–1.0	0.5–0.3	
Eastgate					
Expanding Stem	$\bar{x}$	2.8	2.3	0.32	
	S			0.04	
	n	1	1	5	
	Range			0.4–0.3	
Cottonwood					
Triangular	$\bar{x}$	1.98	1.37	0.32	0.81
	S	0.34	0.23	0.09	0.49
	n	12	36	43	10
	Range	2.5–1.4	1.7–0.9	0.6–0.2	1.9–0.2
Leaf	$\bar{x}$	2.13	1.00	0.28	0.68
	S	0.35	0.16	0.10	0.29
	n	4	4	4	4
	Range	2.5–1.7	1.2–0.8	0.4–0.2	1.0–0.3
Bipoint	$\bar{x}$	2.4	0.95	0.30	0.4
	S		0.07	0.10	
	n	1	2	2	1
	Range		1.0–0.9	0.4–0.2	
Desert Side-notched	$\bar{x}$	2.00	1.21	0.28	0.99
	S	0.33	0.15	0.06	0.14
	n	27	38	49	22
	Range	2.5–1.3	1.6–0.9	0.4–0.2	1.3–0.8

Spring Contracting Stem (O-2591) is broken acutely across the blade and lacks the distal end and one shoulder (fig. 9.12f). The piece is well made with straight sides, a barbed shoulder, and a short, wide stem with straight sides and a convex base. The only measurement that could be obtained from this fragment is thickness, which is 0.4 cm.

Unclassified Rose Spring Series Fragments (6 specimens; all obsidian). These fragments could not be identified as representing any specific Rose Spring type but on the basis of size and shape were placed within this series (fig. 9.12g–l). Four are blade fragments that snapped at the neck; three of them are complete from that point to the distal end. A fifth fragment lacks most of its base and the distal end. The remaining specimen (O-1924) is largely intact, lacking only a small part of the distal end, but does not fit readily in any of the recognized Rose Spring types, though it might be provisionally classified as either Rose Spring Corner-notched or Rose Spring Contracting Stem. This piece is relatively thick and narrow, with convex sides, sloping shoulders, and slightly expanding, straight-based stem that is about as long as it is wide. The maximum width is 1.4 cm, thickness is 0.6 cm, and basal width is 0.8 cm. The lack of proportion between the relatively thick and heavy blade and diminutive stem of this piece is particularly noteworthy given the sugges-

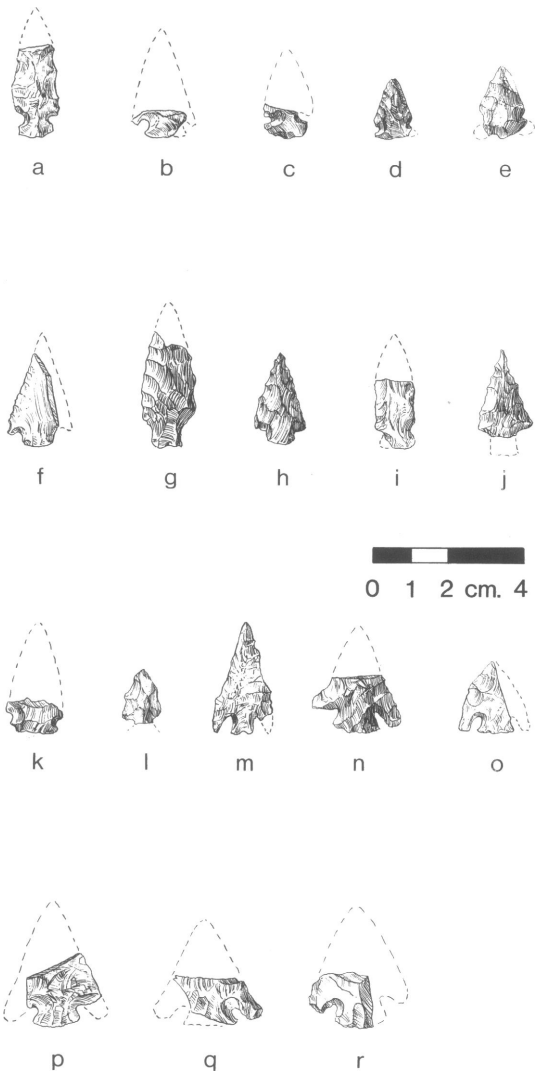

Fig. 9.12. Rose Spring and Eastgate projectile points from Crater Middens. **a–e.** Rose Spring Side-notched; **f.** Rose Spring Contracting Stem; **g–l.** unclassified Rose Spring series fragments; **m–r.** Eastgate Expanding Stem. a. O-3026; b. O-1958; c. O-671/2; d. O-409; e. O-790; f. O-2591; g. O-1924; h. O-427; i. O-4138; j. O-3258; k. O-615; l. O-651; m. O-3321; n. O-614; o. O-4003; p. O-2835; q. O-4006; r. O-776.

tion earlier that the excessive neck breakage noted in Rose Spring Corner-notched points might be the result of a point design that incorrectly matched stem width and blade size.

EASTGATE SERIES: *Eastgate Expanding Stem* (6 examples; all obsidian). There is a broad range of variability among these points in terms of the execution of details, but all of them can be described as broad and thin (table 9.11) with deep, narrow notches (fig. 9.12m–r). Workmanship is uniformly good. None of these points is complete but one lacks for only one barb. Cross sections are lenticular with the exception of one point that is planoconvex as the result of having been extensively flaked on only one side, leaving the opposing face of the large flake from which it was made unmodified except for a series of steep marginal resharpening flakes. The barbs on four specimens are square, on one specimen pointed, and of uncertain configuration on one specimen from which both are missing. Bases vary from straight to moderately convex.

COTTONWOOD SERIES: Along with those of the Desert Side-notched series, Cottonwood series projectile points dominate the collection of typable points recovered at Crater Middens. A total of 49 specimens was classsified as belonging to this series (fig. 9.13). The bulk of these are Cottonwood Triangular but Cottonwood Leaf is also present and two specimens were provisionally typed as Cottonwood Bipoint.

Cottonwood Triangular (43 specimens; 36 obsidian, 6 chert, 1 chalcedony). As is typical for this type, the Cottonwood Triangular points occur in a wide range of sizes and shapes but they all can be described as small, light, and essentially triangular in outline (fig. 9.13a–qq; table 9.11). Workmanship is generally good. Many have been worked extensively on only one face leaving the obverse—generally the ventral face of the flake from which it was made—unmodified except for marginal retouch. Such pieces, which are typically planoconvex in cross section, are, however, far outnumbered by those that have been flaked on both sides and are lenticular in cross section. Blade sides and point bases vary from moderately convex to moderately concave. One specimen (O-2266) is serrated.

Cottonwood Leaf (4 specimens; all obsidian). Four essentially complete Cottonwood Leaf projectile points were recovered at Crater Middens (fig. 9.13rr–uu). All four are relatively narrow and thick, but one is rather

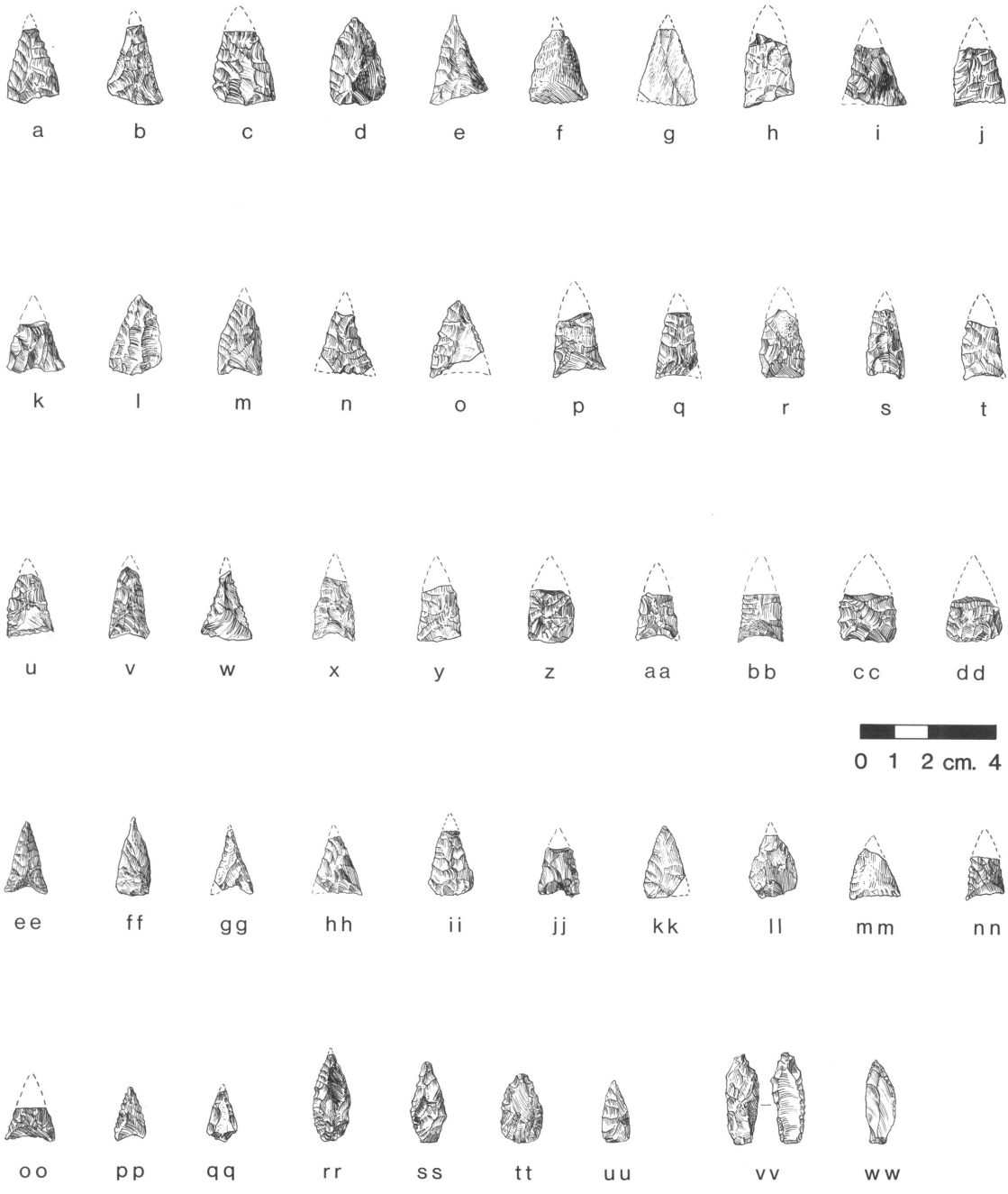

Fig. 9.13. Cottonwood Series projectile points from Crater Middens. a-qq. Cottonwood Triangular; rr-uu. Cottonwood Leaf; vv-ww. Cottonwood Bipoint. a. OV-283; b. O-2294; c. O-1955; d. O-2876; e. O-670/2; f. O-3532; g. O-1892; h. O-4789; i. O-749; j. O-4855; k. O-428; l. O-2318; m. O-802; n. O-3730; o. OV-292; p. O-3398; q. O-3098; r. O-4047; s. O-2726; t. O-3731; u. O-3507; v. O-386; w. O-3679; x. O-3906; y. O-4790; z. O-3533; aa. O-2436; bb. O-764; cc. O-3965; dd. O-1956; ee. O-792; ff. O-801; gg. O-3399; hh. O-410; ii. O-4647; jj. O-803; kk. O-2120; ll. O-3769; mm. O-4716; nn. O-4396; oo. O-3964; pp. O-2266; qq. O-3678; rr. O-3768; ss. O-3397; tt. O-791; uu. O-3531; vv. O-3134; ww. O-668.

more squat in outline than the other three. Three are lenticular in cross section and one is planoconvex, its flat face exhibiting only marginal edge retouch on an otherwise unmodified flake surface. Measurements for these specimens are summarized in table 9.11.

Cottonwood Bipoint (2 specimens; 1 obsidian, 1 chert). Two points were identified as Cottonwood Bipoint (Lanning, 1963: 253)—a variant subtype of the Cottonwood Leaf type—though it is by no means clear that this identification or even their classifications as projectile points, is correct (fig. 9.13vv, ww). Both are quite narrow with respect to their lengths, lenticular in plan, and planoconvex in cross section, the flat face of each exhibiting only marginal edge retouch, which left the balance of the original flake face intact (table 9.11). The opposing convex face of one (O-3134) is extensively flaked but that of the other (O-668) is merely the faceted dorsal face of the original flake, modified only by marginal edge retouch. Both pieces exhibit a slight constriction at one end that evidently marks the beginning of the stem. Neither can be said to be well made but both are certainly within the range of workmanship that typically characterizes Cottonwood series points. The larger of the two (O-3134), which is made of chert, lacks part of the distal end; the smaller (O-668), made of obsidian, is complete.

Each of these artifacts is aberrant in comparison to the balance of the points classified here as belonging to the Cottonwood series. The larger specimen bears some resemblance to certain drill forms, the smaller one to somewhat larger artifacts that have in northeastern California been interpreted as chipped pendants (cf. O'Connell,1975: fig. 6d).

DESERT SIDE-NOTCHED: The Desert Side-notched type, along with the Cottonwood series, dominates the assemblage of projectile points recovered from Crater Middens and is represented by 64 specimens (fig. 9.14), of which 48 can be placed in the subtypes defined by Baumhoff and Byrne (1959).

Sierra (20 specimens; 12 obsidian, 6 chert, 2 chalcedony). All of these pieces exhibit the neatly executed basal notch that defines this subtype (fig. 9.14a–t). Workmanship is uniformly good and in general great care was given to the execution of minor details. Both lenticular and planoconvex cross sections are present, the former outnumbering the latter. The blade sides are straight. Four specimens appear to have been resharpened. There are six basal fragments that snapped across the neck. Two of these, however, clearly broke during manufacture as each exhibits only one side-notch, the breakage evidently occurring during the execution of the second side-notch. From this it can be tentatively concluded that in Desert Side-notched points (at least those of the Sierra subtype), the side-notches were finished last, which makes sense given that the severe notching on these points creates an obvious point of weakness.

It is notable that 40 percent of these points are made of material other than obsidian; no other point subtype, type, or series for which there is a sample of reasonable size in any of the collections considered here displays similarly high frequencies of these materials.

General (21 specimens; 19 obsidian, 1 chert, 1 chalcedony). There is a broad range of variation in workmanship among these points, but in general they are well made (fig. 9.14u–oo). Blade sides are typically straight and cross sections lenticular to planoconvex, the flat side of the latter corresponding to the minimally retouched face of the flake from which the piece was made. Bases vary from moderately to deeply concave (12 examples) to straight (9 examples). Two specimens appear to have been resharpened and there are six basal fragments that snapped across the neck, apparently during use rather than in manufacture. One piece (O-3719) exhibits shallow serration.

Delta (7 specimens; 6 obsidian, 1 chert). The seven points representing this subtype at Crater Middens are somewhat thicker than is normal for the Desert Side-notched series and, perhaps as the result of this, their notches are wider and shallower than those on most Desert Side-notched pieces (fig. 9.14pp–vv). Blade sides are straight and cross sections are predominantly lenticular but one exhibits a planoconvex cross section and, along with two that are lenticular in section, retains in the center of the blade a large unmodified area that is the unworked face of the original flake from which it was fashioned. One specimen (O-3657) is serrated, one (O-2389) ap-

Fig. 9.14. Classifiable Desert Side-notched projectile points from Crater Middens. a–t. Sierra subtype; u–ff. General subtype with concave base; gg–oo. General subtype with straight base; pp–vv. Delta subtype. a. O-4592; b. O-4376; c. O-4004; d. O-484/B; e. O-1829; f. O-484/A; g. O-4569; h. O-3960; i. O-3848; j. O-4858; k. O-3961; l. O-794; m. O-2423; n. O-3907; o. O-4679; p. O-2400; q. O-3771; r. O-3962; s. O-4881; t. O-4859; u. O-3099; v. O-3770; w. O-2119; x. O-2062; y. O-2118; z. O-4079; aa. O-804; bb. O-3656; cc. O-3535; dd. O-2319; ee. O-4857; ff. O-2727/A; gg. OV-291; hh. O-459; ii. O-702; jj. O-4678; kk. O-3719; ll. O-4791; mm. O-3871; nn. O-3963; oo. O-3732; pp. OV-284; qq. O-793; rr. O-2364; ss. O-2363; tt. O-2389; uu. O-3657; vv. O-2151.

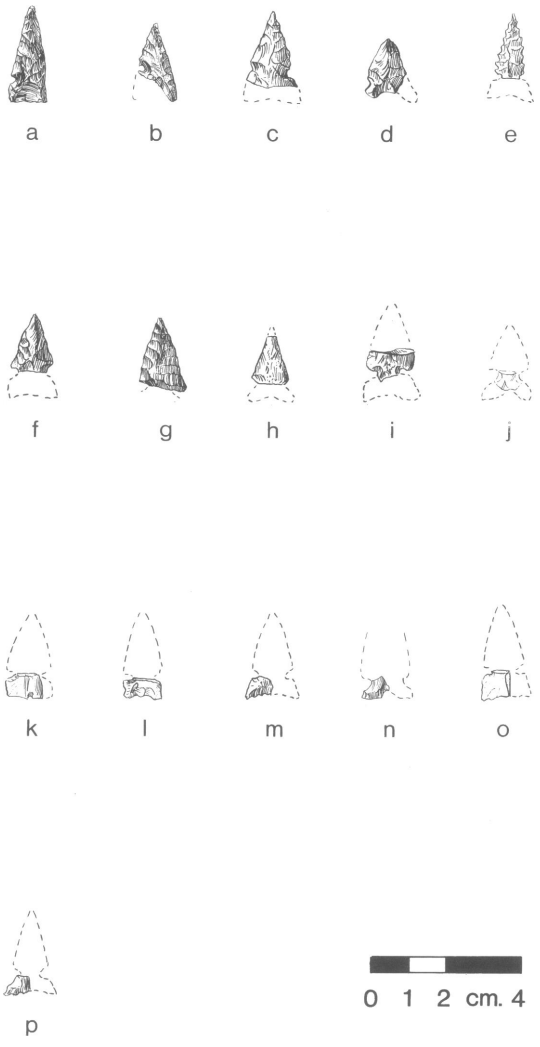

Fig. 9.15. Unclassified Desert Side-notched projectile point fragments from Crater Middens. a. O-687/2; b. O-485; c. O-1925; d. O-2469; e. O-3400; f. O-3536; g. O-777; h. O-4911; i. O-3733; j. O-2727/B; k. O-4648; l. O-2674; m. O-4005; n. O-714; o. O-4856; p. O-1898.

pears to have been resharpened, and one (O-2151) is a basal fragment that snapped across the neck, possibly during use.

Unclassified Desert Side-notched Fragments (16 specimens; 14 obsidian, 1 chert, 1 chalcedony). A total of 16 point fragments were identified as belonging to the Desert Side-notched type on the basis of notching size and location but were too incomplete to be confidently placed in any of its recognized subtypes (fig. 9.15). Where present, the blades are straight-sided and convex in cross section. Two examples are serrated—an ear (O-4005) and a blade (O-3400). Three specimens appear to have been broken during manufacture. Two of these (O-777, O-687/2) exhibit only one side-notch; the third exhibits one side-notch and the basal notch. In combination with the two Sierra subtype specimens broken during manufacture (see above), these pieces would suggest that Desert Side-notched points were first notched on one side, then notched, thinned, or hollowed on the base, and finally notched on the remaining side.

Metric data for all Desert Side-notched points, undistinguished as to subtype, are furnished in table 9.11.

UNTYPABLE PROJECTILE POINT FRAGMENTS: Thirty-nine fragmentary artifacts with notches were identified as projectile points but could not be confidently placed in any particular type or series. Of these, 8 are large enough to suggest dart points, 15 are small enough to suggest arrow points, and the remaining 16 could not be assigned to either size category. A total of 36 are obsidian and the remaining 3 are chert.

DISCUSSION: The composition of the Crater Middens projectile point collection is summarized in table 9.12 according to the archaeological phases identified by Bettinger (1975a). Collections made at the site in 1972 are given separately. The composition of the combined collections of projectile points from other Desert Scrub occupation sites located in 1972—including Two Eagles, but not Crater Middens, the collections from Pinyon House and Two Eagles, and the combined collections from the pinyon camps located during the 1972 surface survey are also provided for comparison. Humboldt series points and Cottonwood Bipoints from Crater Middens are excluded as uncertain regarding either dating or typological identity.

It is remarkable that these figures should be so closely in accord, given the differences in settlement categories and collection methods represented. The discrepancy between the 1972 collection and the total collection now in hand for Crater Middens is clearly the result of sampling error. The same appears to be true of the differences between the com-

TABLE 9.12
Phase Composition of Projectile Point Assemblages from Crater Middens, Pinyon House, Two Eagles, and Other 1972 Survey Occupation Sites and Pinyon Camps

	Clyde Phase	Cowhorn Phase	Baker Phase	Klondike Phase	Total
Crater Middens					
1972				4 (100%)	4
Total		8 (4%)	60 (34%)	111 (62%)	179
Two Eagles		2 (5%)	16 (37%)	25 (58%)	43
Pinyon House	1 (2%)	4 (6%)	19 (30%)	40 (63%)	64
1972 Survey					
Other Desert Scrub occupation sites[a]		1 (6%)	4 (22%)	13 (72%)	18
Pinyon camps[a]		1 (2%)	17 (35%)	30 (63%)	48

[a] Bettinger, 1975a.

bined projectile point samples from the other Desert Scrub occupation sites located in 1972 and the complete Crater Middens collection. Aside from this, there are virtually no differences at all that require attention excepting, perhaps, the slight emphasis toward earlier occupation at Two Eagles. Even this tendency, however, is neither particularly pronounced nor statistically significant (cf. Kolmogorov-Smirnov 2-sample test: Siegel, 1956: 127–136) and might easily be overlooked were it not consistent with the somewhat earlier dating of this site suggested by obsidian hydration rim measurements.

OTHER CHIPPED STONE ARTIFACTS

BIFACES: The category of bifaces is well represented at Crater Middens (tables 9.13, 9.14).

Simple Bifaces (536 specimens; 457 obsidian, 50 chert, 29 chalcedony). Simple bifaces are extremely abundant in the Crater Middens collection. Most of the specimens are small fragments (table 9.15) which, as noted previously in the discussion of the bifaces from Pinyon House and Two Eagles, most likely represent stoneworking debris rather than the cutting, sawing, and scraping tasks for which bifaces are thought to have been used. There are several examples in which burin spalls, evidently detached using the bipolar technique in conjunction with an anvil, were removed to prepare a tool edge for further flaking.

Only 10 bifaces were complete or nearly complete. Of the remainder, 212 are tip sections, 78 are midsections, 69 are butt sections, and 167 could not be reliably identified as representing any particular tool segment. It is probably worth noting that at least some of the tip sections, midsections, and unidentifiable fragments may derive from projectile points rather than bifaces.

For the most part, the biface shapes represented at Crater Middens duplicate those found at Pinyon House and Two Eagles. The majority range between ovate and triangular in plan, with straight to convex sides and bases, but the sides of a few are moderately concave. Cross sections are most commonly lenticular but planoconvex specimens are well represented. Evidence of resharpening, both unifacial and bifacial, is frequently encountered and is often advanced to the point that the tool edge is blunt to the point of being rounded. Wear patterns include edge crushing, abrasion, nicking, and step-fracturing.

Within this collection, certain specimens merit more detailed description. Among these are four large complete or nearly complete bifaces made of a distinctive gray-green chert which accounts for the vast majority of nonobsidian chipped stone tools and debitage at Crater Middens (fig. 9.16). The source of this chert is Eureka Valley, approximately 50 km to the east. The two largest of these four bifaces, both of them found in Structure 16, are quite broad and thin and fashioned principally by the removal of broad thinning flakes and very little pressure retouch. The larger of the two (O-3850), which is complete and

TABLE 9.13
Distribution of Other Chipped Stone Artifacts at Crater Middens

	Midden I			Midden II						Midden III			Midden IV		Midden V		
	St. 3	Surf.	Midden	St. 7	St. 9	St. 10	St. 12	Surf.	Midden	St. 16	Surf.	Midden	Surf.	Midden	Surf.	Midden	Total
Bifaces																	
Simple bifaces	4	4		6	9	9	26	78	172	62	34	84	20	27	1		536
Humboldt Basal-notched					1			1	1								3
Flake knives		1			1		2	2	2	3	1	2					14
Roughouts		4		1	5	3	6	48	80	27	40	56	34	30	2	1	337
Point blanks							2	2	3	6	2	1	4	1			21
Drills																	
Flake	1	1		1				2	4	3	1	3	1	2			19
Shaped									2			1		1			4
Reworked																	
Desert Side-notched					1												1
Rose Spring								1									1
Biface								1						1			2
Bits									6	1	1	6	1	1			16
Unifaces	2	1		1	2	3	9	10	43	25	19	44	9	10	1		179
Eccentrics						1						1					2
Choppers																	
Large		1							6			1					8
Small							1		1	1							3
Cores		2		1	2	1	9	8	31	20	15	8	19	6	1		123

TABLE 9.14
Subsurface Distribution of Other Chipped Stone Artifacts at Crater Middens

	Midden I	Midden II					Midden III						Midden IV					Midden V				
	0–10	0–10	10–20	20–30	30–40	40–50	0–10	10–20	20–30	30–40	40–50	50–60	0–10	10–20	20–30	30–40	40–50	0–10	10–20	20–30	30–40	Total
Bifaces																						
Simple bifaces		79	44	37	12		31	26	12	11	4		14	7	2	3	1					283
Humboldt Basal-notched		1																				1
Flake knives		2					1		1													4
Roughouts		39	24	14	3		23	14	6	7	6		10	13	3	2	2	1				167
Point Blanks		3						1						1								5
Drills																						
Flake		1	1	1	1		1		1	1				1	1							9
Shaped			1	1			1								1							4
Reworked biface															1							1
Bits		2	1	2	1		4	1		1					1							13
Unifaces		19	12	8	4		18	10	4	9	3		4	4	1		1					97
Eccentrics							1															1
Choppers																						
Large		1	1	3	1					1												7
Small				1																		1
Cores		19	7	2	3		5		1	2			1	1	2	2						45

TABLE 9.15
Metrical Data for Bifaces, Roughouts, and Point Blanks from Crater Middens

		Length (cm)	Width (cm)	Thickness (cm)	Weight (g)
Bifaces					
Simple	$\bar{x}$	3.90	2.34	0.57	
	S	2.00	0.86	0.20	
	n	8	37	55	
	Range	7.9–1.9	4.8–0.9	1.1–0.3	
Humboldt Basal-notched	$\bar{x}$	3.80	1.73	0.57	
	S	2.83	0.51	0.12	
	n	2	3	3	
	Range	5.8–1.8	2.3–1.6	0.7–0.5	
Flake knives	$\bar{x}$	3.54	1.88	0.44	
	S	0.51	0.76	0.18	
	n	5	5	12	
	Range	4.1–2.8	2.9–1.0	0.8–0.2	
Roughouts	$\bar{x}$	2.75	2.02	0.81	
	S	0.75	0.47	0.27	
	n	124	158	183	
	Range	5.7–1.4	3.6–0.8	2.0–0.4	
Point blanks	$\bar{x}$	2.26	1.77	0.34	1.33
	S	0.49	0.33	0.06	0.50
	n	7	9	17	7
	Range	2.9–1.6	2.5–1.4	0.4–0.2	2.09–0.92

still retains a segment of the flat platform of the flake blank out of which it was fashioned, is ovate in outline and measures 7.9 cm long, 4.8 cm wide, and 0.7 cm thick (fig. 9.16a). The smaller example (O-4010), which is broken at the base, is also essentially ovate but somewhat more narrow and pointed at the distal end than the first and measures 7.4 cm long, 4.4 cm wide, and 0.8 cm thick (fig. 9.16b). The absence of fine pressure retouch gives these pieces the appearance of blanks, but nicking and abrasion along the edges of both make it clear that they are finished tools that had been well used.

The two other essentially complete chert bifaces differ from the two described above both in terms of size and in degree of finish. One (O-3856), also found in Structure 16, is rather narrow with respect to its length, quite irregular in outline and cross section, and in its present condition measures 6.2 cm long, 3.3 cm wide, and 1.0 cm thick (fig. 9.16c). The distal end of this piece is missing and the base and both sides have been steeply retouched in the course of resharpening or reshaping the tool. It is this steep retouch, predominantly by percussion, that accounts for its irregular outline and cross section. Both lateral edges exhibit substantial use-wear in the form of crushing, nicking, and abrasion.

The remaining chert biface (O-3510), which is complete, is in outline asymmetrically diamond-shaped, with a long, tapering, straight-sided blade and a more steeply converging stem. It is 5.8 cm long, 2.8 cm wide, and 0.6 cm thick (fig. 9.16d). Both sides of this piece exhibit fine pressure retouch which, on one face, is in the form of diagonal parallel flaking. A slight constriction of the blade just above the contracting stem clearly indicates that this biface had been either resharpened or reshaped. There is delicate nicking along both lateral edges as the result of use.

Despite the marked differences in shape and degree of finish among these four bifaces, it is likely that they all represent precisely the same tool form but at different stages within their use cycles. The two largest clearly represent the initial form—relatively little used and not yet resharpened. The finely finished biface, smaller than the first two, has clearly been resharpened at least once, and possibly

TABLE 9.16
Metrical Data for Flake Drills from Crater Middens

	Length (cm)	Width (cm)	Thickness (cm)	Bit length (cm)	Bit width (cm)	Bit thickness (cm)
$\bar{x}$	2.30	1.59	0.41	0.90	0.78	0.29
S	0.39	0.35	0.11	0.41	0.40	0.10
n	10	14	17	15	18	19
Range	2.8–1.7	2.2–1.1	0.6–0.2	1.6–0.2	2.2–0.4	0.5–0.1

many times, and might easily derive from a thin, percussion-flaked biface similar to the two in the Crater Middens collection. The irregular specimen is obviously in an advanced state of wear and, as is clear from the steeply retouched edges, has been resharpened numerous times. It is not unreasonable to suggest that it originally resembled the other specimens in shape—though its thickness indicates it was clearly larger—but through repeated use and resharpening gradually grew more narrow (and therefore thicker with respect to width) and more steep-edged until in its present state it could no longer be resharpened without drastic reshaping. That this piece was recovered in the same context as the two relatively fresh percussion-flaked bifaces, i.e., in Structure 16, suggests that such reshaping was intended and that this artifact was not discarded as unusable trash.

There is a fifth gray-green chert biface, also recovered in Structure 16, that may represent yet another, further advanced, stage of use and rejuvenation of this same basic biface form. This diminutive biface (O-3735) measures 3.6 cm long, 1.6 cm wide, and 0.5 cm thick (fig. 9.16e). Shaping is almost entirely by pressure although there is one large remnant percussion flake scar. Edge polish and nicking indicate use of this artifact in sawing, scraping, and cutting rather than as a projectile point, which it resembles in size and shape. It may be that this piece is essentially in its original condition, being made from a small blank or flake. Given the exhaustive use and reduction sequence postulated for the large chert bifaces described above, however, the interpretation favored here is that it represents the extension of that pattern to its logical conclusion, either by the drastic reworking of a large, thick misshapen specimen or the gradual reduction by delicate pressure work of a specimen that had merely become dull. It is unlikely that this piece would have yielded to additional resharpening by the detachment of thinning flakes but the edge could have been rejuvenated by steep edge retouch, which would have extended its lifespan somewhat.

It is clear from these five bifaces that the distinctive Eureka green chert of which they were made was highly valued as a source of tools and that implements fashioned from it were carefully reworked to extend their utility, not casually discarded and replaced with another of similar kind. This is in keeping with the difficulty and effort that would have been needed to obtain this material, either directly or by trade. At the same time, the obvious skill with which it was worked suggests that this material must have been procured on a sufficiently regular basis that local craftsmen were familiar with its particular fracture quality and resistance to shattering. It is relevant in this regard that the frequency of this green chert appears to increase in debitage samples from late prehistoric contexts, which is consistent with the late prehistoric dating suggested for the three large bifaces and the diminutive biface found in Structure 16. The subsequent discussion of debitage from Crater Middens and concluding chapter dealing with this site review the implications of the apparent late prehistoric rise in this imported chert biface industry in relation to trade, settlement patterns, and sociopolitical organization.

In comparison to those made of green chert, including fragmentary specimens not described above, bifaces made of obsidian and chalcedony are less consistent in form and more eclectic with respect to reuse and resharpening. Among the obsidian bifaces there are no counterparts for the broad, thin, per-

cussion-flaked green chert bifaces, perhaps because obsidian is too brittle to sustain the thin working edges that characterize these implements. A few chalcedony biface fragments, on the other hand, are reminiscent of this form in breadth, thickness, and pattern of flaking. With regard to recycling, although many obsidian and chalcedony bifaces have clearly been used, resharpened, and reshaped to the point of exhaustion, many other apparently salvageable specimens seem to have been discarded prematurely. In the case of the obsidian bifaces, this may have been a matter of momentary supply. This material was certaintly obtained in large quantities on a regular basis and it is reasonable to assume that when the supply on hand was relatively large, craftsmen would be more likely to fashion a new implement than attempt to reshape an older one, the lifespan of which would be relatively limited. As supplies dwindled, however, more effort would presumably be expended in recycling older, misshapen tools.

The discard of still-useful chalcedony biface fragments cannot be similarly explained as a function of the supply, which could never have been large judging from the low frequency (5%) of chalcedony in this category. It may be that chalcedony was so seldom available to the inhabitants of Crater Middens and they were so unfamiliar with its properties of fracture that they were unable to rework it efficiently. Alternatively, it may be that the material did not lend itself to being reworked, or that—being more brittle than chert—the combination of its intractability, the lack of familiarity with it on the part of craftsmen, and its less durable working edge, did not make it regularly worthwhile to rework chalcedony bifaces. In contrast to both obsidian and chalcedony, green chert yielded a very durable edge and though consistently in low supply was procured with sufficient frequency that craftsmen were able to rework it efficiently or, lacking this, found it naturally tractable, with the result that bifaces made of it were consistently reworked and recycled to the point of exhaustion.

That obsidian bifaces may on occasion have been worked to this degree is suggested by a very small, carefully worked biface (O-1819) that is only 1.9 cm long, 0.9 cm wide, and 0.3 cm thick. The convex sides, straight base, and lenticular cross section of this leaf-shaped piece give it the appearance of a Cottonwood series projectile point but it is somewhat thicker than they and there is abrasion and nicking along its edges as the result of use. The occurrence of this piece in Structure 3, which is isolated from the locations of most intensive activity at Crater Middens and may be a seclusion hut used during childbirth (see chap. 4), suggests the possibility that this miniature biface may not represent the exhaustive use and recycling of obsidian bifaces, however, but some special ritual or activity that took place in this isolated structure.

Humboldt Basal-notched Bifaces (3 specimens; all obsidian). Three bifacially flaked lanceolate obsidian bifaces, all exhibiting edge abrasion and nicking as the result of use and facial abrasion as the result of use and handling, were provisionally classified as examples of the Humboldt Basal-notched type. None of these, however, fits the accepted definition of the type exactly (table 9.15). The largest of the three (O-2322), which is complete, is essentially triangular in outline, with straight sides and a base that is more moderately convex than is usual for the Humboldt Basal-notched type (but see Bettinger, 1978: fig. 1e, f). It is 5.8 cm long, 2.3 cm wide, and 0.7 cm thick. Use-wear along both lateral edges of this piece is advanced and the relatively steep edge angles indicate it has been resharpened. Except for its somewhat more deeply concave base, this biface is almost a perfect duplicate of the "skinning knife" of the historic Owens Valley Paiute illustrated in Steward (1933: fig. 3i).

A second biface (O-3401), substantially smaller than the first but also exhibiting advanced use-wear, closely resembles the Humboldt Basal-notched biface type in shape (being roughly triangular in outline with a deeply concave base) but not size (being smaller than nearly all specimens of this type). Lacking a fraction of the distal end, it is 2.6 cm long, 1.6 cm wide, and 0.5 cm thick. Like the first specimen, this piece has been resharpened. As the basal portions of Humboldt Basal-notched bifaces are virtually identical in shape to those of Little Lake series projectile points, there is the possibility

that this biface was reworked from a point belonging to this series.

The third specimen (O-2196) is still smaller but has obviously been reworked and in its original state may have been comparable in size to the other small specimen to which it is identical in thickness. In shape, this biface fits comfortably within the Humboldt Basal-notched biface type; the outline is triangular, the base deeply concave. It measures 1.8 cm long, approximately 1.3 cm wide, and 0.5 cm thick. There is nicking and crushing along both lateral edges that is apparently the result of use, but because these edges are very short, the pattern of wear is difficult to discern and there is the possibility that this damage is the result of an abortive attempt to reshape a projectile point. The facial abrasion observed on this piece, however, though less pronounced than that on the other two, would suggest that it had been handled and used more extensively than is usual unless it had been reworked from a biface fragment or a projectile point that had been trampled underfoot before being retrieved for recycling.

Given their lack of conformance to the accepted definition of the Humboldt Basal-notched biface type, these three pieces are not regarded as reliable time-markers, but all three are identified as bifacial knives on the basis of use-wear.

Flake Knives (14 specimens: 7 obsidian, 7 chert). Flake knives of obsidian are proportionally more common at Crater Middens than at either Pinyon House or Two Eagles. Nevertheless, chert accounts for half of the specimens recovered, which is substantially greater than would be expected given the frequency with which this material is represented in samples of debitage and most other chipped stone tool categories. There is a marked lack of consistent form among these tools but most appear to be large flakes too oddly shaped to be worked into such more formal tools as projectile points or simple bifaces. Thus, at Crater Middens, as at Pinyon House and Two Eagles, flake knives probably reflect an attempt on the part of aboriginal craftsmen to extract some use from material that would have otherwise gone to waste. As this artifact type is not frequently encountered at any of the sites considered in this volume, however, it is presumed that its more formal equivalents, specifically simple bifaces, were more efficient either in respect to working characteristics or susceptibility to resharpening.

The largest complete example from Crater Middens (O-432) is 4.1 cm long, 2.9 cm wide, and 0.9 cm thick; the smallest (O-3773) is 2.8 cm long, 1.0 cm wide, and 0.5 cm thick, but several fragmentary pieces, one only 0.2 cm thick, appear to derive from much smaller tools (table 9.15).

Use-wear is not pronounced and in most instances consists of abrasion, nicking, and crushing that is not readily visible without magnification although its presence can often be detected by touch, the worn edge being smoother and more regular in contour than one that is unmodified.

ROUGHOUTS (337 specimens; 314 obsidian, 21 chert, 1 chalcedony, 1 quartzite): A large fraction of the roughouts from Crater Middens (tables 9.13, 9.14) are imperfect in the sense that they are too misshapen to be easily worked and appear to be rejects rather than blanks set aside to be finished in the future. Nevertheless, the bulk seems suitable for some attempt at shaping and eventual use—though perhaps not as points or knives as was presumably intended originally. The impression, therefore, is one of nonintensive raw material use, most likely because a source of workable stone—the Fish Springs obsidian quarry—lies less than 5 km to the south. In addition, as a large and intensively occupied permanent village, Crater Middens was doubtless routinely restocked with raw materials, which is in contrast to less regularly used camps where the only source of supply was the personal gear brought there on each excursion.

Examples made of chert, chalcedony, and quartzite are proportionally less common in this category (7%) than in those of projectile points (13%), bifaces (15%), and drills (30%), which suggests that these materials were imported in finished form or as blanks considered too valuable to be discarded without persistent attempts to shape them into useful tools of some kind.

Excepting those that are poorly shaped or amorphous, for the most part these roughouts

vary from oval to subrectangular in outline and from lenticular to rectangular in cross section. Those specimens exhibiting emergent tool forms suggest small bifaces and projectile points.

Bipolar flaking is evident on many specimens and was used to redress ragged transverse fractures and blunted edges—patterns also commonly observed on bifaces—as well as to thin the more blocky pieces by blows struck transversely or longitudinally. Metrical data for the roughouts from Crater Middens are given in table 9.15.

It is worth mentioning at this juncture that for all the central Owens Valley collections considered in this volume the distinctions between roughouts, unifaces, and cores are occasionally difficult to apply and that there are no doubt pieces in all three categories that have been misattributed. This is due firstly to the lack of technical formalization within these categories and secondly to the generalized employment of certain manufacturing techniques for a wide range of purposes. Unifacial edge retouch, for instance, was used as a method of edge preparation for bifaces and roughouts, as a method of platform preparation for cores, and as a method of forming a working edge for unifaces. Similarly, bipolar flaking was used as a method of reedging and trimming bifaces and roughouts, as a method of thinning roughouts, and as a method of removing flakes from cores. Both the lack of formality within categories and the generalized use of particular stoneworking techniques—and the problems of archaeological taxonomy they engender—would appear to be attributable primarily to the peculiar characteristics of Fish Springs obsidian, which typically occurs as small cobbles and nodules flawed with weak, ash-filled fissures subject to frequent breakage. Routinely working with this material, stoneworkers in central Owens Valley would have been able to follow no specific reduction sequence in the manufacture of stone tools and probably changed both their procedures and intended tool form according to the character of each piece and the flaws encountered as it was worked. This would necessarily result, in many instances, in rejects rather than useful tools. Thus, the abundance of flake waste that litters the surface of sites in central Owens Valley may be deceptive, reflecting not affluence alone but also the constant failures that stemmed from reliance on a raw material that, though available in virtually limitless quantity, was of only marginal value for stone tools. That the roughouts from Crater Middens were not more intensively worked, therefore, seems best explained by the argument that with a ready supply of raw material nearby, the high rate of manufacturing failure produced more rejects than were needed—in recycled form—as drills and unifaces, especially since easy access to a quarry nearby made it more economical to begin work on a new piece than to expend time attempting to turn a difficult one into a point or knife.

POINT BLANKS (21 specimens; 14 obsidian, 7 chert): Given the size of the lithic collection from Crater Middens, it is surprising that so few projectile point blanks were found (tables 9.13, 9.14). Two-thirds of the point blanks that were found are broken and, with only one or two exceptions, the rest seem to have been discarded because of flaws or oddities of form that would have made them difficult to shape into finished points.

All of these blanks remain substantially unmodified on one or both faces. Where it can be inferred, outline varies from triangular to subovate in plan, the shaping being done by steep unifacial edge retouch. Several specimens exhibit partial thinning by more invasive pressure retouch extending inward from the unifacially retouched edges.

A relatively large proportion of these point blanks are chert (33%). These may have been imported to the site directly. It seems more likely, however, that this material was so valued that the larger waste flakes resulting from the manufacture of bifaces were carefully saved for use as blanks and—as already noted—drills and flake knives, the latter closely resembling these blanks.

As is also true of the specimens from Pinyon House, the Crater Middens point blanks are in both shape and size most similar to points of the Cottonwood and Desert Side-notched series: their thickness, in particular, virtually precludes the possibility that they could have been shaped into any other type or series (table 9.15).

DRILLS (43 specimens; 30 obsidian, 12 chert, 1 chalcedony): Of the 43 whole and

fragmentary drills recovered at Crater Middens (tables 9.13, 9.14), 19 were made by retouching flakes, 4 were intentionally shaped as drills, 4 were reworked from projectile points or bifaces, and the balance, 16 in all, are fragmentary bit sections the original configuration of which is unclear.

The flake drills vary somewhat in size and shape (table 9.16), but most of them exhibit a broad, thin unworked stem that constricts abruptly to form the bit, which is often thicker than the stem, generally being made on the thickest portion of the original flake, its bulb of percussion (fig. 9.17a). Shaping was by either unifacial or bifacial pressure retouch. As the flakes from which they were made are typically thin, most of these drills are suitable only for light work. Accordingly the wear patterns they display—principally edge and face abrasion—are seldom pronounced. One or two specimens made on thick flakes, however, are substantially more stout and exhibit more advanced wear. It is notable that no less than 10 of these drills are chert, which suggests that, along with flake knives and point blanks, this tool type commonly served as an alternative outlet for the use of large flakes resulting from the manufacture of chert bifaces.

The four shaped drills apparently made specifically for this purpose and not reworked from other artifacts exhibit no common form and vary substantially in size and degree of workmanship. One crudely percussion-flaked obsidian piece (O-4156), the base of which is evidently missing, displays a thick, unifacially flaked bit that is triangular in outline and cross section and measures 3.5 cm long, 0.9 cm wide, and 0.7 cm thick. A second obsidian specimen (O-3167), the largest of the four, was carefully shaped by bifacial pressure flaking and is lenticular in cross section. The butt of this drill is square, measuring 2.0 cm long, 1.9 cm wide, and 0.5 cm thick, above which it tapers gently toward the bit, which is missing. A third drill (O-4913), bifacially flaked, lenticular in cross section, and equal in workmanship to the one just described, is rather narrow throughout its length and appears to have been originally bipointed or leaf-shaped in outline, though it is now broken at one end. There is pronounced wear on the intact end of this specimen, which is chert; in addition, the fractured end is both abraded and polished, as though it had been used to gouge or groove wood. The fractional length is 2.5 cm, the width is 1.0 cm, and the thickness 0.4 cm. The fourth shaped drill (O-3448), made of obsidian, is much smaller than the other three and exhibits a triangular bit and sharply contracting stem. It is bifacially flaked and lenticular in cross section. There is moderate abrasion on the distal end of the bit, the sides of which are free of wear but appear to have been resharpened by offset unifacial edge retouch, i.e., the retouch on one side extends onto one face and the retouch on the other side extends onto its obverse.

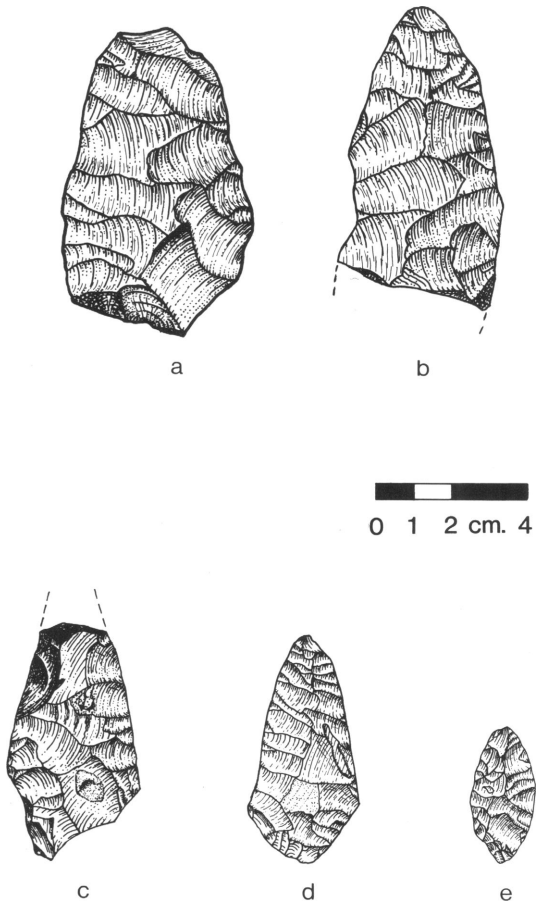

Fig. 9.16. Selected green chert bifaces from Crater Middens. a. O-3850; b. O-4010; c. O-3856; d. O-3510; e. O-3735.

Two of the four drills recycled from other tool forms are reworked projectile points. One of these (O-1926) was originally an obsidian Rose Spring Corner-notched point which, except for one barb, is essentially intact and appears to have been modified only to the extent that the blade has been steeply worked by bifacial pressure edge retouch to form a sharp constriction just above the barbs that tapers gently toward the tip. The complete drill measures 2.8 cm long, 0.4 cm thick, and 1.6 cm at its greatest width, which is from the intact barb to the stub of the broken barb. The bit is 1.7 cm long, 0.9 cm wide, 0.4 cm thick, and is both crushed and abraded from use. The other reworked projectile point (O-2376) originally belonged to the Desert Side-Notched Delta subtype, and is obsidian. As in the case of the reworked Rose Spring point just described, this specimen lacks one corner; its blade has been reshaped bifacially by pressure retouch, in this case forming a constriction just above the notches. The overall length is 2.1 cm, the fractional width is 1.1 cm, and the thickness is 0.3 cm. The bit is 0.9 cm long, 0.4 cm wide, and 0.3 cm thick. Use-wear on this piece is confined to crushing, which extends from the tip along the entire length of the bit.

Two drills are reworked biface midsections, one end of which has been shaped by bifacial pressure retouch to form a bit. In both instances the material is obsidian. The larger of the two (O-2123) is 2.0 cm long, 1.6 cm wide, and 0.4 cm thick; the butt of this piece may have broken after it was reworked into a drill, in which case the intact drill would have been longer and, perhaps, wider. The bit is 1.1 cm long, 0.9 cm wide, and 0.4 cm thick, and exhibits crushing at the tip and along both edges. The other reworked biface (O-703) is smaller than the first and, in addition to the shaping of the bit, has been unifacially retouched to remove both corners of the opposing broken end, possibly to make it less painful to grip during extended periods of use. The complete piece measures 1.3 cm long, 1.2 cm wide, and 0.3 cm thick, and the bit measures 0.4 cm long, 0.3 cm wide, and 0.3 cm thick. The tip and lateral edges are crushed and the entire bit, including both faces, has become somewhat smooth, evidently as the result of abrasion incurred during use.

The remaining 16 examples, all of them obsidian, are distal or mid-bit sections. Of these, 11 are relatively narrow and thin and might derive from any of the drill forms described above. The other five are thicker, heavier, and—where this can be determined—longer than the bits of any of the intact drills in the Crater Middens collection. The largest (O-4464), a fragmentary midsection, is 0.9 cm thick and 1.4 cm wide; the smallest (O-2728), also a midsection, is 0.9 cm wide and 0.4 cm thick. The only distal section is 3.7 cm long, 0.9 cm wide, 0.7 cm thick, and diamond shaped in cross section. For the most part, the wear observed on the larger bit fragments is predominantly in the form of crushing and suggests use with greater force than use-wear on the smaller specimens, which more commonly exhibit abrasion. Thus, as might be logically expected, the heavier bits appear to have been used in heavier tasks, possibly wood working, than the lighter bits, which would have served well in delicate wood, shell, stone, and hide work.

UNIFACES (179 specimens; 164 obsidian, 14 chert, 1 chalcedony): The lack of technical formalization in the collection of unifaces from Crater Middens has already been mentioned with reference to the lack of clear distinctions between this category and the categories of roughouts and cores. Aside from the unifacially flaked working edges that identify them by definition, unifaces are most clearly differentiated from those other two categories by their relative thinness, apparently because they were often made on otherwise unmodified flakes (table 9.17). Perhaps for the same reason, unifaces are generally shorter and narrower than either roughouts or cores, although there is a good deal of overlap between all three categories.

The working edges vary from convex to concave, the majority being concave. The edge angles vary from a minimum of 20° to a maximum of 100°, with a mean very near 60° (table 9.17). Specimens with notched or coarsely denticulate working edges constitute 17 percent of the collection but the finely serrated uniface form represented in certain other collections from central eastern Cali-

fornia is not among them (cf. Harrington, 1957: fig. 47j).

The most commonly observed patterns of use-wear are unifacial edge abrasion and multiple, superimposed step fractures—both impinging primarily on the flaked dorsal tool face; this would indicate use with the unmodified ventral tool face oriented toward the direction of work.

The above characteristics suggest use of these unifaces in a wide range of scraping tasks: the shaping of large and small wooden objects, the working of hide, and the shredding of fiber and sinew. Given this, it is surprising that chert and chalcedony—which are tougher than obsidian and therefore better suited to these purposes—are so poorly represented in this category. In part, this is probably due to the scarcity of chert and chalcedony and the ready availability of obsidian roughouts that had been rejected as unsuitable for further attempts at reduction into finished points or knives. Nevertheless, the preferential use of chert and chalcedony for points and knives rather than unifaces would seem to indicate that the tasks to which unifaces were put were considered less pressing, less demanding, or less important than those accomplished with points and knives; this is consistent with the lack of technical formalization in this tool category in comparison to the categories of projectile points and bifaces. An exception is one finely made uniface in the Crater Middens collection (O-3459), a fragmentary end scraper made of high-quality brown chert. It is so formally distinct from the balance of the specimens that it was almost certainly scavenged from another site (fig. 9.17b). The working edge of this specimen is convex in plan and describes a nearly perfect concentric arc made by careful steep pressure retouch extending dorsally at an angle of 75° to the ventral surface, which is unmodified except for a single percussion flake, evidently an attempt to rejuvenate the working edge. In central eastern California, comparable unifaces are occasionally recovered in association with points that bear a generic resemblance to specimens typical of Clovis assemblages. It is likely that this piece was recovered from such a site and brought to Crater Middens. The more careful manufacture and greater technical formalization evident in the unifaces found in very early archaeological assemblages in central eastern California suggest both a function for this category and a role for that function in adaptive technology, quite different from that which can be inferred for the unifaces at Crater Middens and other late prehistoric sites. In particular, the regular and broadly arcuate bits of these early pieces indicate more finely controlled modification of broader surfaces—the fleshing and scraping of hides or the planing or shaving of wood, for example. Too, the care expended on these tools suggests these tasks were of some importance in the adaptive systems of which they were a part.

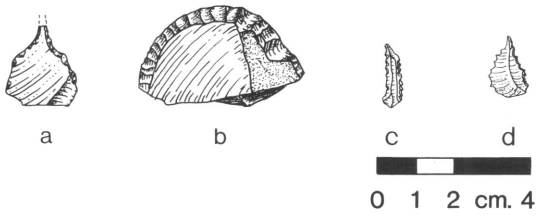

Fig. 9.17. Miscellaneous chipped stone artifacts from Crater Middens. **a.** flake drill; **b.** finely made chert uniface; **c, d.** denticulate eccentrics. a. O-1844; b. O-3459; c. O-2412; d. O-4461.

The metric attributes of unifaces from Crater Middens are summarized in table 9.17. Note again that the unit of measurement for edge angle is the individual working edge, of which there may be more than one on a single tool.

DENTICULATE ECCENTRICS: Two small flakes that had been unifacially pressure flaked to form denticulate crescentlike objects, rounded at one end and pointed at the other, were found (tables 8.13, 8.14). One (O-2412) is chert and measures 1.7 cm long, 0.5 cm wide, and 0.3 cm thick (fig. 9.17c). The other (O-4461) is obsidian and measures 1.7 cm long, 1.0 cm wide, and 0.2 cm thick (fig. 9.17d). The workmanship on both shows considerable care in that the denticulations are quite fine. Neither exhibits any obvious evidence of use, although the chert specimen is completely polished, perhaps by wind or water or, more speculatively, by passage through the crop of a bird. No explanation

TABLE 9.17
Metrical Data for Unifaces, Choppers, and Cores from Crater Middens

		Length (cm)	Width (cm)	Thickness (cm)	Edge angle (°)
Unifaces	$\bar{x}$	2.63	1.75	0.62	61.82
	S	0.64	0.42	0.25	12.87
	n	80	102	142	292
	Range	4.1–1.3	2.8–0.9	1.9–0.2	100–20
Choppers					
Large	$\bar{x}$	17.38	13.13	8.35	
	S	4.06	3.78	3.35	
	n	8	8	8	
	Range	22.5–11.1	18.7–7.9	11.9–4.5	
Small	$\bar{x}$	8.40	6.07	3.17	
	S	1.65	2.72	1.02	
	n	3	3	3	
	Range	10.3–7.4	8.5–4.0	3.9–2.0	
Cores	$\bar{x}$	2.95	2.09	1.35	
	S	0.94	0.76	0.58	
	n	123	123	123	
	Range	7.3–1.5	6.1–0.7	4.8–0.5	

for the function of these pieces can be offered except that they are charms of some kind. Larger items of similar kind have been noted at the Stahl site, Little Lake, just below Owens Valley (Harrington, 1957: fig. 47a, b). There is also some resemblance to the Stockton Curves found in the central valley of California (cf. Schenk and Dawson, 1929: 372), of which these might conceivably be copies, though they are much smaller and less completely flaked.

CHOPPERS (11 specimens; 2 andesite, 4 quartzite, 5 metamorphic): Eleven cobbles (tables 9.13, 9.14) with crudely percussion-flaked working edges, many of them battered and crushed by use, were provisionally identified as tools for heavy chopping—possibly the trimming and splitting of large branches and logs and the separation of joints during the butchering of large game. In all but a few instances, the working bits were prepared bifacially by the removal of an alternating series of heavy percussion flakes, producing a very jagged, sinuous edge serviceable for coarse tasks in which durability was of greater importance than precision. The more heavily worn pieces exhibit evidence of use confined primarily to the ridge of the working edge, which is rounded or flattened by attrition.

Eight of the 11 choppers in this collection are relatively large, the smallest of these (O-3312) measuring 11.1 cm long, 9.1 cm wide, and 5.2 cm thick, the largest (O-2860) 22.5 cm long, 14.4 cm wide, and 7.2 cm thick (table 9.17).

The remaining three are smaller—though still large in comparison to the bifaces and unifaces. Of these three, the smallest (O-431) is 7.4 cm long, 4.0 cm wide, 2.0 cm thick (table 9.17), roughly oval in plan, and exhibits invasive bifacial percussion flaking the full length of its perimeter. The edges of the piece display in places multiple, superimposed step-fractures, as the result of use or serial resharpening, and, more pervasively, a fine polish reminiscent of silica gloss on the ridge of the cutting edge and the higher ridges separating individual flake scars. This crude but well-used tool was initially classified as a roughout and then as a biface, but it fit comfortably in neither category. Its wear was far more advanced than is acceptable for a roughout and its shape was too stout and crude to make it anything but an oddity among the bifaces in the collection. The use-wear found on this piece suggests contact with hard plant matter, probably wood. It is tentatively suggested that this tool was used in heavy woodworking, the planing and shaving of bows or atlatls, for example. Much heavier polish

present near the central portions of both faces, beyond the reach of most of the percussion flake scars, also resembles silica gloss but is more likely stream polish.

The largest of the three small specimens (O-3841) is 10.3 cm long, 8.5 cm wide, 3.6 cm thick, wedge-shaped in cross section, and oval in plan. The working edge of this piece is formed by the juncture of a large fracture plane, either natural or cultural, and a relatively curved cortical surface. This edge exhibits only minor bifacial retouch but is severely battered by use at one end. The other small chopper (O-3310) is an angular cobble 7.5 cm long, 5.7 cm wide, and 3.9 cm thick. It displays one edge with minimal bifacial retouch that appears less used than two of its natural edges, one of which is nicked, the other crushed and abraded.

CORES (123 specimens; 121 obsidian, 2 quartzite): The majority of the cores from Crater Middens (tables 9.13, 9.14) are relatively small, extensively worked, and would appear to hold little potential for producing usable flakes (table 9.17). All of this suggests they were discards rather than items being saved for future use. Several large specimens recovered in structures—notably Structure 12 and Structure 16—have not, however, been worked to the point of exhaustion and were almost certainly cached in these structures in anticipation of future use. In particular, the two largest cores in the collection were found cached together at the foot of the foundation of Structure 12. The larger of the two (O-443) is 7.3 cm long, 6.1 cm wide, and 4.1 cm thick; the smaller (O-441) is 6.9 cm long, 4.8 cm wide, and 4.8 cm thick. The smaller piece has had more flakes removed from it than the larger but neither is intensively worked and both retain larger areas of cortex. Both are Fish Springs obsidian.

As is also true of the cores in the collections from Pinyon House and Two Eagles, there is no obvious pattern of core reduction evident in the specimens from Crater Middens. Use of the bipolar technique, with the core resting on an anvil, is quite common, however. Examples reflecting at least partial reduction by this method constitute 40 percent of the collection.

With regard to material, with the exception of two examples of quartzite, the classification of which is considered questionable, all of the cores from Crater Middens are obsidian and the bulk of these are attributable to the Fish Springs quarry, the glass source nearest the site and readily accessible from it. Among the remainder are five split alluvial obsidian pebbles evidently brought to the site from Owens River. Similar split pebbles have already been noted among the cores from Pinyon House and Two Eagles. That cherts and chalcedony cores are conspicuously absent suggests these materials entered the site as large flakes, roughouts, or finished points and knives. This may reflect the form in which they were normally obtained through trade. It might also reflect the distances that had to be traveled to acquire them directly, as a consequence of which they were worked into lighter, more finished forms to facilitate transport and minimize waste stemming from the transport of pieces that would later break inadvertently or be found to contain flaws during the initial stages of reduction.

DEBITAGE (54,760 specimens; 45,280 obsidian, 9480 chert, chalcedony, quartzite, basalt, rhyolite, and quartz): A total of 14,327.8 g of debitage was recovered (tables 9.18, 9.19). Of this, 10,937.4 g, or 76 percent was obsidian—most of it from the Fish Springs quarry, the glass source nearest the site. Chert, and successively in much smaller quantities, chalcedony, quartzite, basalt, and quartz constitute the remaining 3309.4 g, or 24 percent. By count, however, these materials combined comprise only 17 percent of the debitage because their mean weight ($\bar{x}$ = 0.36 g) is greater than that of obsidian ($\bar{x}$ = 0.24 g). This inequality of size characterizes nearly all individual debitage samples regardless of context despite consistent differences in the mean flake weight for samples from the site surface, structures, and buried midden deposits.

Debitage from controlled surface collections containing more than 50 pieces exhibits the highest mean weights ($\bar{x}$ = 1.68–0.54), debitage from midden deposits the lowest mean weights ($\bar{x}$ = 0.13–0.27). Debitage from structures tends to fall between these two extremes, but the largest mean flake weight for an individual structure, Structure 7 ($\bar{x}$ = 0.58), is slightly greater than the smallest mean weight for the surface debitage from an in-

TABLE 9.18
Distribution, Composition, and Metrical Attributes of Debitage from Crater Middens

	Midden I			Midden II			
	St. 3	Surf.	Midden	St. 7	St. 9	St. 10	St. 12
Debitage							
Count	119	122	17	192	383	1996	2612
Weight (g)	57.3	204.7	0.2	111.4	172.6	466.7	970.1
Mean weight (g)							
Obsidian	0.17	1.19	0.01	0.43	0.40	0.19	0.36
Nonobsidian	0.78	1.88	0.03	0.78	0.51	0.35	0.39
Combined	0.48	1.68	0.01	0.58	0.45	0.23	0.37
Percent obsidian							
Count	49	30	82	58	55	73	54
Weight	17	21	50	44	49	60	52
Miscellaneous debitage							
Notching flakes							
Quartz crystal flakes and shatter							
Burin spall							
Trimming flakes	1	1		3	2		

[a] Total includes 176 pieces (33.6 g) of debitage, 165 obsidian (30.2 g) and 11 nonobsidian (3.4 g), from special surface collections, primarily piles left by relic hunters.

dividual midden, Midden II ($\bar{x} = 0.54$). Conversely, the mean flake weight for Structure 16 ($\bar{x} = 0.18$), the lowest for any structure, is as low as the mean weights of most midden samples. In other words, the debitage from structures exhibits substantial variability of size and bridges the differences between the larger surface debitage and the smaller midden debitage.

The tendency for flakes of obsidian to be smaller than those of other materials duplicates patterns already reported for Pinyon

TABLE 9.19
Distribution, Composition, and Metrical Attributes of Subsurface Debitage from Crater Middens

	Midden I	Midden II					Midden III		
	0–10	0–10	10–20	20–30	30–40	40–50	0–10	10–20	20–30
Debitage									
Count	17	7032	5683	4104	1547	1	6505	3913	2744
Weight (g)	0.2	1903.0	1129.8	760.9	204.2	0.1	1377.4	718.7	469.9
Mean weight (g)									
Obsidian	0.01	0.24	0.18	0.17	0.13	0.1	0.21	0.18	0.17
Nonobsidian	0.03	0.38	0.28	0.31	0.20	0	0.24	0.24	0.17
Combined	0.01	0.27	0.20	0.19	0.13	0.1	0.21	0.18	0.17
Percent obsidian									
Count	82	78	84	91	91	100	91	93	94
Weight	50	70	77	84	87	100	90	92	94
Miscellaneous debitage									
Notching flakes			3	1				2	
Quartz crystal flakes and shatter		3	1						
Burin spall							1		
Trimming flakes		28	17	21	7		28	3	4

TABLE 9.18—(*Continued*)

Midden II		Midden III			Midden IV		Midden V		
Surf.	Midden	St. 16	Surf.	Midden	Surf.	Midden	Surf.	Midden	Total
2958	18,367	5529	1895	15,802	1125	3424	9	34	54,760[a]
1603.6	3998.0	1010.8	1160.3	3032.9	735.9	723.2	17.0	29.5	14,327.8
0.48	0.20	0.16	0.61	0.19	0.66	0.21	1.81	0.82	0.24
1.31	0.33	0.25	0.68	0.22	0.64	0.21	2.15	1.20	0.36
0.54	0.22	0.18	0.61	0.19	0.65	0.21	1.89	0.87	0.26
92	84	75	94	93	82	62	78	88	83
81	75	66	93	92	83	63	75	84	76
	4			3					7
	4	5				1			10
				1					1
5	73	24	3	37	7	16	1	4	177

House and Two Eagles. As in these instances, this difference at Crater Middens can probably be attributed to the greater ease with which obsidian can be worked in smaller sizes and the tendency for chert to be imported as large blanks, the reduction of which into bifaces resulted in large flakes.

That flakes from structures are smaller than flakes from the site surface at Crater Middens likewise parallels differences in debitage from the structures and the surfaces of Pinyon House and Two Eagles. In both cases, this was explained as the result of reticence to engage in heavy stoneworking within struc-

TABLE 9.19—(*Continued*)

Midden III			Midden IV					Midden V				
30–40	40–50	50–60	0–10	10–20	20–30	30–40	40–50	0–10	10–20	20–30	30–40	Total
1721	824	95	1414	1102	557	215	136	24	6	3	1	37,644
323.4	126.5	17.0	305.8	257.4	96.1	41.3	22.6	27.7	1.1	0.2	0.5	7783.8
0.19	0.15	0.18	0.21	0.23	0.18	0.22	0.21	1.10	0.20	0.07	0.50	0.19
0.19	0.18	0.07	0.22	0.24	0.16	0.13	0.11	1.57	0.10	0	0	0.28
0.19	0.15	0.18	0.22	0.23	0.17	0.19	0.17	1.15	0.18	0.07	0.50	0.21
95	94	97	63	62	61	67	59	88	83	100	100	86
95	93	99	62	61	63	78	73	83	91	100	100	81
1												7
			1									5
												1
2			9	4	3			4				130

tures or the constant removal and disposal elsewhere of the waste from this activity when it was done inside structures. The same explanations probably apply here. This cannot be all that is involved, however, for if it were, one would expect that debitage from buried midden deposits would be larger than the debitage from structures and at the same time roughly comparable in size to the debitage from the site surface, neither of which is true: midden debitage is much smaller than either surface debitage or structure debitage. Surface collections made in each square prior to excavation, though small and subject to sampling error, suggest that the difference between surface and subsurface debitage is not the result of shoddy surface collection. As an additional consideration, the debitage from midden deposits exhibits a disturbing near-monotonic decrease in flake size with depth in the middens with substantial subsurface deposits. In effect, then, at Crater Middens debitage decreases in size as one moves from the surface of the site to the base of the cultural deposit.

In considering explanations for this, there would seem to be only three kinds of possibilities. First, flake size might have increased through time, peaking during the terminal occupation of the site. This, however, is inconsistent with other data that indicate substantial differences of age between individual middens. Thus, samples of equivalent depths and, in this case, mean flake size, are not of similar age.

A second possibility is that some kind of natural size-sorting process caused larger flakes to be worked upward or smaller flakes downward. That the Crater Middens deposits are so loose, friable, and thoroughly networked by roots and rodent burrows tends to support this notion. The possibility of similar size sorting at Pinyon House and Two Eagles is, by contrast, precluded by the absence of similar depositional conditions.

A third kind of explanation is that the debitage found in the midden deposits resulted from different kinds of behavior—either production activities or refuse disposal—than the debitage found in structures or on the site surface. As mentioned earlier, the principal objection to this explanation lies in the assumption that the major contrast in aboriginal activities at Crater Middens is between the activities and refuse disposal patterns characterizing structures and those characterizing the open areas outside structures, i.e., the basic distinction between inside and outside. It is also the case, however, that with respect to spatial relationships within this site, each buried midden deposit is at the center of a much larger surficial artifact scatter. Both kinds of areas, zones of midden deposition and zones of surficial scattter, are believed to represent primary cultural deposition rather than natural redeposition. They differ only to the extent that in one cultural activities were of a sort that led to midden deposition while in the other they were of a sort that did not. There is in this, therefore, the suggestion that the activities represented by the midden deposits differ from those where the cultural deposit is entirely surficial. Further, because these central midden deposits are so small, the controlled surface collections are in spatial composition dominated by the areas lacking subsurface deposits.

In short, while debitage samples from buried deposits and from controlled surface collection are similar in the sense of being distinct from those from structures, they are also different in the sense that the midden sample represents activities that occurred at the center of each locus of occupation and led to the formation of buried deposits while surface collection represents activities that occurred at the site periphery and produced no such deposits. Yellen (1977) has shown how, among the modern !Kung San, the larger more objectionable refuse is disposed of—and the heavier, dirtier, and more waste-producing jobs are performed—away from the camp center where most cooking and heating fires were built. At Crater Middens a similar pattern would locate refuse dumps, butchering, and heavy stoneworking at the periphery of each major locus of occupation (the separate middens). The center would be reserved for light stoneworking—and perhaps other tasks such as plant processing and food preparation, which through the production of ash and charcoal would lead to midden formation. This would explain the difference in the mean flake weights that characterize the midden samples and surface samples. It is worth mentioning that a similar pattern obtains at

Pinyon House where the mean flake size in controlled surface collections increases with distance from the center of habitation as indicated by the distribution of structures and artifactual debris. At Two Eagles, on the other hand, debitage is localized some distance from the area of most intensive habitation and most of this material is uniformly small, so this differential distribution by size is not particularly apparent.

We have yet to explain the monotonic decrease in flake size with midden depth at Crater Middens. This can probably be understood as resulting from natural size sorting, the overall effect of which is quite small, corresponding to a decrease in mean flake size from 0.24 g for the top 10 cm of deposit to a mean size of 0.18 g for the bottom 10 cm of deposit (50–60 cm in depth).

Turning to the material composition of debitage samples, as at Pinyon House (but not Two Eagles), there is at Crater Middens systematic variation in the proportional representation of obsidian in different contexts (tables 9.18, 9.19). The same patterns appear whether the analysis is by count or by weight. The following discussion refers specifically to the fractional representation (percentage) of obsidian as measured by counts of individual flakes.

In comparison to the combined mean for all samples from the site ($\bar{x}$ = 83%), the proportion of obsidian is uniformly low throughout the buried deposit in Midden IV ($\bar{x}$ = 59–67%), the surface scatter in Midden I ($\bar{x}$ = 30%), and all structures ($\bar{x}$ = 68%), although it is present in moderate quantity in Structure 10 ($\bar{x}$ = 73%) and Structure 16 ($\bar{x}$ = 75%). By contrast, the proportion of obsidian is relatively high in the entire subsurface deposit of Midden III ($\bar{x}$ = 91–100%), at depths below 20 cm in Midden II (91–100%), and the surface scatters from all middens ($\bar{x}$ = 82–94%) except Midden I. It is present in only moderate quantities in the first 20 cm of buried deposit at Midden II ($\bar{x}$ = 78–84%). The samples from Midden V and the buried deposit at Midden I are too small to be useful in determining relationship to these patterns.

Several explanations that might account for this come readily to mind but cursory comparison with the distribution of time-sensitive projectile points makes it clear that in large degree the differential representation of obsidian in debitage samples varies with time. This is most clearly shown by noting that 93% of the projectile points recovered from the buried deposit at Midden IV (table 9.10), in which the proportion of obsidian is low, are attributable to the Klondike phase (A.D. 1300—historic period). Likewise, 84% of the projectile points recovered from structures (table 9.9), which are similarly poor in obsidian, are attributable to the Klondike phase; moreover, between them Structures 10 and 16, which exhibit moderate amounts of obsidian, together account for 75% of the projectile points from structures that can be attributed to phases earlier than Klondike. More clearly, of the 24 typable projectile points recovered from the buried deposit at Midden III (table 9.10), which exhibits obsidian in high proportion in debitage samples, only 3 (13%) belong to the Klondike phase. In a like sense, at Midden II the transition in the representation of obsidian, from high proportion in debitage below 20 cm to only moderate proportion in the upper 20 cm of deposit, is matched by a shift in the proportion of Klondike phase projectile points, which account for only 18% of the sample recovered below 20 cm but 44% above 20 cm (table 9.10). Radiocarbon dates and obsidian hydration measurements discussed in detail in a subsequent chapter support this dating of structures and midden deposits and, in turn, the notion that there is represented in debitage samples a shift toward the use of materials other than obsidian somewhere near the beginning of the Klondike phase (A.D. 1300).

The surface collections from Middens III and IV tend to run counter to this pattern. Both are dominated by obsidian and at the same time yielded points predominantly of the Klondike phase: at Midden III 94% of the debitage in controlled surface collections is obsidian and 88% of the points are of Klondike age; at Midden IV 82% of the debitage is obsidian and 100% of the points are of Klondike age. In both cases, however, the samples of projectile points in the controlled collections are small (Midden III = 8; Midden IV = 6), so sampling error may be at work. It is difficult, however, to envisage any circumstance that would associate early points with the surface of Midden IV, which yielded

but one of them in its buried deposit (table 9.10). The scavenging of points in Klondike times offers a possible explanation for the scarcity of early forms at Midden III, but again not in the case of Midden IV, where they are almost absent in the deposit.

One suspects that the surface scatter of Midden II, in which the proportion of obsidian debitage is high (94%), is no less recent than the surface scatters of Middens III and IV, but as it happens only half of the datable points found there belong to the Klondike phase so there is no convincing basis for this argument.

For the moment, the best explanation for the discrepancy between the relative dating of surface scatters suggested by point frequencies and by proportion of obsidian in debitage is the one previously offered to account for differences in flake size between midden deposits and surface scatters: surface scatters are dominated by refuse from heavy stoneworking which, as measured by the near absence of nonobsidian cores, is at Crater Middens predominantly in obsidian. Thus, whether early or late, peripheral surface scatters are dominated by obsidian.

There is but one exception to this pattern at Crater Middens: Midden I, where the surface scatter exhibits obsidian in very low proportion ($\bar{x} = 30\%$). As noted earlier with reference to Structure 3, which is in Midden I, this area differs in several important respects from the more intensively occupied parts of the site. The presumption is strong that it represents a seclusion area for families just prior to and just after childbirth. The absence in Structure 3 of certain tools normally used by males was explained with reference to this interpretation as reflecting ritual prohibitions. It may be that such prohibitions extended to heavy stoneworking, so that the bulk of what little debitage was found on the surface of Midden I is more reflective of other activities, for instance the finishing of large chert bifaces.

The observation that the frequency of materials other than obsidian—predominantly green chert—increases beginning around A.D. 1300 at Crater Middens does not, of course, explain why this shift occurred. That the shift was more complicated than a simple change from one stone source to another is indicated by the low frequency with which materials other than obsidian are represented in nearly every common category of chipped stone, the lowest being for cores (2%), the highest for bifaces (15%). Drills (30%) and flake knives (50%) appear to be the only kinds of tools for which materials other than obsidian were commonly used and both are primarily attempts to make use of large flakes resulting as waste from the manufacture of large chert bifaces, which constitute but a very small fraction of the total bifaces.

The puzzle is, therefore, as follows. Beginning around A.D. 1300 much more chert and other material is imported to Crater Midden. Its importation is, evidently, primarily as large biface blanks, rather than cores, for even at the most recent midden at the site, Midden IV, heavy stoneworking debris is dominated by obsidian. Despite its substantial representation in the chipping debris from more recent contexts, however, no concomitant increase is noted in the proportion of nonobsidian materials in any major tool category. At Midden IV, for example, where nonobsidian materials account for roughly 40% of the debitage in buried deposits, only 17% of the bifaces, 3% of the roughouts, 11% of the unifaces, and none of the cores are of nonobsidian materials; 32% of the 25 typable points from Midden IV, however, are of green chert or chalcedony, but the sample is quite small. Even were this figure accurate, it would be well below the value needed to account for the debitage given the dearth of chert and chalcedony represented in the other chipped stone artifact categories.

Thus it would seem that the increase in imported materials beginning around the inception of the Klondike phase served a system other than the one traditionally served by obsidian; i.e., the reduction of stone cores into useable knives, scrapers, and points. The byproducts of chert-work were often cycled into such traditional forms as points, drills, and flake knives, however. In short, the system that drew upon chert as its working material did not supplant the preexisiting mode of tool manufacture but was, rather, added beside it. The only distinctive artifacts made of chert present at the site, albeit in small numbers, are the large, very well-made chert bifaces. These would seem capable poten-

tially of serving as a basis for a separate system of lithic production with a method of primary acquisition different from that of the traditional one, particularly if some special value were placed on them as either items of trade or commodities for local consumption. The care and skill with which the few that were found were made suggests the work of specialists, which is consistent with this hypothesis. Further, that these bifaces are so rare relative to the debitage resulting from their manufacture supports the idea that many more were traded than used locally. The interpretation that emerges, therefore, is one of increasing use of chert in late prehistoric times as a function of the growing specialized production of chert bifaces for trade and in lesser degree local use. The acquisition of the raw material for this industry and its role in the economic and social system of the inhabitants of Crater Middens are considered in detail in the summary chapter for this site.

MISCELLANEOUS DEBITAGE: Several pieces of debitage found at Crater Middens merit separate description because they depart in some respect from the waste that normally results from chipped stonework or because they are particularly good illustrations of certain aspects of that activity (tables 9.18, 9.19). Among these are 10 pieces of clear crystalline quartz debitage and shatter. As no finished tools made of this material were found, these specimens are probably the byproducts of attempts to trim and, possibly, dress quartz crystals for use as talismans or charms. Several of the quartz crystals found at Two Eagles have been percussion flaked in this manner but none was noted at Crater Middens.

Seven small crescentic flakes of obsidian were obviously detached in the process of notching projectile points. The size of these makes it likely they derive from points of either the Rose Spring or Elko series and their distribution furnishes at least some support for this idea. Three were found in the deposit at Midden III, the other four below the top 10 cm of deposit in Midden II, which tends to date them to the earlier occupation of Crater Middens.

Finally, one sliverlike chalcedony burin spall (O-4506) 4.1 cm long, 0.4 cm wide, and 0.4 cm thick was found. It represents the lateral margin of a well-made biface and may have been removed as a first step in reedging that tool. Several similar though smaller specimens were noted in the debitage from Crater Middens. This piece, however, is noteworthy, because it suggests considerable technical competence in the reworking of bifaces by this means.

TRIMMING FLAKES (177 specimens; 94 andesite, 52 quartzite, 12 chert, 9 metamorphic, 6 basalt, 3 granitic, 1 unidentified): Trimming flakes are large percussion debris from the manufacture and refurbishing of heavy grinding, chopping, and pulping tools. These were classified and analyzed separately from debitage resulting from the production of lighter chipped stone tools—points, bifaces, and unifaces, for example. Most specimens are simple percussion flakes but some are angular blocks of shatter. There is marked variation of size within the collection, the largest being more than 14 cm long, the smallest less than a centimeter in any dimension. That andesite and quartzite are so well represented suggests that the bulk of these trimming flakes are from battered cobbles and choppers, which were predominantly made of these particular materials. The balance is probably debris from the manufacture and reshaping of millingstones and manos. Trimming flakes are broadly distributed at Crater Middens (tables 9.18, 9.19), which suggests that the production and maintenance of heavy lithic implements, especially battered cobbles and choppers, was a more or less constant activity throughout the period in which the site was occupied.

ADDITIONAL ARTIFACTS OF STONE

SHAFT SMOOTHERS (4 specimens; all pumice): Two complete shaped and grooved shaft smoothers were found at Crater Middens (tables 9.20, 9.21); tentatively added to these are two other shaped and incipiently grooved midsections that may be fragments of shaft smoothers.

The larger of the two complete specimens (O-473) is ground flat on both faces, smoothed on the ends and sides, and measures 5.4 cm long, 2.9 cm wide, and 1.6 cm thick (fig. 9.18a). One of the faces is made considerably more narrow by the rounding of one of its lateral margins and by a bevel ground on the

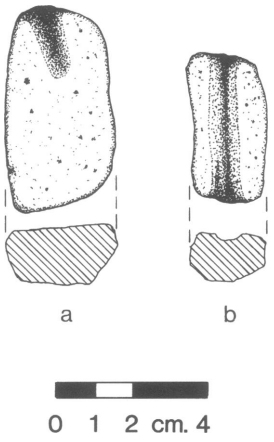

Fig. 9.18. Complete shaft smoothers from Crater Middens. **a.** O-473; **b.** O-2303.

other, giving the implement a distinctly planoconvex cross section. The broader face exhibits a single shallow groove that extends diagonally down to the right from one end, becoming progressively more shallow until it disappears near the midpoint of the piece.

The other complete specimen (O-2303) is smaller and less well finished but more deeply grooved that the first. For the most part, the faces, sides, and ends are irregular and show only minimal attempts at smoothing. The piece can in general be described as rectangular in plan, tabular in long section, and rudely planoconvex in short section, measuring 4.0 cm long, 2.1 cm wide, and 0.2 cm thick (fig. 9.18b). The flatter of the two faces displays a single longitudinal groove about 0.8 cm wide and 0.2 cm deep along its midline.

Of the two fragments, the larger (O-4906) is 2.4 cm wide and 1.8 cm thick and is well smoothed or ground on both sides and one face, on which to one side there is a narrow, lengthwise linear depression that may be a remnant or incipient groove. The smaller fragment (O-4777) is ground flat on both faces, exhibits a shallow groove 0.4 cm wide and less than 1.0 cm deep running the length of one side, but it otherwise unmodified.

A single side-grooved fragment from Pinyon House has already been described. Elsewhere, grooved pumice shaft smoothers are of relatively common occurrence in the Inyo-Mono region (Lanning, 1963: 248; E. Davis, 1964: 281; Riddell and Riddell, 1956: fig. 4; Cowan and Wallof, 1974: 38). Although there is no specific mention of them among the Owens Valley Paiute, several Nevada Shoshoni groups (Steward, 1941: 290) and perhaps the Panamint Shoshoni (Coville, 1892: 360) used a pair of grooved stones to straighten and smooth arrow shafts. The planoconvex cross section of the complete specimens found at Crater Middens and other sites in Owens Valley and the surrounding region also suggests use in pairs.

ABRADERS (2 specimens; pumice): Two ground pieces of pumice were probably used as abraders (tables 9.20, 9.21). One is a small pyramidal specimen (O-4285), ground flat on the base and one side and smooth on two other sides, presumably as the result of use. It stands 1.9 cm high and the base is 2.3 cm long and 1.6 cm wide. The other (O-3880), possibly fragmentary rather than complete, is 2.0 cm long, 1.4 cm wide, and 0.7 cm thick and is ground flat on one face and one side. A specimen somewhat similar to these two is reported from Iny-2 (Riddell, 1951: 16).

STEATITE ARTIFACTS: *Steatite Vessel Sherds* (3 specimens). Three steatite-chlorite sherds were found (tables 9.20, 9.21), each one evidently representing a different vessel. One (O-2315) is a large rim sherd of a crudely shaped and finished bowl that when complete was perhaps 12 cm in diameter and 5 cm high (fig. 9.19a). The wall varies from 0.8 to 1.0 cm in thickness. The rim is direct but irregular and of uneven height when viewed from the side. The lip is in general rounded but varies markedly in thickness and degree of tapering. Scratches and gouge marks made during manufacture remain prominent, particularly on the interior, and the superficial smoothing of the exterior, rim, and interior may be as much the result of use as deliberate finishing.

The two remaining fragments are wall sherds, the edges of which have been ground. These may have been used as scrapers in the manufacture of ceramic vessels, a suggestion that follows from their resemblance to worked sherds, for which such use is tentatively inferred. One of these (O-787) derives from a well-finished vessel and exhibits at least eight different ground facets that together occupy the whole of its perimeter (fig. 9.19b). A small

TABLE 9.20
Distribution of Other Stone Artifacts at Crater Middens

	Midden I			Midden II					Midden III			Midden IV		Midden V		
	St. 3	Surf.	Mid-den	St. 7	St. 9	St. 10	St. 12	Surf.	Mid-den	St. 16	Surf.	Mid-den	Surf.	Mid-den	Surf.	Mid-den	Total
Shaft smoothers							1	1						2			4
Abraders										1		1					2
Steatite																	
Sherds					1				1		1						3
Pipe fragments													1	1			2
Cylinder								1									1
Pendants						1			3			2	2	2			10
Incised stones									1		1		1				3
Pebble scraper									1								1
Anvil								1									1

notch cut into one of these facets remains unexplained. This piece is 4.2 cm long, 2.8 cm wide, and varies in thickness from 0.5 to 0.8 cm and is roughly oval in plan. The other specimen (O-763) is from a less well-finished vessel, though one better made than the rim sherd. It is essentially rhomboidal in outline, measures 3.2 cm in length, 2.3 cm in width, and between 0.5 and 0.8 cm in thickness, and is lightly ground on both ends and slightly smoothed on one side.

The regional distribution of steatite vessels has been summarized previously with reference to specimens found at Two Eagles.

Steatite Pipes (2 specimens). Two small fragments of tubular steatite pipes were found. One (O-4697) is thin-walled, varying from 0.2 to 0.3 cm in thickness (fig. 9.19c). It is smoothed and finely polished on the exterior. The interior exhibits irregularly spaced parallel, transverse grooves, ridges, and scratches left by a drill or perforator used to make or enlarge the central cavity, which is slightly off-center with respect to the exterior surface. When complete, the pipe was about 1.7 cm in outside diameter and 1.4 cm in inside diameter. The second fragment (O-4786) is thicker and more coarsely finished than the first (fig. 9.19d). The wall is uniformly 0.5 cm thick, the central cavity being concentric to the exterior surface. By extrapolation, the outside diameter of this pipe segment was about 1.7 cm, the inside diameter about 0.7 cm. Manufacturing scars—longitudinal scratches and gouge-marks—are present on both interior and exterior surfaces; the more raised portions of the exterior are smoothed and polished. The tool marks on the walls of the interior cavity clearly indicate that it was enlarged by gouging rather than by drilling as in the first specimen, perhaps to keep its diameter small or because it was positioned too far from either end of the pipe to be reached with a chipped stone drill or perforator. In any case the inside diameter of this fragment appears too small to be part of the bowl and is more likely a section of the stem. The drilled cavity of the finely finished fragment, on the other hand, is large enough to serve as a bowl and too large to be a stem. That these specimens are of the same exterior diameter, were both found at Midden IV (tables 9.20, 9.21), and are made of nearly identical varieties of steatite-chlorite, suggests that they are from one pipe that was evidently cylindrical in shape and bored wide at one end for the bowl and narrow at the other for the stem.

Steatite pipes were used by the Owens Valley Paiute for smoking and as sucking tubes (Steward, 1933: 313, 319). Other than one specimen found near Fish Springs, just south of Crater Middens (Steward, 1933: 319), they have not been reported from archaeological contexts in the Inyo-Mono region or surrounding areas.

Steatite Cylinder (1 specimen). A shaped fragment of steatite-chlorite (O-2187), gently bevelled at one end and sawn part-way and then snapped at the other, represents part of

TABLE 9.21
Subsurface Distribution of Other Stone Artifacts at Crater Middens

	Midden I	Midden II				Midden III					Midden IV					Midden V					Total
	0–10	0–10	10–20	20–30	30–40	40–50	0–10	10–20	20–30	30–40	40–50	0–10	10–20	20–30	30–40	40–50	0–10	10–20	20–30	30–40	
Shaft smoothers												1		1							2
Abraders							1														1
Steatite																					
Sherds				1																	1
Pipe fragments												1									1
Pendants		2	1					1	1				1		1						7
Incised stones			1																		1
Pebble scraper		1																			1

one end and side of a diagonally fractured steatite cylinder, possibly a pipe blank (fig. 9.19e; table 9.20). When complete, this piece was more than 5.5 cm long and about 3.5 cm in diameter. The intact original surfaces—which include the bevelled end but not the sawn end, which is a later modification—have been smoothed by grinding, leaving faint longitudinal striations on the sides and two sets of more pronounced parallel striations on the bevel. Both the intact and fractured surfaces have been repeatedly pecked, though the purpose of this is unclear. One lateral margin flanking the sawn end is lightly ground. This was apparently an attempt to smooth and thereby strengthen that edge by rubbing the piece lengthwise over some surface. There is a very small tranversely ground facet on the opposing lateral margin.

This cylinder is larger than the finished pipe represented by two shaped steatite fragments found at Crater Middens, but is of approximately the same size as two scoria pipes found at Iny-2 (Riddell, 1951: 16) and probably best interpreted as a pipe blank that broke prior to or during production. The only other reasonable suggestion would be that it is part of a shaft straightener or a blank intended for that purpose. Subsequent modification of the fragment by sawing and grinding may reflect attempts to conserve it for future use or recycle it into some other form. There is no mention of similar steatite-chlorite cylinders anywhere in or near the Inyo-Mono region, but Latta (1949: 198) illustrates a steatite tube from the southern San Joaquin Valley that is approximately the same size. That piece, however, had been perforated, tapered at both ends, and finely finished.

PENDANTS (10 specimens; all slate): A total of 10 tabular fragments of slate was identified as pendants, but in only one case, a biconically drilled piece, is this classification secure; the other nine specimens are thin scraps that have been incised or ground, or both, and are probably broken pendants. They might also be parts of unperforated incised tablets, however (tables 9.20, 9.21).

The drilled fragment (O-799) bears incised designs on both faces but, aside from a light surface polish that is probably attributable to its having been worn, shows no obvious evidence of shaping. It may have been picked

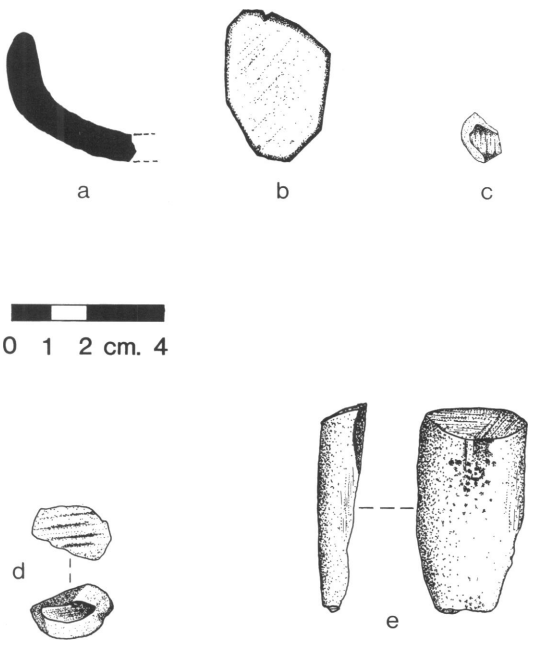

Fig. 9.19. Selected artifacts of steatite from Crater Middens. **a.** vessel rim sherd; **b.** abraded and notched body sherd; **c, d.** pipe fragments; **e.** cylinder. a. O-2315; b. O-787; c. O-4697; d. O-4786; e. O-2187.

up and drilled and incised without being ground on the faces or sides. The fragment is 0.3 cm thick, 3.0 cm long, and 1.7 cm wide; its intact lateral margins are rounded in cross section and convex in plan (fig. 9.20a). The complete pendant was perhaps twice that long and wide and generally oval or egg-shaped in outline, the biconical perforation being set 0.7 cm from the edge at one end.

The nine other specimens are nondescript with respect to their original size, shape, and decoration. The only measurement that can be furnished for them at all—and only for six at that—is thickness; that varied from 0.1 to 0.3 cm, with a mean of 0.17 cm, and a standard deviation of 0.8 cm. Five of the nine are incised and ground on the face (O-2381, O-4849) or side (O-2394, O-3252, O-4934). Two others are ground on the side but not incised (O-612, O-4674); another (O-4540) is incised but not ground, and the remaining one (O-2723) is sawn on one side and ground on its one intact face; this last piece may be a scrap that was trimmed and discarded in the manufacture of a pendant rather than a pendant fragment itself. Among the three incised specimens that retain portions of both original faces, designs are present on both of one (O-3252) and on only one of the other two (O-2395, O-4540). A faint diagonal line from which emanates on one side a row of short horizontal hatchures can be discerned on one specimen (O-4540). The remainder of these small fragments reveal no clear design or pattern.

Similar incised and unincised pendants were found at both Pinyon House and Two Eagles, the discussions pertaining to which summarize the distribution of this artifact category within the Inyo-Mono region.

INCISED STONES (3 specimens; 1 slate, 2 metamorphic): Three pieces of stone that exhibit purposeful incisions were found (tables 9.20, 9.21). The largest (O-3504) is incomplete but was originally 0.7 cm thick and more than 10.4 cm long and 5.0 cm wide (fig. 9.20b). Part of one lateral margin has been smoothed

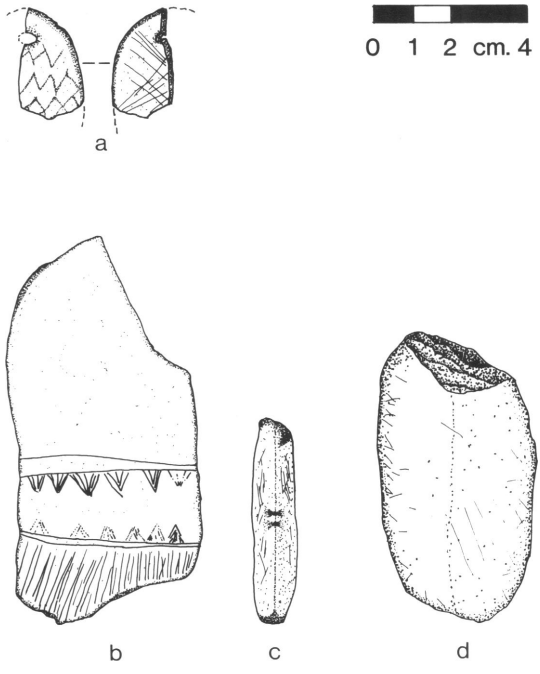

Fig. 9.20. Pendant and incised stones from Crater Middens. **a.** pendant; **b-d.** incised stones. a. O-799; b. O-3504; c. O-2476; d. O-4701.

TABLE 9.22
Distribution of Worked Bone at Crater Middens

	Midden I			Midden II						Midden III			Midden IV		Midden V		
	St. 3	Surf.	Mid-den	St. 7	St. 9	St. 10	St. 12	Surf.	Mid-den	St. 16	Surf.	Mid-den	Surf.	Mid-den	Surf.	Mid-den	Total
Beads	1						2	1	1	7		9		9			30
Tubes									2	1							3
Awls									5	1		3		1			10
Flakers							1		2								3
Spatulas									4		1	2					7
Side-scrapers									2			1					3
Radius needle									1			1					2
Needle									1								1
Scraper												1					1
Pendant												1					1
Manufacturing debris																	
Grooved										1		4	1				6
Sawn														1			1
Sliver							1										1
Awl/flakers							1		4	1		7		1			14
Scratched and polished frags						2			32	11	1	17	1	8		2	74
Shaped scraps	2				1		1	2	46	5		37	1	15		2	112

by grinding and the entire face upon which the design appears has been ground flat, evidently prior to, and as preparation for, incision.

The second incised stone is a slender spall (O-2467), subrectangular in outline and triangular in cross section (fig. 9.20c). Apparently complete, it is 5.6 cm long, 1.4 cm wide (tall), and 1.0 cm thick. Two of its three sides are weathered, the third is freshly broken. Both ends and the fresh surface have been ground and both of the weathered sides exhibit longitudinal incisions that are faint and do not obviously conform to any specific design. There are two very slight notches on the ridge between the two weathered faces.

The third incised stone (O-4701) is a flat stream-rounded metamorphic pebble both faces of which exhibit myriad incisions (fig. 9.20d). These are either so indistinct or confused with each other that, with the possible exception of four parallel hatchures, no specific design can be distinguished. This specimen is 7.9 cm long, 4.1 cm wide, and 1.7 cm thick.

The regional distribution and interpretation of incised stones have already been summarized in reference to specimens from Pinyon House and Two Eagles.

MISCELLANEOUS ARTIFACTS: Two artifacts found at Crater Middens resist inclusion in well-defined categories. One of these (O-519) is a transversely broken, stream-rounded metamorphic pebble, the fractured margin of which at one side is slightly flattened by an abraded facet that suggests use as a scraper. It is 2.2 cm long from the fracture to the opposing end, 3.2 cm wide, and 1.0 cm thick (tables 9.20, 9.21). The use-wear on this specimen is very faint and in all probability it was picked up, used once to scrape or shave something, and tossed away.

The other artifact is a neatly percussion-trimmed block of granite (O-3663; table 9.20). It is 15.6 cm long, 8.2 cm wide, 6.1 cm thick, rectangular in plan, rhomboidal in long section, and essentially tabular in short section. It has been pecked on both faces but aside from this shows no evidence of use. It is possible that this piece was employed as an anvil in bipolar percussion work or the splitting of bone but seems too well made for either purpose. No other specific interpretation, however, can be offered.

TABLE 9.23
Subsurface Distribution of Worked Bone at Crater Middens

	Midden I	Midden II					Midden III						Midden IV					Midden V				
	0–10	0–10	10–20	20–30	30–40	40–50	0–10	10–20	20–30	30–40	40–50	50–60	0–10	10–20	20–30	30–40	40–50	0–10	10–20	20–30	30–40	Total
Worked bone																						
Beads		1					3	2	2	1	1		1	7	1							19
Tubes		1	1																			2
Awls		2		1	2		1	1		1					1							9
Flakers		1	1																			2
Spatulas			3	1					2													6
Side-scrapers		2						1														3
Radius needle			1							1												2
Needle			1																			1
Scraper										1												1
Pendant							1															1
Manufacturing debris																						
Grooved							2		2													4
Sawn														1								1
Awl/flakers		2	1	1			1		3	2	1			1								12
Scratched and polished scraps		15	12	3	2		6	5	4	1	1		1	6	1				2			59
Shaped scraps		13	21	11	1		5	13	12	4	3		5	6	4			2				100

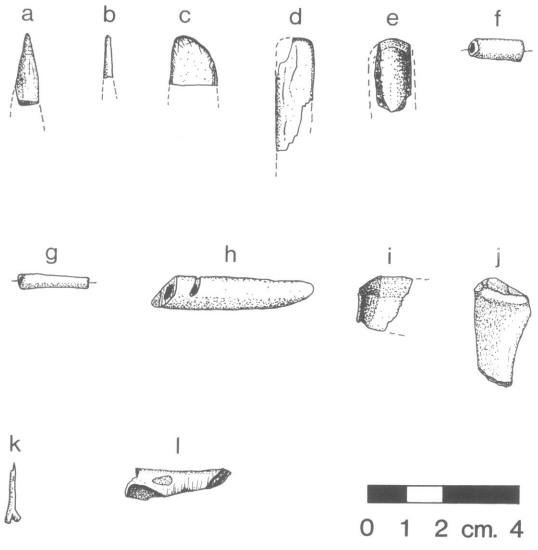

Fig. 9.21. Selected artifacts of worked bone from Crater Middens. **a, b.** awls; **c.** flaker; **d.** spatula; **e.** bone tube; **f, g.** bone beads; **h.** section of sawn bone; **i.** section of cut bone; **j.** bone scraper; **k.** bone needle; **l.** bone side-scraper. a. O-2527; b. O-2798; c. O-400; d. O-2811; e. O-3866; f. O-4563; g. O-4768; h. O-4818; i. O-4152; j. O-580; k. O-548; l. O-3356.

WORKED BONE

The assemblage of worked bone from Crater Middens comprises 269 individual specimens but only five are complete and less than a third can be assigned to a specific category of tool or ornament (tables 9.22, 9.23). The rest are unidentifiable scraps that, in varying degrees, show evidence of modification by use or intentional shaping.

BONE BEADS (30 specimens; all small mammal or bird bone): Bone beads are more common than any other category of worked bone at Crater Middens, probably because even small fragments are readily identified. The bulk of the specimens cannot be measured for either length or diameter. Those that can graduate without obvious discontinuity from 2.1 to 0.4 cm in length (9 specimens) and from 0.6 to 0.2 cm in diameter (8 specimens), although one fragment (O-1951) is from a bead that was more than 0.8 cm in diameter (fig. 9.21f, g). Perhaps a larger sample would disclose standardized lengths and thicknesses.

Two specimens are decorated by incision, one (O-448) by what appear to have been two series of deeply scored hatchures on opposing sides of the bead, the other (O-3838) by lightly incised parallel lines that were oriented perpendicular to the axis of the bead and may have encircled its entirety.

For all the variability in length, diameter, and decoration observed in these beads, mode of manufacture, where it could be determined, was always by snapping a section of bone at either end by means of tranversely sawn grooves and smoothing the ragged ends by grinding. The polish exhibited by some specimens is very likely the result of extended wear.

Bone beads are of near-ubiquitous distribution in the Inyo-Mono region, again, perhaps because they are more readily recognized as fragments than bone artifacts of other types. In the southern part of the region, they are reported in small quantities from the Stahl site (Harrington, 1957: 69), Rose Spring (Lanning, 1963: 260), the Baird site (Hillebrand, 1974: 79), Coville Rockshelter (Meighan, 1953: 182), and Ray Cave (Panlaqui, 1974: 43), but not Iny-2 (Riddell, 1951), or any of the small sites near Owens Lake excavated by Wilke (1983). Both decorated and undecorated bone beads are occasionally present in Death Valley (Hunt, 1960: 146, 269). Further north, both E. Davis (1964: 278) and Enfield and Enfield (1964: 411) report bone beads from sites excavated in Long Valley. The specimens described by Enfield and Enfield, however, are drilled wall sections rather than the tubular type found at Crater Middens and the other sites mentioned above. The absence of tubular bone beads at Iny-2 and in the late prehistoric deposit of the Rose Spring site suggests they may have been replaced in late prehistoric times by beads of steatite and shell, both of which are represented at Iny-2 and the younger deposit of the Rose Spring site. The distribution of bone beads at Crater Middens is ambiguous in this regard (tables 9.22, 9.23). They are very common in the buried deposit of Midden III—which represents the earlier occupation of the site, and in structures and the buried deposit of Midden IV—which represent the more recent occupation. They are not common in the buried deposit of Midden

II—which represents both early and late site occupation. In the Crater Middens case at least, it may be that the spatial distribution of bone beads is more a reflection of local social and economic activity than a reflection of temporal trends in bead styles.

BONE TUBES (3 specimens; all small to medium-size animal bone): Three fragments of small to medium-size animal long bone carefully finished by grinding and polishing on an intact end probably derive from bone tubes (fig. 9.21e; table 9.22).

These fragments are similar to bone beads in shape but differ from them in size and degree of finish. All three are ground and polished on both sides of the lip, rather than merely on the exterior as is the case with beads. None is sufficiently complete to furnish an accurate measurement of either length or diameter, but each one appears to have been more than 1.0 cm in diameter. By comparison, the largest bead that could be measured was only 0.6 cm in diameter although one incomplete piece would have been more than 0.8 cm in diameter when intact.

These bone tubes may have been worn as large beads, incorporated in loop snares (Wheeler, 1942: fig. 26), or used as sucking devices by shamans. With respect to the last it should be noted that there is no specific mention of the ethnographic use of bone tubes by shamans in Owens Valley (Steward, 1933: 313) or by those among the Nevada Shoshoni (Steward, 1941: 320–321), the Ute, or Southern Paiute (Stewart, 1942: 344–345). They were, however, employed by some Northern Paiute shamans (Stewart, 1941: 413).

Aside from one bone pipe found in Death Valley (Hunt, 1960: 269)—which bears no real resemblance to the specimens from Crater Middens, the only recorded example of a bone tube anywhere in or near the Inyo-Mono region is from Coville Rock Shelter (Meighan, 1953: 182, pl. 27r).

AWLS (10 specimens; 9 large mammal bone, 1 bone of indeterminate size class): Ten sharply tapered or pointed fragments were identified as the distal portions, or tips, of awls. All of them appear to have been finished by grinding or shaving, the striations from which are clearly evident, in eight cases somewhat obscured by a fine polish resulting from use. It is possible that these awls were fashioned entirely by grinding but more likely that at least some were initially split out of larger sections of bone and brought to rough shape by percussion retouch along the margins. Several have been lightly burned but it is uncertain whether this is a form of tempering or merely a consequence of their having been tossed into a trash fire.

Three of these fragments (O-2527, O-2619, O-2620) are relatively stout, flattened in cross section, and tapered primarily by reduction in width rather than thickness, which constricts markedly only at the distal extreme (fig. 9.21a). Three other fragments (O-2798, O-4315, O-4353) are much more delicate, symmetrically tapered, and round in cross section, but one (O-2798) may have been used following a lengthwise fracture that left it planoconvex in cross section (fig. 9.21b). The remaining four pieces lack distal terminations and are in other respects so fragmentary that the original configuration cannot be determined.

The use-wear and shape of these tools establishes their probable use in the manufacture of coiled basketry, which requires an awl to insert the weft through the coils as the basket is made. The dichotomy of size and shape between the more complete specimens almost certainly corresponds to differences in the texture of weave for which they were employed. At a working penetration of 1.0 cm, the larger specimens form an opening with a maximum diameter of between 0.4 and 0.5 cm and would be better suited to coarse work than the smaller specimens, which at similar penetration form openings of between 0.2 and 0.3 cm.

The Owens Valley Paiute are reported to have used awls of cactus needles but not bone (Steward, 1933: 271; but see Steward, 1941: 288, 337). Moreover, bone awls—indeed bone artifacts of all kinds—are scarce in archaeological deposits throughout eastern California. Harrington (1957: 69, 80), Lanning (1963: 260), Panlaqui (1974: 32), and E. Davis (1964: 278) report a few examples, however. The absence of bone awls at Iny-2, a site very rich in artifacts of other kinds, is particularly telling and may indicate either the replacement of bone awls with awls of cactus needle or a growing reliance on twining—as opposed to coiling—or a combination of the two, in late

prehistoric times. That most of the awls that have been found in the Inyo-Mono region are from contexts suggesting dates prior to A.D. 1300 tends to support this notion. The sample of awls from Crater Middens is too small to shed much light on this issue but they occur slightly more often in earlier contexts than later contexts (tables 9.22, 9.23).

FLAKERS (3 specimens; all large mammal bone): Three blunt, but well-worked, tool tips were tentatively identified as fragments of flakers. None is longer than 2.1 cm, which precludes assessment of their original size and shape. With respect to the working end or bit, however, one (O-399) appears to have been essentially cylindrical, another (O-2977) essentially conical, and a third (O-400) wedge-shaped in plan and tabular in cross section (fig. 9.21c). All are scratched and scored in the manner consistent with that expected of flakers but it was primarily on the basis of shape—the bluntness of their working ends in particular—that they were classified as flakers.

With the exception of a single blunt-ended object from the Rose Spring site interpreted as a flaker by Lanning (1963: 260), bone artifacts similar to the three flakers found at Crater Middens are missing from the inventories of excavated sites in the Inyo-Mono region. Hunt (1960: 269), however, reports a horn (antler?) flaker from Death Valley and Panlaqui (1974: 33) describes three heavy bone tools from Ray Cave that are suitable for flaking, punching, or digging.

SPATULAS (7 specimens; 6 large mammal bone, 1 small animal bone): Seven relatively flat fragments of long bone wall that show evidence of intentional shaping and use along the sides and an arcuate working end were identified as belonging to spatulas. Three of these (O-757, O-2452, O-2811) appear to have been split, roughly shaped by percussion, and finished by grinding (fig. 9.21d). A fourth (O-4536) was similarly split and trimmed by percussion and then put to use without being ground. The remaining three were split and ground, but are too fragmentary to ascertain whether they had been trimmed by percussion.

All seven are well-smoothed, in some cases polished, as the result of use. The wear is most pronounced on the ends of these fragments but it is also present in less severe form along the lateral edges and, in a few cases, on one or both faces. Despite their similarities in form and use-wear, these fragments represent tools of widely varying size. The smallest (O-2974), the only one made from a small animal bone, was no more than 0.5 cm wide. The end of this piece is asymmetrically bevelled and striated from use. The largest, the one left unground (O-4536), is 1.6 cm wide. Both the shape and wear characterizing the six larger implements is most consistent with the interpretation that they were used in the fleshing, dehairing, and tanning of hides. It is quite possible, however, that they were employed in altogether different tasks, for example to prepare sinew and other fiber or food, or simply as spoons. The smallest of the seven would be serviceable for very fine hidework or, as a chisel, in fine woodwork.

Bone spatulas are not reported from any excavated site within the Inyo-Mono region proper, but a small bone object found in Ray Cave (Panlaqui, 1974: 33) is evidently reminiscent of the smallest spatula recovered at Crater Middens. Hunt (1960: 144–146, 269) reports several examples from Death Valley, all from contexts suggesting dates after A.D. 600, and there is one in the collection from Coville Rock Shelter in the mountains between Death Valley and Saline Valley (Meighan, 1953: 180–181).

SIDE-SCRAPERS (3 specimens; all large mammal bone): Three fragments of large mammal long bone, each one split and trimmed by percussion but unground, show evidence along one lateral margin of having been used as scrapers. In all three fragments the wear resulting from this use extends perpendicularly from the working edge toward the smooth bone exterior (fig. 9.21l). In two instances (O-2525, O-3356) this takes the form of abrasion, polish, and striations, and in one (O-4513) that of a flat, polished bevel. As in the case of bone spatulas, the most probable use for these tools is that of working hide and leather, most likely in the removal of flesh and hair. As is also true of bone spatulas, however, the possibility of other uses cannot be excluded. The piece with the bevelled edge, for example, might as easily be explained as a woodworking tool. Similarly, the other two are suitable for use in the prep-

aration of fiber and display wear that would be consistent with this interpretation.

No specimens comparable to these scrapers are reported anywhere in the Inyo-Mono region or Death Valley, perhaps because they might easily be missed by casual inspection. A chipped bone saw from Ray Cave (Panlaqui, 1974: 46) may be somewhat similar but this is not clear from its description. Outside the region the closest geographical occurrence of similar specimens is a group of notched tools interpreted as fiber- and hide-working implements recovered from sites in the vicinity of the Perris Reservoir, Riverside County, California (Mix, 1974: 190). The Crater Midden specimens, however, are less well-worn than these.

MISCELLANEOUS WORKED BONE: In addition to those that can be readily assigned to formal artifact categories, a substantial number of the worked bone objects found at Crater Middens are either too fragmentary to permit specific classification or do not fit into any well-known or commonly recognized category.

Two cottontail (*Sylvilagus*) (O-548, O-634) radii appear to have been used as needles or awls (fig. 9.21k). Each retains the proximal articulation and has been snapped diagonally, leaving ragged fracture terminating in a sharp point. This diagonally fractured end, which was evidently left undressed, i.e., unground, is smoothed and polished, possibly as the result of use in piercing skins or hides. This smoothing might stem from passage through the gut of a carnivore but the lack of similar attrition on the intact articulations weighs against this possibility. No similar specimens are mentioned for any part of the Inyo-Mono region or Death Valley. They are easily missed, however, and are likely to be recognized as tools only by examination with binocular microscope.

A very small fragment of small animal bone (O-3467) one end of which has been ground on both margins to form a very fine point was probably used as a needle. The tip, which lacks perhaps 0.3–0.4 cm of the termination, is at the point of the break only 0.2 cm wide and 0.1 cm thick. Only a small fraction of the proximal end is intact but its presence confirms that when complete, this tool was no more than 2.5 cm long, which would seem to exclude its use as a fine-tipped awl of the kind described by Ambro (1970). The tip and the raised portions of the shaft are smoothed and polished, presumably by use, and part of the exterior bone surface appears to have been intentionally smoothed and polished during manufacture. The piece has been lightly burned, possibly as an attempt at tempering; alternatively this might only reflect its having been disposed of in a fire. As a small bone fragment of this kind would be easily missed, it is not surprising that there is no mention of similar specimens anywhere in the Inyo-Mono region.

A piece of large mammal bone (O-580), the curvature of which suggests it is a section of long bone wall from the base of an articulation, has been at one end shaped by percussion and shows evidence of use as a scraper or chisel (fig. 9.19j). The shaped working end of this piece, which is the end away from the articulation, is irregularly convex in plan and resembles the working ends of the bone spatulas described previously. Being prepared by bifacial percussion, however, it is sharper and more wedge-shaped in cross section than spatulas. If this piece is complete, the sides and base were evidently left unmodified. In its present condition, however, this artifact would be difficult to use. It is quite small, measuring only 3.0 cm long, 1.6 cm wide, and 0.8 cm thick, which in combination with the roughness of its base, would make it difficult to grasp for any length of time. It seems more likely, therefore, either that it was used as the bit in a socketed tool or that one side and the base—which would have been a section of joint articulation—are missing. Wear is present as a fine polish on the exterior bone surface, set well back from the edge, and there is smoothing and polishing at the juncture between one lateral margin and the interior bone surface. The lateral margin may have been intentionally modified during the preparation of the tool, but the polish on the exterior bone surface is clearly the result of some kind of use that brought this exterior surface into close contact with the material being cut, scraped, or gouged by the leading edge of the tool. Curiously, the working edge shows no similar evidence of wear, perhaps because it had been recently rejuvenated. This implement would

serve well in the same range of tasks that have been inferred for spatulas: fleshing, dehairing, and tanning of hides. Owing to the sharper working edge, however, it might also have been used as a chisel or gouge in woodworking. Indeed, the latter interpretation is the one most consistent with the glosslike polish it exhibits on one face. There is evidently no record of comparable examples in the Inyo-Mono region.

A small, biconically drilled fragment of bone (O-558) is probably part of a pendant. When complete, the original was evidently straight-sided and sublenticular in cross section. Both faces and the one intact side are ground and polished, the latter perhaps as the result of being worn. Somewhat similar drilled bone pendants and beads occur sporadically in the Inyo-Mono region. Ring-shaped beads are reported for Mammoth Creek Cave (Enfield and Enfield, 1964: 411) and a rectangular bead was found at the Rose Spring site (Lanning, 1963: 260). Bone pendants, none closely similar to the one from Crater Middens, have been found in Death Valley (Hunt, 1960: 266) and at Ray Cave (Panlaqui, 1974: 43).

Eight scraps of discarded debris document some of the manufacturing techniques employed with bone. Six pieces, three of large mammal bone and three of small animal bone, exhibit at one margin the remains of transverse grooves used to weaken the bone wall so they could be snapped and removed from adjoining sections, which were evidently saved, while these specimens were thrown away (fig. 9.21i). These grooves suggest use of a tool that was either quite blunt or quite thick. Many of the more heavily used bifaces found at Crater Middens are capable of producing such grooves and exhibit wear suggesting use in this manner.

Another small animal bone (O-4818) was at one end diagonally cut almost completely through from one side before it snapped, evidently by the force of the sawing stroke (fig. 9.21h). A second, incipient cut mark on this piece, parallel to the first and 0.6 cm away, is only 0.1 cm wide but twice that deep. The configuration of both cuts and the manner in which the complete one was executed makes it almost certain that they were made with a fine-toothed metal saw. Accordingly, such saws were either used in early historic times by the occupants of Crater Middens or the inhabitants of the site brought meat or scavenged bones and scraps from nearby settlements or ranches. Either way, this artifact, along with certain others—most of them glass beads—documents the use of the site in early historic or protohistoric times. The occurrence of this bone specimen in the buried deposit of Midden IV (tables 9.22, 9.23) supports the notion that aboriginal residence of this midden dates toward the end of the occupation of the site.

The last piece of bone debris (O-421A) is a splinter 3.8 cm long and 0.4 cm wide, the needlelike configuration of which appears unnatural and may be the byproduct of a process in which long, thin sections of bone were split out of large pieces by means of incised grooves. This fragment shows no obvious groove remnant on either lateral margin, however, and it might be nothing more than an oddly shaped fragment of smashed or chewed bone.

A total of 14 small fragments of large animal long bone have been worked into a gentle taper that suggests they are either awls or flakers but, lacking large sections of the working ends, cannot be reliably assigned to either category. Most of these show some evidence of burning, but as with most other bone tools exhibiting this characteristic, it is uncertain whether this is a form of tempering or the result of their having been disposed of in fires.

The remaining pieces of worked bone, 196 specimens in all, are too small to provide any hint of their original form or intended function. Of these, 74 are modified only by scratching and polishing. Of this group, 26 are large mammal bone, 25 are small animal bone, and 23 are unclassifiable in this regard. There is the possibility that a few of these scratched and polished pieces were modified by animals, for example by gnawing and gut passage, rather than by aboriginal craftsmen. The last 112 worked bone fragments have been shaped during manufacture or as the result of use and are clearly artifacts. Large mammal bone accounts for 62 of these, small animal bone for only 7, the balance being unclassifiable. Given the differential distribution of small and large animal bone between the specimens that are only scratched

TABLE 9.24
Distribution of Shell Beads and Shell Bead Refuse at Crater Middens

	Midden I			Midden II					Midden III			Midden IV		Midden V		
	St. 3	Surf.	Mid-den	St. 7	St. 9	St. 10	St. 12	Surf.	Mid-den	St. 16	Surf.	Mid-den	Surf.	Mid-den	Surf.	Mid-den	Total
Middens																	
Olivella																	
A1a									1								1
E1a	2				1					2							5
E1b				1							1			1			3
E2									2	1		1		1			5
E3a								1	2								3
K1							2							1			3
K2	1											1					2
K3	1								1								2
Refuse									7	2		3		4			16
Tivella																	
Thin disk										1							1
Haliotis disk																	
Nacreous (H3a2)													1				1
Epidermis (H7a)							1		1								2
Limpet ring												1					1
Unidentified													1				1

and polished and those that have been shaped, it would seem likely that many of the scratched and polished pieces are parts of beads and that many of the shaped pieces are parts of awls, flakers, and spatulas.

BEADS OF SHELL, STONE, AND GLASS

SHELL BEADS (30 specimens; 24 *Olivella,* 1 *Tivella,* 3 *Haliotis,* 1 Limpet, 1 Unidentified): Eight different *Olivella* shell bead types were present (tables 9.24, 9.25): Small Spire-lopped (Class A1a), Round Thin Lipped (Class E1a), Oval Thin Lipped (Class E1b), Full Lipped (Class E2), Large Lipped (Class E3a), Cupped (Class K1), Bushing (Class K2), and Cylinder (Class K3). With the exception of the Small Spire-lopped form, which is not sensitive to time, all these types are considered tentative markers of the Klondike phase. If this dating is correct, the bulk of the 16 pieces of *Olivella* bead production refuse must belong to this phase as well. That is, it scarcely seems possible that shell beads would have been made in any frequency locally before imported shell beads were available more or less regularly to the prehistoric inhabitants of Owens Valley.

Represented among the six remaining shell beads were one *Tivella* Thin Disk, a *Haliotis* Nacreous Disk (Class H3a2), two *Haliotis* Epidermis Disks (Class H7a), a Limpet Ring, and an unidentified fragment. The Limpet Ring is regarded tentatively as a marker for the Baker phase, the others as tentative markers for the Klondike phase.

STEATITE DISK BEADS (17 specimens; 16 large, 1 small): Steatite disk beads of two diameters, large and small, were found at Crater Middens (tables 9.26, 9.27). It is uncertain whether variation in size of these beads (the metric data for which will be presented elsewhere along with those for all shell, stone, and glass beads in the collections from these sites) is temporally significant. For the moment, however, both large and small varieties are regarded tentatively as Klondike phase markers.

GLASS BEADS (63 specimens): Glass beads were unexpectedly abundant at Crater Middens, especially in Structure 12 (tables 9.28, 9.29). The identifiable types present can be described as follows: White (Meighan Types

TABLE 9.25
Subsurface Distribution of Shell Beads and Shell Bead Refuse at Crater Middens

	Midden I	Midden II					Midden III						Midden IV					Midden V				
	0–10	0–10	10–20	20–30	30–40	40–50	0–10	10–20	20–30	30–40	40–50	50–60	0–10	10–20	20–30	30–40	40–50	0–10	10–20	20–30	30–40	Total
Olivella																						
A1a		1																				1
E1b													1									1
E2		1	1							1				1								4
E3a		2																				2
K1													1									1
K2								1														1
K3		1																				1
Refuse		1	1	4	1			2		1			1	3								14
Haliotis disk																						
Epidermis (H7a)		1																				1
Limpet ring										1												1
Unidentified													1									1

TABLE 9.26
Distribution of Steatite Disk Beads at Crater Middens

	Midden I			Midden II						Midden III			Midden IV		Midden V		
	St. 3	Surf.	Mid-den	St. 7	St. 9	St. 10	St. 12	Surf.	Mid-den	St. 16	Surf.	Mid-den	Surf.	Mid-den	Surf.	Mid-den	Total
Steatite disks																	
Large				2			3	2	5	3	1						16
Small	1																1

185 and 233), Red with Green Core (Meighan Types 104 and 105), Blue Faceted (Meighan Types 149 and 154), Green with Red Stripes (Meighan Type 246), Opalescent (Meighan Type 189), Red with White Core (Meighan Types 100 and 102), Red with Red Core (Meighan Type 106), Red Pear-Shaped (Meighan Type 118), and Blue (Meighan Type 325). Taken as a whole, this collection seems to date the Trapper and Mexican periods of California history and to predate the Mission period.

MINERALS

QUARTZ CRYSTALS (3 specimens): In contrast to the large collection from Two Eagles, only three specimens of crystalline quartz were found at Crater Middens (tables 9.30, 9.31): one (O-2379) complete clear crystal only 0.8 cm long, 0.4 cm wide, and 0.3 cm thick, a small fragment (O-3116) of a milky quartz crystal less than 1.0 cm long in any dimension, and a mass of milky quartz crystals (O-2795) 2.1 cm long, 1.6 cm wide, and 1.6 cm thick.

OCHER (20 specimens): A total of 19 small bits of red ocher and one large mass of yellow ocher were evidently intended for use as pigment. The red ocher varies in color from 10R to 5YR, but most pieces are 10R. None is larger than a pea or shows definite evidence of use. Most of them presumably owe their color to the presence of iron in some form. A few, however, may be cinnabar, since Steward (1933: 276) records that the Owens Valley Paiute used this mineral, rather than hematite, for red paint, securing it from the Last Chance Mountains, west of Death Valley.

The lump of yellow ocher (O-4483) is 7.7 cm long, 5.0 cm wide, and 3.0 cm thick and appears to be unused. Mustard brown in color (10YR 5/8), it does not resemble the description of the lemon yellow pigment obtained in trade by the Owens Valley Paiute from the Shoshoni to the east (Steward, 1933: 276), but is evidently similar to the orange-yellow ocher found in the upper deposit at Iny-2 (Riddell, 1951: 18).

Red and yellow ocher occurs sporadically at excavated sites throughout the Inyo-Mono region and surrounding areas (Bettinger, 1981c; Meighan, 1953: 185; Panlaqui, 1974: 44). The distribution of the specimens at Crater Middens (tables 9.30, 9.31) suggests greater use of these materials during the earlier occupancy of the site, all but two being found in the deposit of Midden III and the lower deposit of Midden II.

CHALK (15 specimens): A total of 15 small lumps of white, chalky mineral was found (tables 9.30, 9.31). Each one contains some sand in the matrix, but there is marked variation between individual specimens in the quantity, size, and degree of sorting of these inclusions. All 16 specimens reacted vigorously to a moderately strong solution of hydrochloric acid (HCl), presumably owing to the presence of calcium carbonate ($CaCO_3$).

As with similar chalklike lumps of mineral found at Pinyon House, these pieces are probably pigment and may have been obtained at the eastern margin of the Poverty Hills, 11 km southeast of Crater Middens, which was the Owens Valley Paiute source of chalk used for white paint (Steward, 1933: 277). A single lump of white, chalklike pigment is reported for Rose Spring (Lanning, 1963: 262), but no other sites in the Inyo-Mono region.

MICACEOUS SCHIST (696 specimens): Unmodified fragments of micaceous schist are common at Crater Middens and almost certainly represent debris resulting from the use or manufacture of the thin schist milling-

TABLE 9.27
Subsurface Distribution of Steatite Disk Beads at Crater Middens

	Midden I	Midden II				Midden III					Midden IV					Midden V				Total
	0–10	0–10	10–20	20–30	30–40	40–50	0–10	10–20	20–30	30–40	40–50	0–10	10–20	20–30	30–40	40–50	0–10	10–20	20–30	30–40	
Steatite disk																					
Large							5														5

stones described with the groundstone assemblage. It is significant in this regard that although every attempt was made to recover schist scraps at Pinyon House and Two Eagles, none was found at either site. Since, as discussed earlier, schist millingstones were very likely used at both sites, the absence of such scraps at either one tends to imply that these fragments are the byproducts of manufacture, refurbishing, or ritual destruction and not fortuitous losses by attrition from use.

As expected, the distribution of unmodified pieces of schist (tables 9.30, 9.31) is very nearly identical to the distribution of schist millingstones (tables 9.1, 9.2), both implying use of these distinctive grinding implements predominantly during the later occupation of Crater Middens.

SLATE (25 specimens): The 25 unmodified fragments of green or gray-brown slate found at Crater Middens may be pendant or incised tablet blanks, debris from the manufacture of pendants or tablets, or unmodified portions of broken pendants or incised tablets. The bulk of them (80%) were recovered from the buried deposit of Midden II, where they tend to be concentrated in the upper part of the deposit (tables 9.30, 9.31). The other 20 percent were scattered throughout the site in contexts that place them with the later prehistoric occupancy. The interpretation most consistent with these data is that the use or manufacture of slate pendants or incised tablets was at all times more prevalent in Midden II than other parts of Crater Middens and that these items figured more prominently in the later prehistoric occupation of the site than in earlier occupations.

OBSIDIAN FLOAT (31 specimens): Nearly all of the obsidian float found at Crater Middens was in the form of very small rounded pebbles, none much larger than 1.0 cm in diameter (tables 9.30, 9.31). Many of these were undoubtedly obtained from stream deposits along Owens River, where alluvial obsidian is relatively common. Two relatively large specimens in the Crater Middens collection, one (O-3580) 2.4 cm in maximum diameter, the other (O-4667) 3.3 cm in maximum diameter, are probably from the same general alluvial source. At least some of the smaller pieces may be weathered fragments of Fish

TABLE 9.28
Distribution of Glass Beads at Crater Middens

	Midden I			Midden II					Midden III			Midden IV		Midden V		
	St. 3	Surf.	Mid-den	St. 7	St. 9	St. 10	St. 12	Surf.	Mid-den	St. 16	Surf.	Mid-den	Surf.	Mid-den	Surf.	Mid-den	Total
Meighan Type																	
100												1					1
102							1										1
104							2		2		1	1					6
105							2										2
106													1				1
118													1				1
149							2	1			1	1					5
154													2				2
185							6					4					10
189							1										1
233							27										27
246	1																1
325						2											2
Unidentified				1			1					1					3

Springs obsidian inadvertently brought to the site in perlite matrix attached to material quarried at that source. The alluvial specimens, on the other hand, were almost certainly collected and brought to the site deliberately. The larger two may have been intended for use as small cores, there being five worked alluvial obsidian cores in the Crater Middens collection and several other similar specimens in the collections from Two Eagles and Pinyon House. The smaller pebbles admit no clear interpretation, but may have been used in rattles (cf. Steward, 1933: 278).

INDURATED KAOLIN (4 specimens): Four fragmentary nodules of indurated kaolin were found (tables 9.30, 9.31). They are unmodified and no specific interpretation for their intended use immediately suggests itself; possibly they were parts of charms or sources of white paint. Whatever their purpose, it is likely that all four were obtained somewhere in the vicinity of Hot Creek in Long Valley, where kaolin, hydrothermally altered from rhyolite, is common.

MISCELLANEOUS MINERALS: Among the more interesting pieces of unmodified mineral found at Crater Middens (tables 9.30, 9.31) is a small bit of blue turquoise (O-2724) less than 0.6 cm in any dimension. Riddell and Riddell (1956: 31) report the one other occurrence of turquoise from Owens Valley, which they attribute to an eastern Mojave Desert source now thought to have been worked successively by Anasazi, Hakataya, and Paiute miners (Leonard and Drover, 1980: 251–252), or to a local source east of the modern town of Independence. In view of the dearth of this mineral at Owens Valley sites, the former explanation seems the most probable.

Two lumps of iron mineral, perhaps limonite, may have been saved as talismans or intended for use as pigment, though they are very hard and would not easily serve the latter purpose. One (O-4408) is 1.8 cm long, 1.2 cm wide, 0.8 cm thick. The other (O-679/2) is smaller, measuring 0.6 cm long and wide and 0.3 cm thick.

Two pieces of a broken mica tablet (O-631), 0.8 cm wide, 0.2 cm thick, and presently 0.8 cm long, were recovered. It is possible that the original broke during an attempt to drill it for use as a bead or pendant or that it was brought to the site as a charm or to be mounted in mastic on some other object. Alternatively, it may have simply weathered out of a piece of granite and been deposited naturally.

Two additional crystals of unidentified

TABLE 9.29
Subsurface Distribution of Glass Beads at Crater Middens

	Midden I	Midden II				Midden III					Midden IV					Midden V				
	0–10	0–10	10–20	20–30	30–40	40–50	0–10	10–20	20–30	30–40	40–50	0–10	10–20	20–30	30–40	40–50	0–10	10–20	20–30	30–40	Total
Meighan Type																					
100							1														1
104		1		1				1													3
149							1														1
185							4														4
Unidentified							1														1

mineral were recovered. One reddish black columnar specimen (O-2513), octagonal in cross section and measuring only 0.5 cm long, 0.3 cm wide, and 0.2 cm thick, is probably natural to the site. The other (O-420) is a large fibrous mass of pink and green crystals that measures 9.3 cm long, 5.8 cm wide, and 4.3 cm thick. This specimen was almost certainly imported to the site, but its source, mineral composition, and intended purpose are uncertain.

HISTORIC ARTIFACTS

Other than glass beads, which are described elsewhere in this volume, the only historic artifacts that can confidently be ascribed to the aboriginal occupation of Crater Middens are two worked fragments of glass. Of the other historic artifacts found at the site, some are equivocal in terms of their association with the aboriginal assemblage, others are clearly unrelated to it (tables 9.32, 9.33).

Both pieces of worked glass are fragments from the shoulders of green-brown bottles. Both are delicately wrinkled on the exterior and mirror-smooth on the interior, exhibit bubble inclusions, and lack evidence of mold seams; differences in shoulder contour and thickness suggest that two different bottles are represented. The larger (O-527) of the pair shows several percussion flake scars and one nicked and nibbled edge and may have been rudimentarily shaped and used as a scraper or saw. It is 4.7 cm long, 3.1 cm wide, and 0.5 cm thick. The other (O-391) is unifacially flaked and ground on one edge and nibbled by use or light percussion on another. As this piece shows little attrition in other respects, the grinding, which is parallel to the working edge, may be the result of platform preparation rather than use-wear. This specimen is 2.7 cm long, 1.8 cm wide, and 0.4 cm thick.

In addition to these two tools, 13 other pieces of similar green-brown bottle glass were found scattered on the surface or in the upper parts of the midden throughout the site. Several of these bear isolated flake scars but none can be reliably identified as tools. Collectively, they vary in thickness from 0.5 to 0.2 cm, lack mold seams, and exhibit wrinkled exteriors and smooth interiors in all cases

TABLE 9.30
Distribution of Minerals at Crater Middens

	Midden I			Midden II						Midden III			Midden IV		Midden V		
	St. 3	Surf.	Mid-den	St. 7	St. 9	St. 10	St. 12	Surf.	Mid-den	St. 16	Surf.	Mid-den	Surf.	Mid-den	Surf.	Mid-den	Total
Quartz crystals					1				2								3
Ocher																	
Red									4			13		1		1	19
Yellow												1					1
Chalk	4								1	8			1	1			15
Micaceous schist	19	5		6	51	13	26		254	236	8	19	4	55			696
Slate									20	2			1	2			25
Obsidian float								1	2	6	3	10	3	6			31
Indurated kaolin		1								1		2					4
Turquoise									1								1
Limonite												1		1			2
Mica tablet												1					1
Unidentified small crystal									1								1
Crystal mass							1										1

where surface orientation could be established. Bubble inclusions are present in all but the smallest specimens. At least three are from bottles that were round or rounded in cross section (O-574/1, O-574/2, O-3714/1), four are from bottles that were polygonal in cross section (O-3714/2, O-3714/3, O-3658/1, O-3658/2), and six are indeterminate in this respect. Given similarities in color, thickness, and surface texture, it is very likely that these fragments derive from the same bottles as the two glass tools just described and thus relate to historic aboriginal occupation of the site. Such bottle glass could have been easily obtained as fragments or complete containers at town or ranch dumps throughout Owens Valley. A very similar green-glass bottle with round cross section was evidently brought intact to the site of Pinyon House where it later broke accidentally or was broken intentionally, perhaps to obtain pieces that could be worked into tools. The possibility should be noted that some or all of the unworked bottle fragments from Crater Middens may owe their presence to more recent nonaboriginal visitors, for example cowhands, shepherds, prospectors, or workmen who erected an electrical transmission line that passes just east of the site. The historic material clearly attributable to these and other nonnative groups is described later below.

The only other bottle fragment found at Crater Middens is a bladelike spall of milky, opalescent glass (O-3718). It shows no evidence of use and might be part of the historic aboriginal assemblage or debris from a more recent nonaboriginal visit.

Two complete, but opened, cylindrical cans were found on the surface of the site. One (O-3518) is made with folded-edge ends and soldered venthole. These characteristics distinguish cans made between A.D. 1810 and 1922, but are still found on condensed milk containers (Busch, 1981), which this specimen appears to be. It stands 6.1 cm tall, is 6.4 cm in diameter, and is about the size of a modern 4 ounce container. It was opened on one end with a wedge-shaped object, perhaps an axe, and vented at the opposite margin of the same end with a slimmer blade, a knife for example. This can may be part of the historic aboriginal assemblage of the site but is very probably more recent refuse. The other can (O-4689) is made with locked, double end seams and locked side seams that identify it as a sanitary can made sometime after about A.D. 1900 (Busch, 1981) and therefore deposited after the aboriginal abandonment of Crater Middens. It stands 8.1 cm

TABLE 9.31
Subsurface Distribution of Minerals at Crater Middens

	Midden I	Midden II					Midden III			
	0–10	0–10	10–20	20–30	30–40	40–50	0–10	10–20	20–30	30–40
Quartz crystals		2								
Ocher										
Red			2	2			2	8	3	
Yellow							1			
Chalk			1							
Micaceous schist		148	77	26	2	1	11	2	4	
Slate		9	5	4	2					
Obsidian float		2					3	1		4
Indurated kaolin								1		
Turquoise		1								
Limonite							1			
Mica tablet								1		
Unidentified small crystal		1								

high, is 6.1 cm in diameter, and was incompletely opened at one end with a can opener of the hook-bladed type.

Four cartridge components were recovered from the surface and buried deposits of Crater Middens. Two copper-plated, .22 caliber short rimfire slugs clearly found their way into the site very recently. Despite this both were found in well-consolidated midden, one (O-4409) in the upper 10 cm of deposit in Midden III, the other (O-3341) at a depth of between 20 and 30 cm in Midden II. Somewhat older than these two slugs but still too young to be part of the historic aboriginal assemblage, provided the site was abandoned in 1872 or shortly thereafter, is a brass .30-30 cartridge case (O-2054) inscribed, "W.R.A. Co. .30 W.C.F." (Winchester Repeating Arms Company, .30 caliber Winchester Center Fire). A piece of lead shot (O-3983), about size 4, found in Structure 16 might conceivably be part of the historic aboriginal assemblage of the site, but as no other historic debris was found in Structure 16 is better regarded as debris from a more recent hunting trip.

A green and red glass marble (O-785), 1.7 cm in diameter, found on the surface of Midden II might have been brought to Crater Middens by one of its last aboriginal occupants. It might as easily be a sling or sling-shot pellet cast into the vicinity of the site long after it had been abandoned.

The remaining item of historic debris that might be a part of the aboriginal assemblage is what appears to be a tiny scrap of glazed ceramic (O-2422). This identification, however, is tentative as the piece is less than 0.5 cm long in any dimension.

The remainder of the historic debris found at the site is clearly nonaboriginal and consists of seven pieces of aluminum foil (O-2335, O-755, O-2514, O-528), an aluminum shoelace eye (O-2334) of grommet type, three pieces of galvanizing—evidently coatings from metal buckets (O-3749, O-604, O-677), a portion of rubber tread (O-3340), a twisted loop of galvanized wire (O-4965) measuring 18.0 × 12.4 cm overall, and a faintly purpled fully machine-made glass bottle (O-4594A) fluted on the shoulder and at the base and inscribed on the side, "REGISTERED NET CONTENTS 6½ OZS" and on the bottom with the trademark, "PAT. NO. 62785," directly beneath which is the letter *S* centered in a pentacle. The bottle stands 22.2 cm high and is 5.4 cm in maximum diameter. The foil, shoelace, eye, wire, and bottle were all recovered either from the surface or the upper portions of the midden or deposits in structures. The fragments of galvanizing, on the other hand, were found at depths below 40

TABLE 9.31—(*Continued*)

Midden III		Midden IV					Midden V				
40–50	50–60	0–10	10–20	20–30	30–40	40–50	0–10	10–20	20–30	30–40	Total
											2
		1							1		19
											1
		1									2
2		23	11	12	5	4					328
		1		1							22
2		3	1	2							18
1											2
											1
		1									2
											1
											1

cm, suggesting they are parts of the buckets used as excavation equipment; similarly, the rubber tread was found at a depth of between 20 and 30 cm and probably belonged to the boot of an excavator.

The machine-made bottle is curious in certain respects that deserve mention. First, found jammed on its side in a rock fissure, it exhibits multiple longitudinal striations on the sides while the base is little worn in com-

TABLE 9.32
Distribution of Historic Artifacts at Crater Middens

	Midden I			Midden II					Midden III			Midden IV		Midden V		
	St. 3	Surf.	Mid-den	St. 7	St. 9	St. 10	St. 12	Surf.	Mid-den	St. 16	Surf.	Mid-den	Surf.	Mid-den	Surf.	Mid-den	Total
Glass																	
Green-brown							1		1		9	3		1			15
White								1					1				1
Bottle																	1
Cans																	
Hole-in-top											1						1
Sanitary													1				1
Cartridge parts																	
30-30 casing								1									1
#4 lead shot										1							1
.22 short slug									1			1					2
Aluminum foil					1				5			1					7
Grommet					1												1
Marble								1									1
Glazeware(?)						1											1
Galvanizing										1		3					4
Rubber tread									1								1
Galvanized wire loop															1		1

TABLE 9.33
Subsurface Distribution of Historic Artifacts at Crater Middens

	Midden I	Midden II				Midden III					Midden IV					Midden V				Total
	0–10	0–10	10–20	20–30	30–40	40–50	0–10	10–20	20–30	30–40	40–50	50–60	0–10	10–20	20–30	30–40	40–50	0–10	10–20	20–30	30–40	
Green-brown glass			1				3						1									5
.22 short slugs				1			1															2
Aluminum foil		2	3				1															6
Galvanizing								1		2												3
Rubber tread				1																		1

parison. Second, when found, it contained a beetle carapace, a burned twig, and a section of large mammal rib. The beetle may have climbed in on its own, but the burned twig and the mammal bone were clearly inserted by design. The purpose to which this bottle and its strange contents were put remains unclear but the scratched sides of the bottle would indicate several repetitions of the same act.

UNMODIFIED VERTEBRATE FAUNAL REMAINS

A total of 7657 pieces of unmodified bone was recovered at Crater Middens (tables 9.34, 9.35). Among these were 347 identifiable specimens representing 13 different genera and the order Artiodactyla, including at least a few specimens representing *Ovis canadensis, Odocoileus hemionus,* and *Antilocapra americana.* Of these, it seems very likely that some fraction of the elements representing the genera *Lepus, Sylvilagus, Marmota, Lynx,* and *Canis* and the artiodactyls are products of cultural deposition. In the cases of *Lynx, Canis,* and the artiodactyls, the connection is probable because these taxa are scarce in the local fauna relative to their frequency at Crater Middens and because all three are known to have been important to the ethnographic inhabitants of Owens Valley (cf. Steward, 1933: 252–256), either as sources of food and skins (*Artiodactyla* and *Lynx*) or as pets (*Canis*)—provided, of course, the domestic species, *C. familiaris,* is the one represented and not the wild one, *C. latrans,* which was not eaten but probably taken for skins although specific reports of this are evidently lacking (Steward, 1933: 256, 257).

In addition to the above taxa, there is hardly any doubt that the abundance of remains representing *Lepus* and *Sylvilagus* conveys accurately their importance as staples of diet and as sources of skins from which the basic native garment in ethnographic times, the woven rabbitskin blanket, was fashioned (Steward, 1933: 269–270). Apart from their near-universal importance to aboriginal groups throughout western North America including Owens Valley (Steward, 1933: 254–255), both species are simply too common in the Crater Middens collections for this to be

TABLE 9.34
Distribution of Unmodified Vertebrate Faunal Remains[a] and Other Unmodified Organic Material at Crater Middens

	Midden I			Midden II						Midden III			Midden IV		Midden V	
	St. 3	Surf.	Mid-den	St. 7	St. 9	St. 10	St. 12	Surf.	Mid-den	St. 16	Surf.	Mid-den	Surf.	Mid-den	Surf.	Mid-den	Total
UNMODIFIED VERTEBRATE FAUNAL REMAINS																	
Lepus				2	2	3	3		21	21	1	37	3	17		3	113
Sylvilagus	1					2	4		11	5		18		7		2	50
Marmota									3	1		2	1				7
Ammospermophilus									3	2		5		2			12
Spermophilus							1		3			11		4			19
Perognathus							2		1			8		3			14
Dipodomys									6	17		11		10			44
Thomomys									8	3		18		6		3	38
Neotoma									4	3		5		8		1	21
Microtus												1					1
Mustela														1			1
Lynx									1					1			2
Canis									2								2
Artiodactyla							4	1	1	3	1	11	1	1			23
Number identified specimens	1			2	2	5	14	1	62	55	2	129	5	60		9	347
Total bone	68		1	12	62	74	386	39	2243	997	33	2740	43	925		34	7657
OTHER UNMODIFIED ORGANICS																	
Anodonta shell					23	1	82	1	71	23	2	9	3	44			259
Horn/Hoof									6					1			7
Eggshell												4					4
Walnut hull									2								2
Unidentified skin/rind									1								1

[a] Tabulated as the number of identified specimens.

entirely an artifact of natural deposition or differential preservation. It is tempting, further, to speculate that the dominance of jackrabbits over all other taxa virtually everywhere at Crater Middens is indicative of its occupation by large social groups, since this rodent was often the object of communal drives in the fall, particularly when antelope were too scarce to warrant such attention. There is, however, no evidence assuring that any of these jackrabbits were taken by drive. Thus it is also possible that, like cottontails and other rodents, they were taken by arrow and snare, their superiority in numbers in the archaeological fauna reflecting their greater proportional abundance in the native fauna, greater susceptibility to capture, or greater value in native estimation.

As in the case of cottontail and jackrabbit, the presence of marmot (certainly *Marmota flaviventris*) in the Crater Middens faunal collection most probably reflects its aboriginal use for food and skins (cf. Steward, 1933: 255). This conclusion is particularly secure in that the taxon does not frequent the arid Desert Scrub community in which Crater Middens is located. It would follow that the specimens in the collection must derive from individuals taken elsewhere and brought back to the site. The nearest known marmot colony is situated 11.5 km to the west in Big Pine Canyon (Larson, 1977: 2) at an eleva-

TABLE 9.35
Subsurface Distribution of Unmodified Vertebrate Faunal Remains[a] and Other Unmodified Organic Material at Crater Middens

	Midden I	Midden II					Midden III		
	0–10	0–10	10–20	20–30	30–40	40–50	0–10	10–20	20–30
UNMODIFIED VERTEBRATE FAUNAL REMAINS									
Lepus		9	5	6	1		12	7	6
Sylvilagus		3	4	3	1		4	3	5
Marmota		1			2		1		1
Ammospermophilus		1		2				1	2
Spermophilus		1	1	1			2		3
Perognathus			1				1	1	1
Dipodomys			5	1			1	1	5
Thomomys		3	4	1			1	6	5
Neotoma		3		1					3
Microtus									
Mustela									
Lynx				1					
Canis							1		1
Artiodactyla		1					2	2	3
Number identified specimens		22	20	16	4		25	21	35
Total bone	1	673	707	618	245		718	773	476
OTHER UNMODIFIED ORGANICS									
Anodonta shell		30	29	11	1		1		1
Horn/hoof		2	2	1	1				
Eggshell									
Walnut hull		2							

[a] Tabulated as the number of identified specimens.

[b] Includes one (1) unprovenienced specimen from Midden III.

[c] Includes two (2) unprovenienced specimens (one identified, one unidentified) from Midden III and one (1) unidentified and unprovenienced specimen from Midden IV.

tion of 2317 m. This lowest recorded colony on the eastern slope of the Sierra Nevada almost certainly furnished the individuals represented archaeologically at Crater Middens. This is of interest in two respects. First, this colony lies 6.5 km beyond the western boundary of the site exploitation area (catchment) projected for Crater Middens. Presumably this reflects the movement of hunters, at least occasionally and perhaps frequently, beyond this area during the course of a day. This seems quite likely given that the two-hour foraging radius upon which the site catchment concept rests applies primarily to plant exploitation rather than animal exploitation, hunters routinely working at greater distances from base camps than gatherers. Secondly, it is of importance that between 1972 and 1977, adults in the Big Pine Canyon marmot colony emerged between March and April and were not to be seen above ground after 22 July. Assuming these dates translate more or less directly to precontact times, the presence of marmot bones at Crater Middens is reasonably convincing evidence the site was occupied sometime within this interval, i.e., between spring and midsummer.

More problematic are the eight remaining taxa represented in the Crater Middens faunal assemblage: antelope squirrel (*Ammospermophilis*), ground squirrel (*Spermophilus*), pocket mouse (*Perognathus*), kangaroo rat (*Dipodomys*), gopher (*Thomomys*), woodrat (*Neotoma*), vole (*Microtus*), and weasel (*Mustela*). The last (weasel) is fairly rare in the vicinity of the site today and was presumably so in the past, so one is tempted to

TABLE 9.35—(*Continued*)

Midden III			Midden IV					Midden V				
30–40	40–50	50–60	0–10	10–20	20–30	30–40	40–50	0–10	10–20	20–30	30–40	Total
7	5		3	6	3	3	2	1	1	1		78
5	1			3	1	2	1	1	1			38
												5
1	1				1	1						10
4	1		1	2		1						18[b]
2	3				3							12
3	1		1	3	4	2						27
6				1	2	2	1		1		2	35
	2		1	4	2	1					1	18
			1									1
							1					1
							1					2
												2
2	2		1									13
31	16		7	20	16	12	4	3	2	4		260
532	222	17	323	317	178	70	37	5	9	16	3	5943[c]
2	5		15	13	10	5	1					124
				1								7
	4											4
												2

argue that its presence at Crater Middens is significant. This one identified element, however, discourages any serious attempt in this regard. The single identified element of vole similarly defies unambiguous interpretation. The six remaining taxa are significantly more abundant. This, along with ethnographic records suggesting that small rodents were, by a variety of methods, regularly captured and eaten, sometimes in large quantities (Steward, 1933: 255), would seem to favor interpretation of the remains of these taxa as food residue. Unfortunately, there is a problem with this interpretation. In contrast to nearly all artifact categories at Crater Middens, these taxa all show a disturbing tendency to increase in frequency with added depth within the site. The simplest interpretation of this pattern is that the remains of these burrowing animals found their way into the archaeological deposits of Crater Middens naturally. Most of the specimens probably represent individuals that died in one of the myriad dens or passages that riddle the cultural deposit of this site.

Overall the faunal assemblage is much as one would expect from ethnographic accounts, both qualitatively and quantitatively (Steward, 1938a). All the more important ethnographic taxa, including deer, antelope, mountain sheep, cottontail, and jackrabbit are represented and small animals far outnumber large animals. The sample is rather too small to provide a reliable measure of possible temporal changes in these patterns. It would appear, however, that artiodactyls are more common in the buried deposits of Midden III than elsewhere at the site, which

suggests that small mammals increased in importance relative to large mammals over time at Crater Middens.

OTHER UNMODIFIED ORGANIC MATERIAL

In addition to the collection of animal bone discussed above, and the sample of charred plant macrofossils discussed in chapter 9, an assortment of other unmodified organic material was found at Crater Middens (tables 9.34, 9.35).

ANODONTA SHELL (259 specimens): Paper-thin fragments of nacreous shell were found in 53 separate surface and subsurface samples, that is, individual surface collection units or discrete levels of excavation. In physical appearance, they resemble more complete specimens of *Anodonta californica,* which is native to Owens River, and are probably referable to that species and that source. As the valves of this slow-water species are quite fragile and unlikely to have been used as either tools or ornaments, the fragments recovered at Crater Middens probably reflect procurement and consumption of this mollusc for food. This same species is probably the shellfish *cöyö'dö,* that was collected in Owens River, boiled in the shell, and eaten by the Owens Valley Paiute (Steward, 1933: 255).

Riddell (1951: 19) notes that shell, again probably *Anodonta,* is an important constituent of certain middens along Owens River, but found only a single fragment of this shell an Iny-2. Wilke (1983) found four fragments at one of the sites he excavated near Owens Lake and on this basis asserts that the role of shellfish has been overlooked in recent works on the archaeology of Owens Valley. Lanning (1963: 262), on the other hand, who notes the presence of a few scraps of shell—probably *Anodonta*—at Rose Spring, concludes that the species was of little importance at that site; but this is not surprising because Rose Spring is well removed from any habitat suitable for *Anodonta.*

Anodonta shell is certainly too scarce at Crater Middens to support the notion this species was ever an important element of the prehistoric diet. There are, however, two respects in which this scarcity may be deceptive. First, because the shell is quite fragile, it is possible that the sample recovered is but a small fraction of the original population. This is unlikely: the abundance of this species at certain riverine sites suggests it preserves well or at least relatively well. Second, it may be that the initial processing of *Anodonta* was normally done at the location of procurement and that only the meat was brought back to Crater Middens and other similar villages. This would contradict the ethnographic record, which indicates that the species was boiled in the shell, unless it is assumed that this, too, was done at the spot of procurement. It is not, of course, inconceivable that the prehistoric treatment of *Anodonta* was different from that recorded ethnographically. Were the ethnographic method followed, however, it seems unlikely that both shucking and boiling would be done at the location of procurement unless a temporary camp were established specifically for that purpose. It would appear that the whole process would be more efficiently done by transporting the daily shellfish catch to base camps for processing, although this would increase the cost of transport and reduce the total quantity that could be carried. The role of *Anodonta* in the prehistoric diet at Crater Middens, therefore, remain unclear but at the present there is no substantive basis to infer it was more than a supplementary food.

This aside, a good case can be made that the relative intensity with which *Anodonta* was used as a resource varied during the interval in which Crater Middens was inhabited. The bulk of this material is concentrated in structures, the upper portion of Midden II and Midden IV, all suggesting more frequent use of this species in the later periods of prehistoric occupation (tables 9.30, 9.31). This increase might indicate more intensive or extensive use of the resources available within the site exploitation area of Crater Middens or only a change in the manner in which this particular resource was collected and processed. Indeed, a shift from a pattern in which *Anodonta* was shucked at riverine sites to one in which it was brought to Crater Middens without any preliminary processing would account for the observed concentration of shell fragments in late prehistoric contexts.

MISCELLANEOUS ORGANIC REMAINS: Seven pieces of horny material—sheep, cow, or

mountain sheep horn sheaths or hooves—were found in the deposit of Midden II (6 specimens) and Midden IV (1 specimen) (tables 9.34, 9.35). The possibility that these scraps are mountain sheep horn is lent some support by their occurrence in the lower, as well as upper, deposit of Midden II. The sample is so small, however, and the identification so equivocal, that nothing substantial can be concluded in regard to them.

Four small bits of eggshell (O-4578) were found toward the base of the deposit of Midden III. It is difficult to be certain on the basis of these few fragments, but the shell is much thinner than that of modern domestic chickens and this, along with the depth at which they were found, would suggest they derive from a native bird.

Two pieces of walnut (*Juglans*) hull (O-2797) were found in the top 10 cm of the deposit of Midden II. They may be historic aboriginal refuse but were more likely introduced to the site very recently by humans or animals.

Finally, a small bit of dried animal skin or fruit rind (O-2888) was found at a depth of between 20 and 30 cm in the deposit of Midden II. In the absence of definitive identification, nothing of substance can be said about this specimen.

CHAPTER 10. CRATER MIDDENS: PLANT MACROFOSSILS

In contrast to Pinyon House, where plant macrofossils were frequently found in situ or recovered while screening, at Crater Middens charred plant macrofossils were obtained only through water separation of flotation samples. In the field, these were extracted from each 10 cm level of each square excavated and from all discrete subsurface features (e.g., hearths) and natural levels for each separate areal subdivision (e.g., quadrant) of each excavated structure. A total of 46 of these samples, selected to represent the open cultural deposits and excavated structures of all five middens, were processed and analyzed.

METHODS

Equipment used in water separation consisted of a floating wooden box fitted with a hinged 0.5 mm stainless steel mesh bottom, a scoop fitted with matching 0.5 mm stainless steel mesh, and heavy-duty filter paper to receive the separated light fraction of each sample. The processing was done in a stream the running current of which lessens the possibility of contamination between samples and reduces the quantity of clay and silt retained in the separated material. In the procedure used, the empty flotation box was placed in the water and 1.5 liters of each sample, about one-half the total collected, was gradually added to it and then gently stirred. The floating light fraction was then scooped from the surface and deposited on an appropriately labeled filter paper nearby. As the more freely floating material was exhausted, the box and its contents were periodically agitated, raised and lowered, or swirled, so that by the circulation of water, the more sodden organic material resting on the screen bottom was momentarily held in suspension where it could be retrieved by the scoop. When the sample appeared depleted and repeated agitation failed to suspend any additional material, the hinged screen bottom of the box was opened to release the coarse heavy fraction in the bottom. The box was then thoroughly flushed to remove any remaining material in it or embedded in the screen and reclosed to receive the next sample.

The labeled filter paper containing the damp light fraction of the sample was gently folded, sealed by stapling, and allowed to dry slowly to prevent damage resulting from rapid desiccation.

To assure that no water-borne seeds had entered from the processing environment (the stream) and been recovered by the scoop, during the course of each processing session "dummy samples" were periodically obtained by running the scoop through the empty box while it rested afloat in the water. In no instance did these yield any seeds or other plant parts.

ANALYSIS

The dry, water-separated samples were submitted for analysis to K. T. Harper and P. D. Collins, Department of Botany and Range Science, Brigham Young University. In their laboratory, each sample was weighed and its gross composition recorded in terms of the estimated fraction of carbonized material and the presence and general kind of uncharred material (e.g., rootlets, rodent feces, etc.). The sample was then passed through a graduated stack of three nested seives of 2.0 mm, 1.0 mm, and 0.5 mm mesh. Each of the four fractions thus separated (>2.0 mm, 2.0–1.0 mm, 1.0–0.5 mm, and <0.5 mm) was separately examined for identifiable seeds with the aid of a binocular microscope fitted with 10× oculars. Only charred seeds were identified.

Presumably the charred components of these samples are either residue from cultural occupation or leavings from natural brush fires incorporated in the midden deposit by rodent activity or slope wash. That off-site samples treated by water separation yielded no charred material of any sort, however, suggests that the vast majority of the plant macrofossils from Crater Middens are of cultural rather than natural origin.

Instead of counting charred seeds individually by species, with the aid of extensive comparative herbarium specimens and a large folio of photographs made especially for this analysis, Collins recorded the presence of identifiable species in the sample in terms of three ordinal categories of frequency: *rare,*

present, abundant. In operational terms, *rare* refers to those species represented by only one or two seeds in a sample. *Abundant* refers to those species that are ubiquitously present in a sample, that is, that are almost constantly in the field of view of the binocular microscope when inspecting the sample fraction of appropriate size for the species in question. *Present* refers to those species that are only occasionally in the field of view when inspecting the appropriate sample fraction.

RESULTS

Four of the 46 samples examined were entirely devoid of identifiable seeds. The remaining 42 samples contained a total of 24 different plant species of 19 different genera. The most common taxon appeared in 24 separate samples, the least common taxon in just one, all 24 taxa in aggregate appearing 123 times. Of these 123 separate occurrences, 58 (47%) were cases in which a taxon was judged to be rare in a given sample, 41 (33%) cases in which a taxon was judged to be present, and 24 (20%) cases in which a taxon was abundant.

As in many natural populations, the richness in total number of plant taxa represented in the Crater Middens samples exaggerates the diversity of the collection as a whole in that the four most commonly occurring species (*Coleogyne, Oryzposis, Mentzelia,* and *Ephedra*) account for nearly 60 percent of the total number of individual occurrences for all species together. Further, in terms of the inferences that can be drawn about subsistence patterns from this material, two of these four species (*Coleogyne* and *Ephedra*) are unlikely to have been important sources of food and more likely represent fuel or medicinal plants. The characteristics and probable uses for all 24 plant taxa found in the samples are summarized below. Table 10.1 indicates the distribution of these species in the samples examined. Additionally, in this discussion the period of seed availability is provided for each taxon, here roughly estimated as beginning one month after the onset of flowering and extending one month after the close of flowering, the reference for the flowering period in each case being Munz and Keck (1959). Munz and Keck (1959) and Lloyd and Mitchell (1973) are the principal sources regarding plant distributions in California and Owens Valley. Floral inventories of the modern vegetation of Crater Middens made by Harper, Collins, and Bettinger are additional sources of information. The principal sources consulted in regard to native use of plants include Steward, 1933, 1938a; Kelly, 1964; Irwin, 1980; Bye, 1972; Stewart, 1941; Zigmond, 1981; Train et al., 1957; and Coville, 1892. Other sources consulted are noted as appropriate below.

SAMPLE CONSTITUENTS: *Coleogyne ramosissima.* Blackbrush (*C. ramosissima*), the species most commonly represented in the flotation samples, is an important constituent of the site flora today and was so evidently in the past, as witnessed by its presence in samples from all parts of the midden. Unmentioned as a food source in either the Great Basin or eastern California, the only record of its aboriginal use, an ambiguous one at that, is as a fuel for pinecone roasting among the Panamint Shoshoni (Irwin, 1980: 7). In the absence of any additional evidence, it is presumed that at Crater Middens the species was used for heating and cooking fires and, perhaps, building material.

The period of seed availability is from May through July.

Oryzopsis hymenoides. Ricegrass (*O. hymenoides*) was virtually equal in abundance to blackbrush, appearing in half of the samples examined. The seed of this grass is prominently mentioned as a staple food throughout the southern Great Basin and eastern California (Steward, 1933: 244; 1938a: 26–27). For both the Owens Valley Paiute and the Reese River Shoshoni, ricegrass equaled the pine nut in importance as an element of the native diet.

Perhaps more abundant prior to recent livestock grazing, ricegrass is now a minor constituent of the flora of Crater Middens but is exceptionally abundant in the lava fields that flank the site to the south. This species flowers from April to July, which places the period of seed availability from May through August.

Mentzelia congesta. The seeds of blazing star (*M. congesta*) were well represented in the flotation samples, though not so common as those of either blackbrush or ricegrass. Its

TABLE 10.1
Distribution of Plant Macrofossils at Crater Middens

	Midden I						Midden II								
	St. 1			Midden			St. 7			St. 9			St. 10		
Number of samples	(1)			(1)			(3)			(2)			(3)		
quantity observed[a]	A	P	R	A	P	R	A	P	R	A	P	R	A	P	R
Coleogyne ramosissima						1							2		1
Oryzopsis hymenoides		1					1		1			1	1		
Mentzelia dispersa	1						3					1			
Ephedra nevadensis														1	
Sphaeralcea															
parvifolia												1			
ambigua															
coccinea[b]															
Atriplex															
polycarpa									1						
torreyi												1			
lentiformis[b]															
Artemisia															
tridentata									2						
ludoviciana								1				1			
Chenopodium fremontii									1						1
Grayia spinosa															
Sporobolus airoides		1							1						
Haplopappus sp.															
Populus sp.						1			1						
Cenchrus pauciflorus															
Stipa speciosa												1			
Prunus andersonii															
Rumex sp.															
Bromus rubens															
Convolvulus sp.															
Brassica sp.															

[a] A = abundant, P = present, R = rare.
[b] Identification doubtful.

seeds were noted in 14 separate samples, 30 percent of those examined, and in six of these cases were judged to be abundant. The seeds of various species of blazing star were gathered, processed, and eaten by many Northern Paiute, Shoshoni, and Southern Paiute, including those in eastern California (Steward, 1938a: 26; Kelly, 1964: 42, 153; Bye, 1972: 94, table 1; Irwin, 1980: 10, 12, 14, 15; Zigmond, 1981: 41; Stewart, 1941: 375, 428). Steward (1933) did not record the use of *Mentzelia* by the Owens Valley Paiute, but it is almost certain that the unidentified food plant, *kū'ha* (Steward, 1933: 243), of the Owens Valley Paiute and Mono Basin Paiute belongs to this genus (compare, Steward, 1938a: 26).

Blazing star grows on the site at present but is not a major constituent of its flora. The period of seeding is from June through August.

Ephedra nevadensis. A total of 12 samples contained this species, in 10 of which it was either "present" or "abundant," i.e., not "rare."

Jointfir, or mormon tea, either *E. viridis* or *E. nevadensis,* was employed as a medicinal plant throughout the Great Basin, although of the two *E. viridis* was evidently preferred (Steward, 1938a: 24–25, 1933: 245; Zigmond, 1981: 27–28; Bye, 1972: 90; Train et al., 1957: 45–46). The seeds of *E. nevadensis* are recorded as having been collected and ground into flour for food only by the Pan-

TABLE 10.1—(*Continued*)

Midden II			Midden III						Midden IV			Midden V						
Midden (15)			St. 16 (2)			Midden (11)			Midden (5)			Midden (3)			Combined			
A	P	R	A	P	R	A	P	R	A	P	R	A	P	R	A	P	R	Total
3	1	6	1	1			3	1	2	1			1		8	7	9	24
	5	2				1	3	1	1	4			1		4	14	5	23
	3	1			1	1		1	1					1	6	3	5	14
1				1	1		4		2	1				1	3	7	2	12
	2	2					2									4	3	7
		3															3	3
		1				1		1		1	1				1	1	3	5
		1						3									5	5
	1															1	1	2
		1															1	1
											1						3	3
		1														1	2	3
	1						1	1						1		2	4	6
		2															2	2
																1	1	2
1															1			1
																	2	2
		1															1	1
																	1	1
								1									1	1
		1															1	1
		1															1	1
1		1													1		1	2
		1															1	1

amint Shoshoni of Death Valley (Coville, 1892: 353). More common is the medicinal practice of boiling the greens into a tea. Train et al. (1957) report that both species were occasionally ground to make poultices.

As *E. nevadensis* is a major component of the modern flora of Crater Middens, and was likely so during the occupation of the site, the abundance of its charred seeds in the flotation samples seems most readily explained as resulting from its use for fuel. The possibility that occasional use of the plant for food is responsible for some fraction of these seeds or that they represent residue from brewing teas or poultices cannot be excluded, however. The period of seed availability is estimated to begin in April and extend through May.

Sphaeralcea. Seeds of *Sphaeralcea,* or globemallow, were observed in 15 samples. In seven instances these were referred to the species *S. parvifolia* and in three instances to *S. ambigua,* desert mallow, both of which are common to Owens Valley and present at or near Crater Middens. The remaining five samples most closely resembled and were tentatively referred to *S. coccinea,* which does not occur in eastern California. It is reasonable to assume that these five occurrences are either *S. parvifolia* or *S. ambigua,* that is, that their identification is correct only to the level of genus.

The Panamint Shoshoni ate the ground and cooked seeds of *S. fremontii* (Irwin, 1980: 2; see below) but aside from this there are apparently only two references to the aboriginal

consumption of globemallow in the Great Basin, both among the Southern Paiute (Kelly, 1964: 41, 153), both involving seeds of *S. marginata.* Despite the paucity of ethnographic evidence for this practice in eastern California, the frequency with which the charred seeds of globemallow appeared in flotation samples from Crater Middens strongly suggests it was regularly used and since it is edible, probably for food. One alternative suggestion, however, deserves mention. Steward (1933: 266–267) recorded the use of a syrup boiled from *S. fremontii* Jeps., now classified as *Malacothamnus fremontii* (cf. Irwin, 1980; above), as a preparation for green ceramic vessels awaiting firing and as a moistening agent for clay to be used for ceramics. The genus *Malacothamnus* is absent in Owens Valley and a globemallow was probably the one involved. Accordingly, it is possible that some of the seeds found in the samples may have resulted from some step in preparing this plant for use in the manufacture of ceramics.

The seeds of *S. ambigua* are in general available from April through July (although this is quite variable), the seeds of *S. parvifolia* from July through August.

Atriplex. The genus *Atriplex,* or saltbush, was represented in a total of seven samples, of which four contained *A. polycarpa,* desert saltbush, one contained *A. torreyi,* and one contained both. The remaining sample contained seeds referred to the species *A. lentiformis.* The first two species are presently found in Owens Valley; the last is restricted to areas south of Owens Valley, most notably the Mojave Desert, where its upper elevational limit is about 600 m, some 600 m lower than the valley floor in the vicinity of Crater Middens. It is possible that this is a valid extralimital occurrence of *A. lentiformis* but it seems more readily explained as an aberrant specimen of one of the other two local species.

Neither *A. polycarpa* nor *A. torreyi* is common at the site, but both are abundant on the alkaline floodplain of the Owens River less than 3 km to the east, where the seeds found in the flotation samples were presumably obtained.

Not considered an important element of the native diet, the seeds of *Atriplex* were collected and processed for food by the Owens Valley Paiute (Steward, 1933: 244). Many other aboriginal groups in eastern California and the Great Basin also used the genus (Steward, 1938a: 22; Stewart, 1941: 375; Bye, 1972: 92, table 1), for some of whom its seeds were the only available source of salt seasoning (Stewart, 1941: 428–429). This, however, was not true in Owens Valley, where that valued mineral was abundant (Steward, 1933: 250).

The seeds of both *A. polycarpa* and *A. torreyi* mature in late summer and fall, those of the former from August through November, those of the latter from July through November.

Artemisia. Two species of *Artemisia,* sagebrush, *A. tridentata,* big sagebrush, and *A. ludoviciana,* silver sagebrush, were represented in the flotation samples from Crater Middens, each appearing in three samples, once together in the same sample. Both species occur in the vicinity of Crater Middens and big sagebrush is relatively well-represented on the site itself.

The seeds of big sagebrush were occasionally eaten in times of food shortage by the Owens Valley Paiute (Steward, 1933: 243) when, owing to their bitterness, they were mixed with other seeds. Several Great Basin groups evidently followed in this practice (Steward, 1938a: 22). Other species of *Artemisia,* including *A. ludoviciana,* were also eaten (Steward, 1938a: 21; Kelly, 1964: 42, 153, 179; Bye, 1972: 92).

As a cautionary tale for those tempted to make simple extrapolations between charred plant macrofossils and prehistoric diet, it is worth mentioning that the Kawaiisu of the southern Sierra Nevada reported that certain eastern California groups, perhaps the Owens Valley Paiute, used sagebrush seeds as noisemakers during celebrations, tossing them into fires where they exploded like firecrackers (Zigmond, 1981: 13). The frequency with which sagebrush seeds were encountered at Crater Middens does not suggest this particular usage but it is possible that some represent the use of these species for fuel rather than food.

The seeds of *A. tridentata* are ripe from September through November, those of *A. ludoviciana* from August through October.

Chenopodium fremontii. Goosefoot, *C. fremontii,* was found in six separate samples, but in four of these was judged to be rare and in the other two merely present, i.e., not abundant. Disregarding myriad pitfalls of interpretation, this suggests regular, but non-intensive, procurement of the species as a source of food, which is in keeping with the ethnographic record of the use of this species by the Owens Valley Paiute (Steward, 1933: 243–244). An introduced pigweed, *C. album,* occurring on lands irrigated by these Monospeakers, was also eaten. Both species, and several additional members of this genus, were gathered and consumed by many other groups across the Great Basin (Steward, 1938a: 23; Stewart, 1941: 429; Kelly, 1964: 42, 153, 179; Bye, 1972: 92, table 1).

C. fremontii was not noted in the modern vegetation of Crater Middens but is common in similar habitats throughout Owens Valley. The seeds mature from July through November.

Grayia spinosa. Two samples contained seeds of the spiny hopsage, *G. spinosa.* Nowhere mentioned as an aboriginal source of food or medicine, the plant is presently an important constituent of the flora of the site and these seeds probably represent its use as fuel. The seeds are mature from April through July.

Sporobolus airoides. Two samples yielded seeds of dropseed, *S. airoides,* a plant used as food by the Panamint Shoshoni (Irwin, 1980: 14) and Southern Paiute (Kelly, 1964: 42; Bye, 1972: 91), but avoided by the Kawaiisu (Zigmond, 1981: 65). As the species frequents moist alkaline localities quite unlike Crater Middens, it may be presumed that the seeds found in the flotation samples are from plants brought to the site from the floodplain of Owens River, or some similar location, and were probably intended for food. The seeds of this species are available from May through November.

Haplopappus. The genus *Haplopappus,* goldenweed, was represented in only one sample, in which it was abundant. These charred specimens most closely resembled *H. nutallii,* which is not found anywhere in California, including Owens Valley. At least six species, however, are present in Owens Valley, *H. acaulis, H. apargioides, H. cooperi, H. cuneatus, H. macronema,* and *H. suffruticosus,* all of them locally common depending on elevation and location. If it is presumed that the seeds in the sample from Crater Middens were obtained on the valley floor, which is likely but by no means certain, then either *H. cooperi* or *H. cuneatus* is probably indicated.

Steward (1933: 243) notes the use of an unspecified *Haplopappus* as food by the Owens Valley Paiute. Aside from this, the genus is noted only for its medicinal uses among the Kawaiisu (Zigmond, 1981: 33–34).

The seeds of *H. cooperi* are available from April through July, those of *H. cuneatus* from October through December.

Populus. Very sparsely represented in two samples were the seeds of *Populus,* at this elevation presumably *P. fremontii,* cottonwood, although it is not inconceivable that they are *P. tremuloides,* aspen. There is no suggestion in the principal sources on Great Basin ethnobotany that either species was used as food. Both, however, were occasionally employed as medicinal plants (Zigmond, 1981: 53; Train et al., 1957: 80–81). The seeds found at Crater Middens are probably best interpreted as resulting from the use of *P. fremontii* for fuel. The seeds of this species are present from April through May, the seeds of *P. tremuloides* from May to July.

Cenchrus pauciflorus. Seed of *C. pauciflorus,* sand-bur, was found in one sample. None of the principal sources on aboriginal plant use in the Great Basin notes the procurement of this plant for any purpose, but as its seeds are reasonably large, it may have been occasionally collected and ground into meal. In relation to this possibility it is worth noting that several plants mentioned by the Owens Valley Paiute as sources of food, including some staples, remain unidentified (e.g., Steward, 1933: 243). Further, as Irwin (1980: 17) has pointed out with specific reference to the Panamint Shoshoni, the same native term was often applied to many different genera, particularly grasses, only the most prominent of which are generally recorded. In short, because on both counts our record of historic native plant use is incomplete with reference to the list of individual species exploited we would not expect a perfect match between archaeological specimens and ethnographic

accounts even if prehistoric plant use precisely duplicated historic plant use, which, of course, may not be true. Accordingly, the archaeological presence of species unmentioned in ethnographic accounts should not be dismissed as unrelated to basic patterns of resource use. In the case of sand-bur, this is no assurance that the species was actually an element of the diet; the idea deserves consideration, nevertheless. Particularly notable here is that sand-bur typically thrives in sandy spots more typical of the Owens River floodplain than the rocky foothills that characterize the immediate environs of Crater Middens. Unless collected in the sandy bottom of the arroyo at the southern edge of the site, sand-bur would had to have been an import, increasing the likelihood it was an actively exploited resource.

Sand-bur bears seeds from August through October.

Stipa speciosa. Needlegrass was found in only one sample. Steward (1933: 243) notes that the ground seeds of *S. speciosa* were an important element of the Owens Valley Paiute diet and highly favored as an ingredient of mush. Presuming it is not an artifact of the manner in which this species was processed, however, the scarcity of this plant in the samples from Crater Middens suggests only sporadic use.

The seeds of *S. speciosa* are available from May through July and, assuming no major changes in the local distribution of this plant, could have been obtained in many localities along the eastern Sierra front, including Crater Middens, where it grows in small quantity today.

Prunus andersonii. The stones of the desert peach, *P. andersonii,* were present in but one sample. Across the Great Basin several species of *Prunus* are mentioned as having been collected and processed for food, evidently by pounding them entire to extract the juice from the pulp, which was then dried and stored for future consumption (Steward, 1938a: 28; Kelly, 1964: 43, 153, 180; Zigmond, 1981: 54–55). The use of the genus extends to southern California, where the seeds were dried, ground, and leached in the same manner as acorns (Sparkman, 1908: 194). Curiously, *P. andersonii* is never mentioned as one of the species exploited. Nevertheless, within the Inyo-Mono region archaeological specimens have previously been found in rock-shelters excavated by E. Davis (1964: 297) and it seems likely that the presence of the stones of this plant at Crater Middens represents its procurement and processing for food. Desert peach is common on the rocky slopes of the eastern Sierra and although none were noted on the site itself, it is doubtless available within a short distance. The fruits ripen from April through May.

Rumex. The genus *Rumex,* dock, is poorly represented at Crater Middens, occurring in but one sample in which it was judged to be rare. Among the species found in Owens Valley, the specimens in the flotation samples are most probably one of the two most common lowland forms, *R. crispus,* an introduced plant, or *R. salicifolius,* a native. Both are common in moist places, which implies that the seeds found at Crater Middens were collected elsewhere and imported to the site, for example, from Big Pine Creek, just to the north.

The seeds and greens of *Rumex* were used as food and its roots as medicine by numerous groups in the Great Basin (Steward, 1938a: 29; Stewart, 1941: 375, 428; Kelly, 1964: 46, 180). Neither of the two species probably in question here, nor any other *Rumex,* is specifically noted as having been used by the Owens Valley Paiute (cf. Steward, 1933), however. In nearly all accounts the species used is identified as *R. crispus,* the introduced form, but at least among the Kawaiisu this appears to be a recent extension of the aboriginal use of *R. salicifolius,* to which the same name is applied and for which the medical uses are identical (Zigmond, 1981: 60). As the seed of *R. crispus* is quite large, it is possible that with the appearance of this species in historic times, an earlier use of *R. salicifolius* for seeds and greens was abandoned. In any case, it is reasonable to attribute what little dock is present at Crater Middens to the use of one or the other species for food. The seeds of *R. salicifolius* are available from June through October, those of *R. crispus* in virtually every month of the year, which may at least in part account for its greater attraction as a native foodstuff in historic times.

Bromus rubens. Red brome, *B. rubens,* a

species introduced from the Mediterranean and present in minor amounts in the modern vegetation of Crater Middens, was very sparsely represented in a single flotation sample obtained at a depth of 10–20 cm in Midden II. Chamberlin (1911: 54) provides the only notable record of the use of the genus *Bromus* within the Great Basin, in this case a native species, *B. carinatus,* the seeds of which were eaten. Chestnut (1902: 312) notes similar use of the same species in northern California.

There are two possible explanations for red brome in the Crater Middens deposits. First, as in the case of *R. crispus* noted above, it may represent the aboriginal use of an introduced species for food. Second, it may be a case in which a seed charred during a recent fire was fortuitously included in the buried deposit of the site. That the sample in which the seed was found was obtained relatively near the surface is consistent with either explanation. In view of other evidence suggesting occupation of the site in early historic times, however, the former interpretation is favored here.

The seeds of red brome are available from April through July.

Convolvulus. Two flotation samples obtained from the shallower portions of the site yielded seeds tentatively referred to the species *C. longipes,* morning glory. This identification is considered only marginally secure as they bear some resemblance to the species *Ipomea purpurea,* the introduced morning glory. Neither *C. longipes* nor *Ipomea* is mentioned as having any use, culinary, medicinal, hallucinogenic, or otherwise, anywhere in the Great Basin. As in the case of the *Rumex* seed found here, the plausible explanations are either that the seeds are those of the introduced *Ipomea, I. purpurea,* in which case they may represent either early historic procurement of an introduced plant or postoccupational brush fires in the vicinity of the site, or those of the native *C. longipes,* again, representing either native procurement or more recent brush fires. In this case, because the seeds in question are reasonably well represented, appearing in two samples, one containing multiple examples, and because the plant is not represented in the modern site flora, the interpretation favored is that of aboriginal procurement, most probably of the native plant. The seeds of *C. longipes* are available from June through August, the seeds of *I. purpurea* from July through December.

Brassica. A single sample contained a trace of the seed of *Brassica,* mustard, a genus wholly introduced from Europe. Among the various species potentially involved, *B. campestris,* field mustard, is the most nearly cosmopolitan and therefore the most likely. Prior to the identification of this seed, the stratigraphic location from which the sample was obtained was considered reasonably secure in the sense that it lay below a group of rocks that appeared not to have been disturbed subsequent to aboriginal abandonment of the site. As uncharred roots composed 25–50 percent of the light fraction submitted for analysis, however, there is the possibility of contamination with younger materials worked downward from the surface of the site.

There is virtually no mention at all of the use of field mustard among the aboriginal inhabitants of the Great Basin, the lone exception being one record of the use of a ground seed poultice for burns (Train et al., 1957: 34). Chestnut (1902: 352) notes the use of its greens for food in northern California. Again, the absence of the plant in the modern flora of Crater Middens tends to weigh in favor of the explanation that this introduced species was added to the native pharmacopoeia or food list in early historic times. The seeds of *B. campestris* are erratic in availability but the heaviest crops appear from February through June.

ANALYSIS

In the broadest sense, the following analysis rests on the assumption that where charred seeds are present as one element of the assemblage of an archaeological site, the composition of those seeds ought to vary predictably in relation to, and hence offer potentially useful information about, the seasons in which that site was occupied and the subsistence patterns in those seasons. These inferences, however, are inherently tenuous owing to uncertainties that surround the relationships between: (1) the larger population of charred seeds present at the locality and the sample obtained archaeologically; (2) pat-

terns of native seed plant use and this larger population; and (3) the basic patterns of subsistence and seasonal occupation and native seed plant use. The question is whether in each instance the less general phenomenon accurately reflects the more general one and ultimately whether the linkages that connect all three are sufficiently well articulated and understood to sustain inferences about the most general, subsistence and seasonality, from the least general, the archaeological sample of charred seeds.

Only the most serious of these interpretive obstacles can be reviewed here in relation to the sample of charred seeds obtained at Crater Middens and then only briefly. Grayson (1979, 1981) has considered in more detail the difficulties encountered in analyzing materials of this kind. His discussion concerns faunal remains specifically but the issues he raises are for the most part germane to the analysis of archaeological plant remains.

THE SAMPLE AND ITS QUANTIFICATION: It should be noted firstly that the flotation samples selected for processing and analysis were not drawn to represent in a statistical sense the total population of charred seeds present at Crater Middens but more temporally, spatially, or functionally, limited subsets, or strata, within this population. The open, i.e., nonstructural, deposit of each midden and each excavated structure (except Structure 12, which was not sampled) constituted these sampling strata, 10 in all for the entire site. With so many strata and so few samples to allocate among them, there was little point in selecting samples randomly within strata, thereby gaining the appearance of statistical rigor. In no instance did the number of samples that could be allocated to any one stratum approach the minimum number, approximately 30, required for statistical validity. Instead, samples were allocated to strata and from these strata individually drawn on the basis of the phenomena of interest, our perception of the variability in these phenomena, and our judgments about the archaeological contexts in which these could be most readily observed. In general, samples were distributed in proportion to the suspected intensity of, and variability in, activities related to seed processing and use. Within individual strata, sampling decisions were governed by three more limited considerations. First, structure samples were preferentially drawn from hearths, the contents of which seemed more contextually secure and likely to reflect activities occurring within these features than the balance of deposits there. Second, to assure broad temporal representation and increase the possibility of recognizing temporal change, in each open midden samples were selected only from the lowermost and uppermost portions of the deposit, though never from the topmost 10 cm, which was invariably so rich in surface organics that the samples were difficult to process and analyze. And third, to ascertain the contribution of seed processing to the total suite of seeds in these deposits, at Middens II and IV, where bedrock milling features were especially prominent, samples were extracted and analyzed from the immediate vicinity of these features in addition to those from the midden at large.

As a direct consequence of these deliberate choices, the charred seeds obtained from Crater Middens cannot be assumed to represent statistically either the total population of seeds at the site or any of the strata defined within that population. This does not mean that the sample obtained is unrepresentative, only that it does not satisfy the requirements of a statistically valid sample.

Inextricably related to the question of what these samples represent in a statistical sense, is the question of how their constituents, the individual species/genera are themselves to be represented for analysis and comparison, i.e., how they are to be counted. As the measurement of individual taxon abundance in a sample is not in interval scale but ordinal scale, there are in effect only three choices.

Firstly, it might be that both the number of samples in which an individual taxon appeared and the relative quantity in which it appeared in those samples are somehow fatally biased or skewed to the extent that they do not reflect true variability in the population but only the manner in which it was sampled. If so, the safest alternative would be simply to treat the sample of seeds from the site qualitatively, that is, as nominal scale variables, eschewing any inferences as to their relative abundance or frequency. This would leave a list of 24 taxa, 22 excluding the two

TABLE 10.2
Individual Occurrences of Most Common, Midranking, and Least Common Taxa Represented by Plant Macrofossils at Crater Middens

	Strata										
	Structures					Open middens					
	1	7	9	10	16	I	II	III	IV	V	Total
Most common (N = 4)	2	5	2	5	5	1	22	15	12	4	73
Midranking (N = 7)		5	3	1			13	9	3	1	35
Least common (N = 11)	1	2	1			1	9	1			15
Total	3	12	6	6	5	2	44	25	15	5	123
Samples	1	3	2	3	2	1	15	11	5	3	46
Mean per sample	3	4	3	2	2.5	2	2.9	2.3	3	1.7	2.7

species whose identification is suspect. In any resulting interpretations, the evidence provided by each taxon would be weighted equally. The nature of the sample might be taken by some to justify this most conservative approach, but it risks giving undue weight to truly rare taxa and might magnify errors of identification, which are more likely when only one or two specimens are involved.

Alternatively, it seems quite possible that at least some of the variability in the frequency of these taxa in the sample actually reflects their variability in the deposits. If so, then as an alternative to treating them nominally, the frequency of these taxa could be ordinally scaled according to the distribution of their rank scores (absent, rare, present, abundant) across all 46 samples that were analyzed.

As a third variation, an ordinal scale of frequency could be obtained by merely counting the number of samples in which individual taxa appeared, that is, by collapsing the categories of *rare, present,* and *abundant* into a single category. As in the case where the data are treated as nominal variables, though not to the same degree, the principal justification for this more conservative ordinal scaling would be that of leveling distortions potentially resulting from an inequitably drawn sample. Thus, it might be argued that some taxa are underrepresented because they tend to occur in contexts to which few samples were allocated and by chance error did not occur in truly representative quantities in those samples.

The potential severity of this problem can be evaluated empirically by observing the degree to which rare and common taxa are differentially distributed between various sampling strata and the degree to which they exhibit the same frequency distributions in the samples in which they are found. If rare taxa tend to occur in strata where common taxa are rare and, where found, tend to occur in quantities (i.e., rare, present, abundant) similar to those of common taxa, then unfortunate choices in sample distribution might well bias the frequency in which individual taxa appear.

Neither tendency is evident in the Crater Middens case. To demonstrate this in terms of taxa distribution between sampling strata, if we combine the four most common taxa (*Coleogyne, Oryzopsis, Mentzelia,* and *Ephedra*) into one group, the 11 species that appeared only once or twice into a second group, and into a third group the nine taxa present in frequencies midway between those of the first group (the most common) and second group (least common), we obtain the distribution shown in table 10.2 for the number of samples in which these taxa appeared. Though it is represented only twice, *Atriplex torreyi* is included in the midranking taxa on the possibility that the sample identified as *A. lentiformis* is actually this species.

It is apparent that the distribution of the least common taxa closely parallels that of the midranking and most common taxa and that in general all three follow the proportional distribution of samples. Indeed, the only notable exception to this pattern not

TABLE 10.3
Quantity Observed for Individual Occurrences of Most Common, Midranking, and Least Common Taxa Represented by Plant Macrofossils at Crater Middens

	Quantity observed			
	Abundant	Present	Rare	Total
Most common	21 (29%)	31 (42%)	21 (29%)	73
Midranking	1 (3%)	9 (26%)	25 (71%)	35
Least common	2 (13%)	1 (7%)	12 (80%)	15

readily explained by sampling error is the relatively low frequency with which all taxa are represented in Midden III. This aside, it seems unlikely that the differences in the frequency of rare and common taxa can be attributed to differential distribution between them or to the differential distribution of samples between strata.

In terms of the differences in the quantities in which rare and common taxa appear, the distribution shown in table 10.3 is obtained.

Here it is clear that the rarer taxa are not only less widely distributed within the deposits, as measured by the number of samples in which they appear, but also occur in lesser abundance in the samples in which they are found than do the midranking and most common taxa. On both counts, then, there is reason to believe that species that are rare in the samples that were analyzed are in fact relatively rarer in the deposits as a whole than are the midranking taxa, which are, in turn, rarer than the most common taxa. In short, the sample seems to more or less accurately monitor variability in the abundance with which charred seeds are present at this site.

CHARRED PLANT MACROFOSSILS AND NATIVE PATTERNS OF SEED PLANT USE: Of the various circumstances that might intervene to obscure the relationship between native patterns of seed plant use and the population of charred seeds left as residue by this use, two seem particularly important.

The first is related to the relationship between native seed plant use and basic patterns of subsistence and seasonality. This general problem is taken up in detail below but one aspect deserves recognition here. This is the difficulty of distinguishing the different activities archaeologically discovered charred seeds reflect. The preceding discussion of the individual taxa represented in the Crater Middens samples makes some attempt to consider the probabilities of these various uses but complete discrimination is unlikely to be achieved except in rare cases in which the taxa involved are few and well understood or in which sample sizes are sufficiently large to permit discrimination on some other basis, e.g., distribution. The degree to which this is a problem depends on the kinds of questions being asked. It is certainly serious in the case of interpretations of diet. More generally, it reduces the level of interpretive resolution that can be attained.

The second problem is that of the degree to which charred macrofossils are subject to bias as a consequence of preservation and aboriginal processing. We can be fairly certain that some seed plants were habitually handled in a manner that failed to result in their accidental charring, that others were so thoroughly processed that little if anything remained, and that, irrespective of either of these, a variety of subsequent processes acted differentially to preserve seeds of different taxa. Arguably, seed size is perhaps the most critical in this respect. The largest seeds, for example pine nuts or acorns, tend to be more thoroughly processed, less subject to charring, and when charred more subject to breakage. On this basis, one suspects that the charred macrofossils from Crater Middens represent small seed use more faithfully than large seed use, but this is largely guesswork and the degree to which it is expressed and the critical sizes at which it becomes important remain conjecture.

NATIVE SEED PLANT USE AND PATTERNS OF SEASONAL OCCUPATION AND SUBSISTENCE: That the degree to which subsistence patterns can be inferred from plant macrofossils hinges ultimately on the success with which one can distinguish seeds used for food from seeds used or produced as incidental byproducts from other activities has already been mentioned. In addition, it suffices to note without lengthy review that the evidence provided by charred plant macrofossils is inherently limited in its implications for subsistence patterns, having no direct bearing on the use of large or small vertebrates or plants not bearing seeds. The principal contribution of seed

remains is most likely to be in understanding the intensity with which these specific resources were exploited as evident in the number of kinds of taxa used and the procurement patterns they suggest in terms of the use of different microhabitats. The role of these particular resources in the larger system of subsistence must be inferred from other lines of evidence, the composition of archaeological assemblages, for instance, or on the basis of theoretical propositions about the manner in which these particular resources are likely to articulate with subsistence patterns (e.g., Bettinger and Baumhoff, 1983).

In theory, seasonality of site occupation should be less difficult to interpret from plant macrofossils than should subsistence patterns because the former, unlike the latter, does not require inferences about the manner in which individual taxa were used, only the time of year in which they were available. In fact, however, a host of circumstances thwart any attempt to draw straightforward conclusions on the basis of this evidence. Foremost among these is that the availability of seeds in the natural environment varies seasonally so that some seasons (e.g., summer) are more likely to be represented than others (e.g., winter). Further, we cannot be certain that the suite of seed-bearing plants used qualitatively or quantitatively represents the seeds available in these seasons or that all seed-bearing plants were handled in the same way and so as a group represent accurately intensity of seasonal occupation.

Even more problematic, to interpret seasonality from these plants requires the additional assumption that they were collected by individuals residing at Crater Middens rather than at some other location, a temporary seed camp, for example. As there is some reason to believe that Crater Middens was occupied in the winter months, when reliance was on food collected in other seasons, potentially from other settlements, this assumption is in one sense unjustified. Confinement of the analysis to species used only for fuel offers a partial solution to this particular problem, but does not resolve the others noted above.

It should be evident by now that the kinds of inferences that can be sustained about the seasonal occupation of Crater Middens and about subsistence patterns during those seasons on the basis of charred plant macrofossils are quite limited. Given uncertainties about the activities and sources of bias reflected in the sample of seeds recovered, interpretations that make the fewest demands on these data are the most convincing, even though in many cases these interpretations are less interesting than those that we would like to make. In general, we are on firmer grounds when drawing inferences on the basis of qualitative rather than quantitative data, yet even qualitative inferences entail risks for the simple reason that while the presence of a taxon may be taken as evidence that it was used, the absence of another cannot be taken as evidence that it was not. Indeed there are so many strictures here that one might legitimately take the position of leaving the problem of interpretation to the reader, should he care to try. But to echo Steward and Setzler (1938) it is we, not the reader, who are in the best position to interpret these data and the attempt seems worthwhile so long as the tentative quality of the interpretation is understood.

SEASONAL IMPLICATIONS

Table 10.4 shows the estimated seed-bearing season for each of the taxa potentially represented in the sample of charred seeds obtained at Crater Middens. We shall assume that these estimates are essentially correct or that, failing this, their errors are systematic so that despite any corrections the absolute seasonal span in months for each taxon would remain the same as would the order in which they appear.

Table 10.5 summarizes seasonal patterning in various groups of taxa according to three different measures. The first is quantitative and assesses the distribution of taxa as a series of variable monthly values. For each group these values indicate the sum of the monthly weights for all its taxa available in that month divided by the total number of taxa in the group, where they monthly weight of each taxon is the inverse of the number of months in which it is available. Thus, a taxon available over four months has a monthly weight of $\frac{1}{4} = 0.25$, a taxon available over five months has a monthly weight of $\frac{1}{5} =$

TABLE 10.4
Seasonal Distribution of Taxa Represented by Plant Macrofossils at Crater Middens

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Most common taxa												
Coleogyne ramosissima					+	+	+					
Oryzopsis hymenoides					+	+	+	+				
Mentzelia congesta						+	+	+				
Ephedra nevadensis				+	+							
Midranking taxa												
Atriplex polycarpa								+	+	+	+	
Atriplex torreyii							+	+	+	+	+	
Sphaeralcea ambigua				+	+	+	+					
Sphaeralcea parvifolia							+	+				
Artemisia tridentata									+	+	+	
Artemisia ludoviciana								+	+	+		
Chenopodium fremontii							+	+	+	+	+	
Least common taxa												
Grayia spinosa				+	+	+	+					
Sporobolus airoides					+	+	+	+	+	+	+	
Populus fremontii[a]				+	+							
Haplopappus cooperi[b]				+	+	+	+					
Haplopappus cuneatus[b]										+	+	+
Cenchrus pauciflorus								+	+	+		
Stipa speciosa[a]					+	+	+					
Prunus andersonii				+	+							
Rumex salicifolia[b]						+	+	+	+	+		
Rumex crispus[b]	+	+	+	+	+	+	+	+	+	+	+	+
Bromus rubens				+	+	+	+					
Convolvulus longipes[a]						+	+	+				
Brassica campestris[a]		+	+	+	+	+						

[a] Species identification uncertain, form noted is most likely alternative.
[b] Species identification uncertain, one of two alternatives.

0.20, and so on. These weights remove the unwanted effect of differential period of taxon availability on the distribution of monthly values. Generally, one would also weight each taxon according to its frequency, but in this case dividing the data into groups representing the most common, least common, and midranking taxa accomplishes essentially the same thing and makes the desired patterns clearer. The distribution obtained for each group amounts to a crude estimate of the probabilities that a taxon chosen at random from that group represents a given month. As such, it is also a measure of the probabilities that occupation occurred in any month insofar as the seasonality of charred plant macrofossils is taken to indicate this.

The other two measures reflected in table 10.5 are qualitative and treat seasonality as a specific span of months without making inferences about the probability of occupation during specific months within this interval. The first, termed the *maximum season of occupation,* is the longest continuous span of months indicated by assuming that occupation occurred in each month represented by at least one taxon. This is the previous measure put in purely qualitative terms, that is, calculated on the basis of those months with quantitative values greater than zero.

The second measure, termed the *minimum season of occupation,* is the shortest span of months sufficient to account for all taxa. This measure will generally (but need not) indicate shorter spans than the first and thus intuitively seems more parsimonious. Unless, how-

TABLE 10.5
Seasonal Patterning in Plant Macrofossils from Crater Middens

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Most common taxa												
Fuel taxa (N = 2)				.25	.42	.17	.17					
Food taxa[a] (N = 2)					.13	.29	.29	.29				
Most common and midranking taxa												
(N = 11)				.07	.12	.11	.19	.19	.12	.12	.09	
Securely identified taxa (N = 16)				.11	.16	.11	.17	.16	.11	.11	.07	
All taxa (N = 24)	.00+	.01	.01	.12	.16	.13	.16	.13	.09	.10	.06	.02

[a] The minimum season of occupation may be June, July, or August.

Notes: For each group, the monthly values are probabilities calculated as the sum of the weighted values for all its taxa available in that month divided by the number of taxa in the group, where the weight of each taxon is the inverse of the number of months in which it is available. For each group the maximum season of occupation is simply the span of contiguous months with values greater than 0.00 and the minimum season of occupation is underlined.

ever, there is good reason to assume that short occupation is more likely than long occupation (and there is none here), it is no more reliable than the first. In simple terms, the minimum season of occupation is that span of months throughout which occupation must have occurred if that occupation is taken to be a single event. This measure differs most fundamentally from the other two in that it takes the probability that a taxon represents a given month to be strongly conditioned by the availability of other taxa in the same month.

Turning attention to the data in table 10.5, if we exclude for the moment all food species owing to the possibility they were collected at other settlements and consider only the seasonal patterning of the two most common taxa probably used for fuel (*Coleogyne* and *Ephedra*), occupation from April through July is suggested both quantitatively and qualitatively by the maximum season of occupation. Within this span, occupation is most probable in the month of May, during which residence is required according to the minimum season of occupation (note that the minimum season of occupation will always include the month in which occupation is most probable). Because both of these species are so abundantly and ubiquitously distributed throughout the site, the longer interval, April through July, seems more reasonable and is favored here.

The two most common food taxa (*Oryzopsis, Mentzelia*) have rather different seasonal implications. They indicate the most probable season of occupation to be from about May through August, the maximum season of occupation being the same span, the minimum season of occupation requiring residence in one of the months of June, July, or August. The question is whether these two taxa represent material actually collected from Crater Middens and hence reliably indicate its seasonal occupation.

There is at least some circumstantial evidence favoring this possibility. Both species are available in abundance in or around Crater Middens and in more expansive perspective the site is ideally situated for the procurement of both in the sense that it is centrally located within the lower eastern Sierra foothills where they are concentrated. It is likely, then, that Crater Middens would have been sporadically occupied throughout this period by groups using this central place as a base of foraging and as a place to stockpile food and repair equipment between trips to more distant foothill collecting locations. The abundance of both species within the foraging radius of Crater Middens alone raises the possibility that residence was concentrated at the site throughout this interval at least to the extent that some individuals were always there. Granting that this is so, the seasonal distribution of these two most common

food taxa in combination with that of the two most common fuel taxa would suggest occupation from April through August.

If we apply similar reasoning to the mid-ranking taxa, all of which were presumably used for food and all of which are readily available within the foraging radius of Crater Middens, both the most probable and maximum season of occupation would be extended for an additional three months now lasting from April through November, the minimum season of occupation requiring residence from May through September.

The principal difficulty with this interpretation is that two of the five taxa representing the latter part of all these periods, *Atriplex polycarpa* and *A. torreyi,* do not occur locally and as imports are more likely to have been collected at other settlements. These weaken the case for fall occupation. Two other taxa representing this same interval, however, *Artemisia tridentata* and *A. ludoviciana,* are so common throughout the valley and, judging from ethnographic accounts, so little esteemed as food except in times of shortage, that it is unlikely much time would have been spent collecting and transporting them from more distant locations when they were so locally abundant in and around Crater Middens. If we accept both species of *Artemisia* as reliable indicators, then occupation could have ended no earlier than September and might have lasted through November.

The remaining fall taxon, *Chenopodium fremontii,* is mute on this point. Widely distributed, it probably grows in close proximity to Crater Middens and might well have been collected there. Alternatively, it was probably of sufficient attraction as a food source that it might as easily have been collected elsewhere and simply brought back to the site for winter use.

In weighing all the evidence, the presence of *A. tridentata* and *A. ludoviciana* seems particularly telling and on the strength of that the occupation of Crater Middens can be inferred to have extended into the fall at least as late as October and quite possibly as late as November.

Broadening our consideration to all securely identified taxa, and beyond that to all taxa potentially represented, does not materially change this picture. If we take April through November as accounted for, the remaining months of December through March are collectively represented by only three taxa, two of them introduced, none securely identified. This interval, however, is precisely the one in which seed production in general is lowest. None of the seed-bearing taxa commonly used by the Owens Valley Paiute, for example, have seeds in any great quantity during this period; and it is unlikely that any that were available would have gone unnoticed.

In sum, the charred seeds from Crater Middens seem to document occupation from April through November but do not speak to the possibility of occupation during the remainder of the year.

The question that remains is whether seasonal patterns inferred from the sample of charred plant remains in toto can be assumed to represent faithfully any given segment of time within the 2000 years over which occupation is now thought to have taken place. The issue arises because our interpretations of seasonality are a composite pieced together from many individual observations, each one potentially representing a different point in time. Accordingly, there is the possibility that the resulting pattern applies to no one period of occupation at all. This in turn raises the possibility that there were changes in seasonal occupation not monitored by these data. Since a variety of data now suggest that the excavated structures and open deposits of individual middens are indeed temporally limited it should in theory be possible to ascertain the presence of such differences by comparing the seasonal implications of macrofossils from different temporal contexts. In practice, however, the samples obtained are far too few to sustain inferences of this kind. About all that can be said is that the samples of seeds obtained from Structures 7, 9, 10, and from Middens II, III, IV, and V can each be interpreted as suggesting occupations that stretch from May through November and that in the cases of Midden I and Structures 3 and 16, where this is not true, we cannot be sure it is not an artifact of sample size. There is, then, for the moment no good reason to believe that there are seasonal differences between the earlier occupation and the later occupation. Similarly, there are no obvious

seasonal differences between the deposits found in structures and those of open middens.

SUBSISTENCE IMPLICATIONS

A variety of circumstances referred to earlier discourage any attempt to interpret the broader picture of subsistence or plant use related to subsistence on the basis of the charred plant macrofossils recovered at Crater Middens. Several circumspect inferences can nevertheless be ventured about limited features of prehistoric diet and exploitative patterns. Part of the difficulty of analysis here lies in the absence of any comparable body of archaeological data from nearby localities. At least some degree of perspective can be achieved, however, if we begin by relating the suite of seeds obtained archaeologically from Crater Middens to the record of seed use among the northern Owens Valley Paiute, the ethnographic inhabitants of the territory in which the site is located.

Listed in table 10.6 are the 11 most important plant foods of the northern Owens Valley Paiute (Steward, 1933: 242–246). As a reminder of the limited degree to which macrofossils would reflect subsistence patterns here, note firstly that two (*Dichelostemma, Cyperus*) are roots for which no archaeological evidence in the form of macrofossils is expected. That is, roughly speaking perhaps 10 to 20 percent of the plant diet and, more importantly, a whole class of critically important plant foods are not monitored by these data. With this understood, note also that a comparison between the nine seed-bearing taxa on this list and the list of taxa obtained archaeologically at Crater Middens reveals at least one striking similarity in that ricegrass ranks at the top of both, being the most common food taxon in the archaeological sample and, along with pine nuts, the most important ethnographic food source. It would be unwise to draw parallels on this basis alone but a family resemblance is suggested between ethnographic and prehistoric subsistence patterns as these relate to seed plants. In reference to the longer list of seed-bearing taxa used ethnographically in eastern California (e.g., Steward, 1933, 1938a), this resemblance might be underscored by noting that all of the more common archaeological taxa, and beyond that all but one or two of the rarer taxa, find mention as dietary elements on one or another of these lists. This is not entirely unexpected since the range of plants available was the same or essentially the same for both historic and prehistoric groups so that overlap is natural. Even so, that ricegrass was apparently so important in both cases suggests that more than mere circumstance is at work here.

Turning once again to just the most important ethnographic taxa, however, it is equally striking that apart from ricegrass, just one other plant (*Stipa*) is represented among the archaeological taxa and then in only one sample. That is, seven of nine ethnographic seed staples are entirely lacking at Crater Middens. Several circumstances might conceivably account for this.

Because their seeds are relatively large, it might be argued that in the cases of *Pinus, Elymus,* and *Helianthus* this is the result of more thorough processing, lesser likelihood of charring, and greater susceptibility to destruction, all of which reduce the probability of their recovery. The other missing taxa (*Salvia, Eragrostis, Agropyron,* and "*pauponiva*") might also have been handled in a manner that did not promote preservation but as there is no particular reason, apart from their absence, to suspect that this ought to be true, the argument is not especially telling. Being unidentified, "*pauponiva*" is a special case and might actually be represented among the archaeological taxa. Even this is unlikely, however, because as just noted virtually every taxon recovered, and all the more common ones, are accounted for by name in at least one of the ethnographic plant lists.

That these missing taxa were available in seasons in which Crater Middens was unoccupied or in habitats not accessible from it might in theory but does not in fact account for their absence. With the obvious exception of *Pinus,* which has been accounted for otherwise, and the possible exception of "*pauponiva,*" which is unidentified, these plants are available in the same season and locations as those that were recovered. Indeed, had not biased preservation intervened, one might reasonably have expected the occurrence of *Pinus* because, although not available locally,

TABLE 10.6
Principal Plants Contributing to the Diet of the Northern Owens Valley Paiute

Taxon	Native evaluation	Part eaten	Community[a]		
			R/M	DS	PW
Pinus monophylla	most important	seeds (nuts)			+
Oryzopsis hymenoides	most important	seeds		+	+
Stipa speciosa	very important	seeds		+	+
Elymus cinereus[b]	very important	seeds	+	+	+
Salvia columbariae	important	seeds		+	
Agropyron trachycaulum[b]	common	seeds	+	+	
Eragrostis orcuttiana[b]	very important	seeds	+	+	
Helianthus nuttalli[b]	major importance	seeds	+	+	+
"*pauponiva*"	major importance	seeds	?	?	
Dichelostemma pulchellum[b]	very important	bulbs	+	+	+
Cyperus esculentus[b]	very important	tubers	+	+	

[a] R/M = Riparian or Marsh; DS = Desert Scrub; PW = Pinyon Woodland.

[b] Identifications modified from those given by Steward (1933: 242–246): *Elymus condensatus, Agropyron* sp., *Eragrostis secundiflora, Helianthus bolanderi, Eleocharis* sp., *Brodiaea capitata.*

it was transported to lowland villages in the ethnographic pattern, which is the standard of comparison here.

To take another tack, since it is certainly true that Steward meant his detailed plant list to apply to the northern Owens Valley Paiute generally, rather than any particular group of them, it might well gloss local variation in plant use. Accordingly, apart from other considerations, the discrepancy between the ethnographic list and the archaeological taxa may be no greater than the differences in seed use between any two local ethnographic groups in early historic times. Some support for this suggestion can be found in Steward's more cursory summary of plant use among the southern Owens Valley Paiute (Steward, 1938a: 52–53). As do the macrofossils from Crater Middens, the list of taxa regularly used in southern Owens Valley, 11 in all, shows some resemblance to, but does not by any means match exactly, the list of seed-bearing taxa important in northern Owens Valley. Six taxa (*Pinus, Oryzopsis, Salvia, Stipa, Helianthus,* and *Agropyron*) are shared in common with northern Owens Valley and as in the north among these the special importance of *Pinus* and *Oryzopsis* is at least implied (Steward, 1938a: 26–28). Notably present among these six taxa ethnographically shared between northern and southern Owens Valley are the same two (*Oryzopsis* and *Stipa*) that we have already noted as being shared between Crater Middens and northern Owens Valley. *Oryzopsis,* then, is the most common food taxon at Crater Middens and at the same time one of the two most important ethnographic food plants in both northern and southern Owens Valley. Equally interesting, of the remaining five taxa ethnographically important in southern but not northern Owens Valley (*Juncus, Sophia, Chenopodium, Mentzelia,* and *Artemisia*), no less than three (*Chenopodium, Mentzelia,* and *Artemisia*) are among the more common food taxa found archaeologically at Crater Middens. In other words, taken at face value, the ethnographic pattern of seed use in southern Owens Valley shows about the same degree of overlap with the pattern documented archaeologically at Crater Middens as it does with the ethnographic pattern in northern Owens Valley. Differences in perspective afforded by ethnographic and archaeological data, however, very likely overstate the degree of similarity between the ethnographic patterns and the degree of difference between ethnographic patterns and the archaeological pattern at Crater Middens (they do not, for example, compensate for differential processing or preservation). Taking this into consideration, a fairly close resemblance is suggested between the ethnographic pattern of seed use in southern Owens Valley and the

archaeological pattern at Crater Middens. As hinted earlier, a more generic resemblance is suggested between the archaeological pattern at Crater Middens and the ethnographic pattern in northern Owens Valley. This resemblance is similar in degree to that which existed between the ethnographic patterns in northern and southern Owens Valley. From this it follows that the differences between the patterns of seed use noted archaeologically at Crater Middens and recorded ethnographically among the Owens Valley Paiute are no greater than we might expect as the result of local differences in the availability of various plant taxa. At least this would be true were we to grant the fundamental similarity of ethnographic exploitative patterns in northern and southern Owens Valley (Steward, 1933, 1938a: 50–57) and then explain the observed differences in seed use between those areas in terms of variations in plant geography. This is so because, after allowing for the difficulties involved in comparing archaeological data and ethnographic accounts, the differences between the archaeological pattern of seed use at Crater Middens and the ethnographic pattern in northern Owens Valley (to which it is least similar) are evidently no greater than those between the ethnographic patterns in southern and northern Owens Valley.

Let it be clear that this does not mean that the archaeological pattern of seed use at Crater Middens was the same as the ethnographic pattern, only that the differences are apparently no greater than those observed locally in the ethnographic pattern as the result of differential access to various taxa. By anticipating such variability, a geographical interpretation of this sort has the additional advantage of explaining why Crater Middens in northern Owens Valley might well exhibit patterns of seed use most similar to those noted ethnographically in southern Owens Valley. That the site is located near the boundary between northern and southern Owens Valley and that the boundary itself was apparently drawn as a matter of convenience makes this similarity all the more understandable.

To pursue this matter in a somewhat different vein, it is curious that *Artemisia* appears on the list of taxa regularly exploited in southern Owens Valley at all since Steward (1938a: 22) is quite clear that it was not highly valued as food. Perhaps despite their rank taste, the seeds were more frequently used in places where those of other kinds were not abundant relative to demand. If so, the taxon might then serve as an index of the relative intensity of seed use. This would certainly fit with the declining gradient in annual precipitation, and presumably seed productivity, from north to south in Owens Valley. Further, if we apply the notion to Crater Middens, the presence of *Artemisia* might be taken to indicate that seed procurement there was relatively intensive and as it is a fall plant, presumably in anticipation of winter use, perhaps when other seeds had fallen short of expectation. This would in turn suggest winter residence.

As with the interpretation of seasonality, the question that logically follows here is whether any temporal changes in patterns of seed procurement are reflected at Crater Middens. Here again our ability to address this question is limited by the sample sizes available for specific segments of time. There is, however, at least some suggestion for such change. In relation to sample size, Midden III, which represents the earlier occupation at the site, produced relatively fewer taxa and fewer separate occurrences of all taxa than did either Midden II, which represents a mixture of early and late occupations, or Midden IV, which represents only late occupation. In particular, 3 of 11 samples obtained from Midden III were devoid of any macrofossils, while none of the 5 from Midden IV and only 1 of 15 from Midden II yielded similarly negative results. One of the three empty samples from Midden III, however, was drawn from a square just outside the midden boundary and should perhaps be discounted, as should, by similar reasoning, the empty sample from Midden II, which is from a square straddling the midden boundary there. This leaves the two empty samples from Midden III which are from the center of the cultural deposit, which is rich in material of other kinds and which is in close proximity to bedrock milling facilities. If we discount all the empty samples and do not count fuel taxa, then Middens II, III, and IV are essentially identical in terms of the number of food taxa represented and

the number of their occurrences relative to sample size. The degree to which there are differences in the abundance of macrofossils represented, then, hinges on just the two empty samples from the central portions of Midden III.

Perhaps these two are merely quirks of sampling. Alternatively, they may truly reflect a lower incidence of plant macrofossils in Midden III. If so, two explanations might be offered to account for this. First it might be that in the earlier period seed processing was concentrated at Midden II rather than Midden III, where presumably other activities would have taken place. That is, functional variation between the middens might account for the lack of abundant seed remains in Midden III. Some evidence supporting this idea is presented in the summary chapter on Crater Middens. On the other hand, it might be that there are actual differences in the intensity of seed use between the early and late periods, this being reflected by the dearth of plant remains in Midden III relative to those noted in Middens II and IV. The data here are not at all conclusive but that seed milling features are more abundantly represented in the two middens that contain deposits attributable to the later occupation and occur in lesser abundance at the only midden containing deposits attributable to the earlier occupation exclusively tends to weigh slightly in favor of the argument that a real, if perhaps only slight, change toward more intensive seed use occurred toward the latter part of the occupation.

Finally, it is worth considering briefly the spatial distribution of the taxa represented by the macrofossils in terms of the site catchment they reflect. Note that this spatial unit is distinguished from the exploitation area defined by the foraging radius around the site, the former being larger than the latter in including areas exploited from ancillary settlement types, the proceeds from which eventually find their way back to the settlement in question.

It is remarkable in view of the extensive riparian community easily within access of Crater Middens and the emphasis that has been put on riparian plant resources in the literature dealing with Great Basin subsistence patterns, that this community is essentially unrepresented in the macrofossils from Crater Middens. This can only in small degree be laid to the possibility that this community was more intensively used as a source of roots than seeds, for the seed-bearing taxa of this community are well represented archaeologically in many localities. An examination of the plant lists of Steward (1933, 1938a) for Owens Valley, however, illustrate the same phenomenon in that very few truly riparian plants, e.g., *Juncus* and *Echinochloa*, are mentioned. Many of the plants listed, however, clearly benefitted from the moist conditions along stream banks or in periodically watered washes, conditions reproduced artificially by aboriginal irrigation in late prehistoric times. For the most part, the species used by the Owens Valley Paiute and those represented in the archaeological deposits of Crater Middens are of the Desert Scrub community. This is as we would expect from the location of Crater Middens itself, which would be difficult to explain except in terms of the potential advantages it affords in providing access to these resources. This would seem also to be the basis for the location of ethnographic villages (Steward, 1938a: 50–53) in the foothills at some distance from the riparian community along the margins of Owens River. In the course of our earlier research, it was the appearance of villages in such settings in central Owens Valley around A.D. 600 that originally led to the suggestion that there had at this time been a shift toward the more intensive procurement of Desert Scrub plants relative to riparian plants (Bettinger, 1977a).

CHAPTER 11. CRATER MIDDENS: CHRONOLOGY, SPATIAL DISTRIBUTIONS, AND SUMMARY INTERPRETATIONS

CHRONOLOGY

A total of 5 radiocarbon assays and 45 obsidian hydration rim measurements are available for Crater Middens but it is time-sensitive artifacts—especially projectile points and ceramics, but also green chert debitage and beads—that provide the soundest basis for establishing the chronology of occupation at this site.

For this discussion it is convenient to subdivide Crater Middens to reflect what seem to be important distinctions in functional, depositional, and spatial context that exist within site and, to some extent at least, the manner in which its different parts were sampled. Most of these subdivisions are anticipated by the manner in which artifact provenience is reported in the preceding chapters. Each of the five spatially discrete middens are so distinguished, and within each one its surface, subsurface (midden) deposit, and structures. In some cases it is useful further to subdivide open midden deposits according to depth. Stratigraphic divisions of deposits within structures, on the other hand, were so difficult to recognize in the field, and the samples they yielded are individually so small, that they are generally ignored unless relevant to the contextual integrity of a particular sample.

RADIOCARBON: The five radiocarbon assays for Crater Middens (UCR-1557-1561) suggest dates for the broad span of occupation at the site but do little more than hint at temporal relationships between its various middens and structures (table 11.1). When corrected for secular variation, the 95 percent confidence interval for the oldest of these dates (UCR-1561), obtained on a sheep (*Ovis canadensis*) scapula recovered at the base of the deposit of Midden III, is A.D. 30 ± 200, which is in keeping with other data cited below suggesting initial occupation of the site around that time. At the other extreme, two dates on samples of charcoal, one recovered between 20 and 30 cm in Midden II (UCR-1558), the other between 10 and 20 cm also in Midden II (UCR-1559), both yielded dates the 95 percent confidence interval for which is A.D. 1520 ± 135. These two samples refer to the more recent occupation of Crater Middens but almost certainly not to its terminal occupation, since both lay stratigraphically below substantial accumulations of midden.

The two radiocarbon dates obtained for structures fall toward the later end of the temporal span indicated above. The 95 percent confidence interval of the older, which refers to the lower deposit within Structure 7, is A.D. 1160 ± 240 (UCR-1557). The same confidence interval for the younger of the two dates, which refers to the lower deposit within Structure 16, is A.D. 1490 ± 150 (UCR-1560), which is virtually identical to the two youngest dates obtained from midden deposits.

OBSIDIAN HYDRATION: Of the 41 pieces of Fish Springs obsidian debitage that were sectioned, ground, and microscopically examined for hydration, two lacked visible rims. Among the remaining 39 specimens, 33 exhibited a single hydration rim of uniform thickness and 6 others exhibited rims that varied enough in thickness to suggest two different dates of breakage. In the absence of any reliable means of determining the agency responsible for this breakage, each of one of the paired readings is accepted as marking some kind of aboriginal activity at Crater Middens. A total of 45 hydration rim measurements are thus available for the site (table 11.2).

Disregarding a single unusually large example measuring 6.3 μ (OHL-926), these rims range in thickness from 4.1 to 1.2 μ (table 11.2), which according to the Fish Springs hydration rate used here, corresponds to a span in excess of 2000 years, running from about 500 B.C. to A.D. 1821, which is nearly identical to the spans of occupation suggested by obsidian hydration for Pinyon House and Two Eagles.

Distinguished by cultural phase, one rim measurement (2%) corresponds to a date that

TABLE 11.1
Radiocarbon Dates for Crater Middens

Sample no.	Provenience	Radiocarbon age	Calendar age (95% confidence interval)
UCR-1557	Midden II: St. 7, level 3	800 ± 130 B.P.	A.D. 920–1395
UCR-1558	Midden II: S1E10, 20–30 cm	390 ± 80 B.P.	A.D. 1385–1655
UCR-1559	Midden II: S8E5, 10–20 cm	390 ± 90 B.P.	A.D. 1385–1655
UCR-1560	Midden III: St. 16, level 4	425 ± 100 B.P.	A.D. 1340–1645
UCR-1561	Midden III: N3E5, 30–40 cm	1940 ± 100 B.P.	170 B.C.–A.D. 235

falls within the Clyde phase, 20 (44%) to dates within the Cowhorn phase, 15 (33%) to dates within the Baker phase, and 9 (20%) to dates within the Klondike phase. As is also the case at Two Eagles, this dating is disproportionately old when compared to the dating suggested by time-sensitive artifacts (see below).

Since there are only 45 hydration rim measurements for the site as a whole, it is difficult to speak of temporal relationships between the various middens and subdivisions within them. The data (table 11.2) seem to suggest, however, that the lower portion of the buried deposit at Midden II, specifically the part more than 20 cm below the surface, and the whole of the buried deposit at Midden III are relatively early: the bulk of the hydration measurements for each suggest dates within the Cowhorn phase. Two of the three rim measurements available for Midden V fall within the same interval and the third is only slightly more recent than that (A.D. 700), so this Midden might be equally early; given the size of the sample, however, this is hardly more than a guess.

The upper portion of the buried deposit of Midden II, i.e., the part less than 20 cm below the surface, and the whole of the buried deposit at Midden IV are, on the other hand, relatively late: the bulk of their obsidian hydration dates falls in the Baker and Klondike phases. No hydration rim measurements are available for the scanty subsurface deposit of Midden I. There are, further, none for any surface material, which might provide some clue to the effect of surface exposure on hydration rates.

Rim measurements obtained for structures are as a group relatively late, the bulk corresponding to dates within the Baker or Klondike phases. As no more than three measurements derive from any structure individually, their dating cannot be reliably determined on the basis of these data alone. There is some hint, however, that Structures 10 and 12 are older than Structure 7.

PROJECTILE POINTS: Crater Middens yielded 179 projectile points belonging to types that have been well-dated in the western Great Basin and are identified with specific cultural phases in central Owens Valley (Bettinger, 1975a). Of these, 8 (4%) are of types that identify the Cowhorn phase, 60 (34%) of types that identify the Baker phase, and 111 (62%) of types that identify the Klondike phase. As just noted, the proportional distribution of these time-markers is not in accord with the apparent temporal distribution of obsidian hydration rim measurements. It is, however, nearly identical to the proportional distribution of typable projectile point by phase at Pinyon House and very close to the one at Two Eagles, just as the range of hydration dates for those sites are comparable to those for Crater Middens.

The distribution of typable projectiles points by phase is shown in table 11.3. These data leave little doubt that the subsurface deposit of Midden III is relatively early and probably dates from the late Cowhorn phase through the Baker phase but not much later than that. By contrast, the subsurface deposit of Midden IV is relatively late and dates no earlier than the Klondike phase. The lone point found in the subsurface deposit of Midden I suggests that what little is there is also recent.

The subsurface deposit of Midden II evidently contains both early and late components. Its lower reaches clearly belong to the Baker phase and possibly to the Cowhorn phase as well. Conversely, Klondike time-

TABLE 11.2

Obsidian Hydration Rim Measurements and Dates for Crater Middens

Specimen no.	UCD-OHL no.	Provenience[a]	Mean hydration rim reading (μ)	Calendar date
Midden I				
O-1905CA	920	Structure 3	2.5 ± 0.1	A.D. 780
O-1905CB	921	Structure 3	1.8 ± 0.1	A.D. 1341
O-1905CC	922	Structure 3	4.1 ± 0.1	500 B.C.
Midden II				
O-2279CA	923	Structure 7	2.0 ± 0.1	A.D. 1181
O-2279CB	924	Structure 7	1.5, 1.2 ± 0.1	A.D. 1581, A.D. 1821
O-2352CA	925	Structure 9	1.6 ± 0.1	A.D. 1501
O-2352CB	926	Structure 9	6.33, 3.1 ± 0.2	2261 B.C., A.D. 300
O-2424CA	927	Structure 10	2.5 ± 0.2	A.D. 780
O-2424CB	928	Structure 10	2.1 ± 0.1	A.D. 1101
O-444CA	897	Structure 12	2.4, 2.1 ± 0.1	A.D. 860, A.D. 1101
O-444CB	898	Structure 12	2.0 ± 0.1	A.D. 1181
O-554CA	899	Unit B, 10–20	1.9 ± 0.2	A.D. 1261
O-554CB	900	Unit B, 10–20	1.8 ± 0.2	A.D. 1341
O-554CC	901	Unit B, 10–20	1.4 ± 0.2	A.D. 1661
O-2626CA	929	Unit N1E10, 30–40	3.6 ± 0.1	100 B.C.
O-2626CB	930	Unit N1E10, 30–40	3.6 ± 0.2	100 B.C.
O-2626CC	931	Unit N1E10, 30–40	4.0, 3.5 ± 0.1	420 B.C., 20 B.C.
O-2932CA	932	Unit S1E10, 30–40	2.6 ± 0.2	A.D. 700
O-2932CB	933	Unit S1E10, 30–40	3.6 ± 0.2	100 B.C.
O-2932CC	934	Unit S1E10, 30–40	3.7 ± 0.2	180 B.C.
O-3199CA	935	Unit S3E8, 30–40	3.6 ± 0.2	100 B.C.
O-3199CB	936	Unit S3E8, 30–40	2.4 ± 0.1	A.D. 860
O-3199CC	937	Unit S3E8, 30–40	1.6 ± 0.1	A.D. 1501
Midden III				
O-573CA	902	Unit C, 0–10	3.1 ± 0.2	A.D. 300
O-573CB	903	Unit C, 0–10	1.9 ± 0.2	A.D. 1261
O-629CA	906	Unit C, 10–20	3.5, 3.1 ± 0.1	20 B.C., A.D. 300
O-629CB	907	Unit C, 10–20	3.4 ± 0.2	A.D. 60
O-603CA	904	Unit C, 20–30	1.9 ± 0.2	A.D. 1261
O-603CB	905	Unit C, 20–30	3.0 ± 0.2	A.D. 380
O-662CA	908	Unit C, 30–40	3.3 ± 0.1	A.D. 140
O-662CB	909	Unit C, 30–40	3.3 ± 0.2	A.D. 140
O-676CA	910	Unit C, 40–50	3.3 ± 0.2	A.D. 140
O-676CA	911	Unit C, 40–50	NVH[b]	—
Midden IV				
O-678C/2A	912	Unit D, 0–10	2.4 ± 0.1	A.D. 860
O-678C/2B	913	Unit D, 0–10	NVH[b]	—
O-678C/2C	914	Unit D, 0–10	1.7 ± 0.4	A.D. 1421
O-712C	915	Unit D, 30–40	2.5 ± 0.1	A.D. 780
O-718CA	916	Unit D, 40–50	3.3 ± 0.2	A.D. 140
O-718CB	917	Unit D, 40–50	1.7 ± 0.2	A.D. 1421
Midden V				
O-727CA	918	Unit E, 20–30	2.8, 2.6 ± 0.1	A.D. 540, A.D. 700
O-727CB	919	Unit E, 20–30	2.9 ± 0.1	A.D. 460

[a] Where given, depth is in centimeters.

[b] No visible hydration rim.

Notes: Calendar dates calculated as $Y = 800.3X - 831.2$, where X is the rim measurement in microns and Y is the date in years before present, which is taken to be 1950.

TABLE 11.3
Distribution of Typable Projectile Points by Phase at Crater Middens

	Cowhorn	Baker	Klondike	Total
Structures				
3			1	1
7			2	2
9			4	4
10		2	4	6
12		2	7	9
16	1	3	23	27
Midden I[a]				
Surface			1	1
0–10			1	1
Midden II[a]				
Surface		9	9	18
0–10		6	10	16
10–20	1	8	2	11
20–30		8	2	10
30–40	1			1
Midden III[a]				
Surface	3	2	14	19
0–10	1	6	2	9
10–20	1	7		8
20–30		3		3
30–40		3		3
40–50			1	1
Midden IV[a]				
Surface			10	10
0–10		1	4	5
10–20			7	7
20–30			2	2
40–50			1	1
Total	8	60	107[b]	175

[a] Depth given in centimeters.

[b] Not entered in this table are four additional Klondike phase specimens that were collected in 1972 and lack provenience within the site.

markers dominate the uppermost 10 cm of deposit, suggesting it dates sometime after A.D. 1300. That Baker phase points are so well represented in this upper deposit and Klondike points are found in those lower down, however, indicates at least some vertical mixing has occurred. A single point of Klondike age toward the bottom of the deposit at Midden III points to mixture there as well, probably by tunneling rodents.

More than 80 percent of the projectile points recovered from structures are time-markers for the Klondike phase. This clearly places these features with the later occupation of Crater Middens, which is to say, roughly contemporaneous with the upper subsurface deposit of Midden II and the whole of the subsurface deposit of Midden IV. Within this span Structures 3, 7, and 9 appear slightly younger than Structures 10, 12, and 16, all three of which also contain material suggesting use during the Baker phase and, in the case of Structure 16, during the Cowhorn phase. Dates derived in this manner should be regarded with some caution, however, because the samples are small and there is the possibility of fortuitous associations between points and structures.

As might be expected, points collected from the surface belong predominantly to the Klondike phase. The only notable exception to this is the surface collection from Midden II, in which there are equal numbers of Baker and Klondike phase points. Since Klondike phase points outnumber Baker phase points in the uppermost buried deposits of this midden, the unusual abundance of Baker phase points on its surface must be laid to a combination of sampling error and vertical mixing within the deposit.

CERAMICS: Sherds belonging to at least three different ceramic wares were found at Crater Middens but only the 524 specimens of Owens Valley Brown Ware are useful as time-markers (Riddell, 1951). This ware is apparently no older than A.D. 1300 (Lanning, 1963) and, along with Cottonwood and Desert Side-notched points, is identified with the Klondike phase in central Owens Valley (Bettinger, 1975a). Since these items lack any older functional equivalent, they indicate the presence and distribution of Klondike phase occupation, but not the intensity of those occupations relative to earlier ones.

As shown in tables 9.5 and 9.6 (chap. 9), Owens Valley Brown Ware sherds are broadly distributed within the site, so much so it is highly unlikely that their presence everywhere indicates Klondike phase occupation. More probably, many specimens have become mixed with earlier deposits. It is reasonably certain that the collections of sherds from each of the structures excavated and from the surfaces of Middens II (143), III

(51), and IV (19) denote Klondike occupations of some kind. The sample recovered from the top 10 cm of deposit at Midden II (94) is also sufficiently large to assure the affiliation of that part of the deposit with the Klondike phase. In all the remaining cases this affiliation is less certain.

The sample of sherds recovered between 10 and 20 cm below the surface of Midden II (40) is large when taken alone and would seem to indicate Klondike phase occupation. It is, however, much smaller than the sample from the level immediately above, raising the possibility that mixture between the two levels is responsible for the sherds found in the lower one. Mixture almost certainly accounts for the handful of sherds (10) found at depths greater than 20 cm at Midden III and may well account for the remaining subsurface sherds (13), all of which were found within 10 cm of the surface.

Very few sherds (14) were found below the surface of Midden IV, which is understandable because excavation there was limited. Since even these minimal tests yielded nearly as many sherds as were found on the surface of Midden IV, it is improbable that mixture with surface materials accounts for all of the subsurface specimens. At least some of the buried deposit at Midden IV must therefore date to the Klondike phase.

SHELL AND STONE BEADS: Out of 45 shell and stone beads identified as belonging to temporally sensitive types, all save one Limpet Ring denote Klondike phase occupation. The distribution of these items suggests use sometime during this phase of Structures 3, 7, 9, 12, and 16, and of Middens II, III, and IV. The Limpet Ring recovered at a depth of between 30 and 40 cm in Midden III is consistent with other evidence presented here that the bulk of buried deposit of that Midden dates to the Baker phase.

HISTORIC ARTIFACTS: Sixty-three glass beads and two bottle glass tools are the only historic artifacts that can be reliably linked to aboriginal occupation at Crater Middens. The distribution of these items suggests protohistoric or historic use of Structures 3, 7, 10, and 12 and the surfaces of Middens II, III, and IV. Several glass beads recovered in the upper 20 cm of buried deposit of Midden III could conceivably link those deposits with equally recent occupations. Other evidence cited above and below, however, weighs strongly against this possibility. More likely these specimens worked their way downward from the surface or very near it, perhaps by trampling. Such mixture might also account for the three subsurface specimens (two beads and a glass tool) from Midden II. This explanation, however, need not be invoked to account for those two found in the upper deposit, which is clearly recent and thus stratigraphically compatible (at least potentially) with the historic dating of these pieces.

DEBITAGE: As noted in chapter 9 (cf. tables 9.18, 9.19), at Crater Middens the proportion of obsidian debitage consistently decreases with time relative to debitage of certain other materials, most notably green chert. As was also noted, a developing industry specializing in the production of large chert bifaces for trade or local consumption very likely underlies this shift in debitage composition.

The same shift, presumably with the same underlying explanation, is evident at Pinyon House but it is unclear how much farther than that it extends within Owens Valley. If this biface industry was highly localized, equivalent changes in debitage composition might easily be lacking elsewhere. Even in central Owens Valley it would not be expressed at sites and activity areas within sites where the specialized production of chert bifaces did not occur. This explains why there is no evident temporal change in debitage composition at Two Eagles or in most of the peripheral debitage scatters at Crater Middens itself. Elsewhere at Crater Middens, however, late prehistoric chert biface production gives rise to marked variations in the material composition of debitage that are exceptionally helpful in sorting out the relative chronology of occupation.

Obsidian debitage occurs in highest proportion (more than 90% by count and 87% by weight) at depths greater than 20 cm in the buried deposit of Midden II and throughout the buried deposit of Midden III, which suggests they are relatively early. It occurs in lower proportion (less than 78% by count and weight) in all the structures, the upper 10 cm of deposit at Midden II, and the whole of the buried deposit of Midden IV, suggesting that they represent more recent occupation of the

TABLE 11.4
Summary of Chronometric Information for Crater Middens

Unit	Radiocarbon	Obsidian hydration	Projectile Points			Owens Valley Brown Ware	Shell and stone beads		Historic	Obsidian debitage (%) by count
			Cow-horn	Baker	Klon-dike		Baker	Klon-dike		
Structure 3		500 B.C.–A.D. 1341			1			5	1	49
Midden I[a]:										
Surface					1	8				30[b]
0–10					1					(82)
Structure 7	A.D. 1160	A.D. 1181–1821			2	13		3	1	58
Structure 9		2261 B.C.–A.D. 1501			4	29		1		55
Structure 10		A.D. 780–1101		2	4	9			2	73
Structure 12		A.D. 860–1181		2	7	46		6	43	54
Midden II[a]:										
Surface				9	9	143		3	1	92[b]
0–10				6	10	94		5	1	78
10–20	A.D. 1520	A.D. 1261–1661	1	8	2	40		1	1	84
20–30	A.D. 1520			8	2	10			1	91
30–40		420 B.C.–860[c]	1			2				91
40–50										(100)
Structure 16	A.D. 1490		1	3	23	23		7		75
Midden III[a]:										
Surface			3	2	14	51		2	2	94[b]
0–10		A.D. 300–1261	1	6	2	13		5	7	91
10–20		20 B.C.–A.D. 300	1	7				1	1	93
20–30		A.D. 380–1261		3		5				94
30–40	A.D. 30	A.D. 140 (2)		3		2	1	1		95
40–50		A.D. 140 (1)			1	3				94
50–60										97
Midden IV[a]:										
Surface					10	19		1	4	82[b]
0–10		A.D. 860–1421		1	4	8		2		63
10–20					7	5		1		62
20–30					2	1				61
30–40		A.D. 780 (1)								67
40–50		A.D. 140–1421			1					59
Midden V[a]:										
Surface										(78)
0–10										88
10–20										(83)
20–30		A.D. 460–700								(100)
30–40										(100)

Notes: Debitage percentages in parentheses indicate samples of fewer than 20 specimens.
[a] Depth given in centimeters.
[b] Surface sample not regarded as a reliable measure of age.
[c] The range is for eight samples and disregards a ninth with an indicated age of A.D. 1501.

site. Debitage recovered at depths of between 10 and 20 cm below the surface of Midden II falls between these extremes, which would seem to indicate either that it is a mixture of early and late material or that it represents an occupation of intermediate age.

SUMMARY OF CHRONOLOGY: Table 11.4 summarizes the various data. At the outset

it is clear these offer no substantive basis at all for dating Midden V and very little for the surface and subsurface assemblages of Midden I. It is equally clear that the subsurface deposits of Middens II, III, and IV are to some extent mixed within and that in each case some buried material has worked its way to the surface. The basic chronological relationships between various Middens and structures, however, are reasonably evident: the structures, upper 10 cm of buried deposit of Midden II, and the entire buried deposit of Midden IV are late, and the buried deposit below 20 cm of Midden II and the entire buried deposit of Midden III are early. There is greater ambiguity surrounding the deposit at depths of between 10 and 20 cm in Midden II, which is either a mixture of early and late material or of intermediate age. What little evidence is available for Midden I suggests its surface and subsurface assemblages are recent. There is simply not enough material recovered from Midden V to estimate its age.

Radiocarbon dates, obsidian hydration measurements, and, especially, time-sensitive artifacts suggest that the earlier occupation of Crater Middens dates from the latter part of the Cowhorn phase through the Baker phase, or roughly from 0 B.C./A.D. to A.D. 1300, and the later occupation to the Klondike phase, or from A.D. 1300 into historic times.

Given stratigraphic mixing and imprecision in the various methods of dating that were used, it is pointless to attempt a chronology more refined than this for buried deposits outside structures. The data in hand indicate that relative stratigraphic relationships are meaningful to the extent that within the same deposit material at greater depth is on the whole older than that at lesser depth. Beyond this and the simple divisions noted above, however, they do not provide a reliable basis for relating a specific segment of one midden to a specific segment of another.

We face the same problem when attempting to assess the relative chronological relationships among structures and between individual structures and middens. It is reasonably certain that these features were in use during the more recent occupation of Crater Middens. Each one, however, also contains at least some material potentially linking it with the earlier occupation as well. There is never very much of this material and associations between structures and individual pieces found within them, whether early or late, are never certain. Nevertheless, a reasonably strong case can be made that Structures 10, 12, and 16 were in use during the Baker phase and there is at least some evidence to suggest that Structure 16 was built and occupied even earlier than that, during the latter part of the Cowhorn phase.

That these structures retain so little material from earlier occupations is presumably a reflection of many subsequent episodes of reuse. Later inhabitants contemplating the construction of new dwellings were evidently attracted to the locations of older ones, choosing to remove loose debris from their interiors and refit their walls, rather than start afresh somewhere else. As a consequence, at Crater Middens—and this is probably true of other villages in Owens Valley and perhaps elsewhere—the contents of houses are likely to be more recent than the houses themselves. That is, assemblages recovered from dwellings cannot be expected to represent the entire span over which such features were in use at these sites.

For all its flaws and gaps, the chronological record from Crater Middens is clear enough at least to fix the principal occupation of the site between 0 B.C./A.D. and historic times and to indicate that during this time locations of aboriginal activity shifted enough so that not all of its parts were in use simultaneously. During earlier occupancy, from the late Cowhorn phase through the Baker phase, this activity concentrated at Middens II and III, which are adjacent to each other and contain the largest subsurface deposits found at the site. Three houses dating to this period—Structures 10 and 12 at Midden II, and Structure 16 at Midden III—and the general character of the assemblages from this period at both middens suggest that family groups maintained residence at the site for extended periods, including the winter months, using it as a base camp for plant and animal procurement.

Occupation during the succeeding Klondike phase is of the same general character but the locations of activity are noticeably different. Extensive surface and subsurface

assemblages from this period show that activity at Midden II certainly did not slacken, and residential use there evidently increased since two new houses—Structures 7 and 9—were built, bringing the number of features occupied to four, as the two existing ones remained in use. Midden III, on the other hand, was less intensively used than before. Klondike phase activity there centered on Structure 16, which was evidently not a domestic residence but served some other purpose, for example, a storehouse. The remaining material from this period at Midden III, most of it surficial, may well be connected with the use of Structure 16 rather than activities occurring over Midden III at large. As aboriginal activity declined at Midden III, it appeared in two locations, Middens I and IV, previously unoccupied. At Midden I this late-period activity was apparently sporadic and largely confined to Structure 3, which may have been occupied by families seeking seclusion, perhaps during childbirth. Though it is small, Midden IV was much more intensively used for a broader range of activities. This evidently never included residence by families, however, since there are no structures on its surface and we found evidence of none during excavation.

The late-period occupation of Crater Middens is, thus, characterized by several shifts in the locations of aboriginal activity. It closed with a dramatic shift: sometime in the early historic period all of its families evidently picked up and moved about a kilometer to the northeast to a new village location. This abandonment may have occurred when water previously flowing by the site was diverted elsewhere by the 1872 earthquake or when its inhabitants saw greater advantage in occupying a spot nearer the growing town of Big Pine or one of its outlying ranches. Either way, the move was a short one, only slightly greater in scale than those that had occurred earlier.

SPATIAL AND TEMPORAL VARIATION

In comparison to the run of open sites generally encountered in Owens Valley and elsewhere in the Great Basin, Crater Middens is unusual in that its assemblage is not confined to a single locus but occurs as five spatially discrete concentrations (middens) within which there are important distinctions of archaeological context (structures, surface scatters, and buried deposits).

We turn now to consider in more detail the nature of these differences by comparing the artifact assemblages from different locations within the site. Two issues are of particular concern. The first is that of temporal change in the nature of site use, that is, whether the role of Crater Middens changed with respect to the larger subsistence-settlement system of which it was a part. The second is that of spatial differentiation within the site, that is, to what extent activities of different kinds were segregated from each other at given times. Both of these are essentially functional in their implications, the first having to do with the function of Crater Middens as a whole vis a vis other sites occupied at the same time, the second with the function of its individual parts vis a vis other parts in use at the same time.

PROCEDURE: The first part of this analysis considers the distribution of a few important artifact categories in various parts of Crater Middens and consequent implications about the temporal and spatial distribution of activities.

In the main, the divisions of the site recognized here are the ones followed earlier with reference to site chronology. Surface scatters, subsurface deposits, and individual structures are treated separately. Since data presented above establish that the subsurface deposit of Midden III is uniformly early (late Cowhorn/Baker phase), while that of Midden IV is uniformly late (Klondike phase), and do not permit distinctions finer than this, those assemblages are not further divided. The subsurface assemblages of Middens I and V are similarly left undivided, the latter case because it is small and largely undated, the former because it comprises but a single level.

Chronological data available for the subsurface deposit of Midden II, on the other hand, indicate the presence of two more or less stratigraphically discrete components: an early one (late Cowhorn/Baker phase) at depths below 20 cm and a later one (Klondike phase) in the upper 10 cm. Those two assemblages are treated separately in recognition of

TABLE 11.5
Raw Counts for Major Artifact Categories in Local Assemblages at Crater Middens

Unit	Milling-stones	Owens Valley Brown Ware	Projectile points	Simple bifaces	Rough-outs	Unifaces	Cores	Debitage	Total
Midden I:									
Surface	5	8	2	4	4	1	2	122	148
0–10 cm	0	0	1	0	0	0	0	17	18
Structure 3	5	0	1	4	0	2	0	119	131
Midden II:									
Surface	9	26	11	56	32	10	7	2958	3109
0–10 cm	45	94	21	79	39	19	19	7032	7348
20–50 cm	23	12	16	49	17	12	5	5652	5786
Structure 7	4	13	2	6	1	1	1	192	220
Structure 9	11	29	5	9	5	2	2	383	446
Structure 10	4	9	6	9	3	3	1	1996	2031
Structure 12	20	46	11	26	6	9	9	2612	2739
Midden III:									
Surface	9	20	10	23	36	19	14	1895	2026
0–60 cm	23	23	34	84	56	44	8	15,802	16,074
Structure 16	28	23	28	62	27	25	20	5529	5742
Midden IV:									
Surface	10	19	11	20	34	9	19	1125	1247
0–50 cm	24	14	16	27	30	10	6	3424	3551
Midden V:									
Surface	1	0	0	1	2	1	1	9	15
0–40 cm	0	0	0	0	1	0	0	34	35
Total	221	336	175	459	293	167	114	48,901	50,666

their temporal differences. Because the assemblage from the intervening deposit (10–20 cm) is either stratigraphically mixed or transitional between the early and late periods of occupation, it is eliminated from consideration.

The analysis is initially restricted to artifact categories that are either reasonably well represented or reasonably well understood in terms of the uses they served or the behaviors they imply: ceramics (Owens Valley Brown Ware), millingstones, projectile points, simple bifaces, roughouts, unifaces, cores, and debitage. These same categories form the basis for the functional analyses for Pinyon House (chap. 4) and Two Eagles (chap. 7), establishing a common basis for linking all three together in chapter 12.

The distribution of these 8 categories among the 17 assemblages (here termed local assemblages) defined above is shown in table 11.5. Note that the surface assemblages reported for Middens II and III are samples recovered from systematically placed 15 × 15 m quadrats (four in each midden). Surface collections in the remaining areas of both middens are discounted since they intentionally excluded several artifact categories of interest here (roughouts, unifaces, cores, and debitage).

We can regard table 11.5 as a contingency table with 17 rows (local assemblages) and 8 columns (artifact categories) of nominal scale variables. As such it is susceptible to analysis by a variety of standard techniques developed to examine the degree and strength of association between variables defined in this scale. Perhaps the most familiar of these is the chi-square test (Thomas, 1976), which assesses the probability of associations observed between variables. We are only incidentally concerned with the overall proba-

bility of the distribution observed in table 11.5—in terms of its usual implications regarding significance. This is partly because the data do not fully satisfy the assumptions of chi-square, which precludes any attempt to determine exact probabilities.

It would be useful, of course, to have some basis for judging whether the observed assortments of artifact categories (local assemblages) could have occurred by chance because, if true, this would imply that at Crater Middens assemblage composition does not vary with local archaeological context. Merely to reject this null hypothesis (or at least to find it unlikely), on the other hand, tells us very little: it indicates dependence between some of the variables but not which ones or the strength of that dependence (association), which are of primary concern here.

Fortunately, as originally described by Haberman (1973; cf. Everitt, 1977) and more recently illustrated with archaeological data by Grayson (1984), chi-square values can easily be made to yield this more useful sort of information through an analysis of their residuals. The term "residuals" here refers to the numerical difference between the expected and observed values for a given combination of nominal variables, in this case between a given artifact category in a given local assemblage; the greater this residual, the greater the association, negative or positive, between the two variables.

In this procedure the expected values for each individual row-column combination, E_{ij} are first computed as in a normal chi-square test. Thus

$$E_{ij} = \frac{n_i . n_{.j}}{N}$$

where E_{ij} is the expected value, $n_i.$ is the sum of ith variable over all rows (r), and $n_{.j}$ is the sum of the jth variable over all columns (c).

The difference (residual) between expected and observed values for each row-column combination can, of course, at this point be used to calculate the chi-square statistic for the overall distribution observed:

$$\chi^2 = \sum_{i=1}^{r} \sum_{j=1}^{c} \frac{(n_{ij} - E_{ij})^2}{E_{ij}} .$$

The probability of this distribution is given by the chi-square distribution with degrees of freedom (df) equal to:

$$\text{df} = (r - 1)(c - 1).$$

Analysis of residuals, on the other hand, proceeds somewhat differently by first standardizing the individual row-column residuals:

$$e_{ij} = (n_{ij} - E_{ij})/\sqrt{E_{ij}},$$

where e_{ij} is the standardized residual for the cell defined by the ith row and the jth column, or in this case, for the jth artifact category in the ith assemblage.

These standardized residuals are then adjusted according to their estimated variance:

$$d_{ij} = e_{ij}/\sqrt{v_{ij}},$$

where d_{ij} is the adjusted residual for the ith artifact category in the jth assemblage, and v_{ij} is the estimated variance of that standardized residual (e_{ij}), calculated as:

$$v_{ij} = (1 - n_{i.}/N)(1 - n_{.j}/N),$$

where $n_{i.}$ and $n_{.j}$ are as defined earlier.

When the variables in a contingency table are independent, its adjusted residuals are approximately normally distributed with a mean of zero (0) and a standard deviation of one (1). Accordingly, adjusted residuals greater than 1.96 have associated probabilities of less than or equal to 0.05 and can therefore be held significant at this alpha-level. Note again, however, that we are not so much concerned with significance in its own right—and certainly not in the precise significance of individual values—as in using it to detect associations between artifact categories and assemblages that seem worthy of attention.

Analysis of adjusted residuals presumes that the contingency table in question meets the basic requirements for the standard chi-square test. Among other things, this means that no more than 20 percent of its cells can contain expected values of less than 5. Even casual inspection of table 11.5 shows that this condition cannot be met. By deleting the six smallest local assemblages (i.e., those consisting of fewer than 400 items), however, we obtain a smaller table consisting of all 8 of the original columns (artifact categories) but only 11 of the original 17 rows (local assem-

TABLE 11.6
Adjusted Residuals for Major Artifact Categories in Local Assemblages of N > 400 at Crater Middens

Unit	Milling-stones	Owens Valley Brown Ware	Projectile points	Simple bifaces	Roughouts	Unifaces	Cores	Debitage
Midden II:								
Surface	−1.09	1.51	0.16	5.62	3.52	−0.02	0.07	−4.72
0–10 cm	2.92	7.64	−0.82	1.87	−0.47	−1.06	0.77	−4.75
20–50 cm	−0.17	−4.31	−0.85	−0.34	−2.96	−1.65	−2.30	4.74
Structure 9	6.81	15.76	2.87	2.56	1.56	0.47	1.04	−12.63
Structure 10	−1.54	−1.08	−0.33	−2.18	−2.58	−1.42	−1.67	4.21
Structure 12	2.68	7.15	0.60	0.36	−2.50	0.05	1.25	−3.76
Midden III:								
Surface	0.24	2.08	1.24	1.22	7.38	4.97	4.63	−7.86
0–60 cm	−6.45	−9.45	−3.34	−5.97	−4.51	−1.34	−5.58	14.34
Structure 16	0.96	−2.32	2.09	1.66	−1.06	1.59	2.22	−1.49
Midden IV:								
Surface	2.18	4.05	3.36	2.74	10.26	2.51	9.96	−12.69
0–50 cm	2.56	−1.83	1.21	−0.83	2.27	−0.45	−0.67	−0.69

$\chi^2 = 1087.5$, df = 70, $p < 0.001$.

blages), in which less than 15 percent of the expected values are less than or equal to 5. Without correcting for continuity, the chi-square statistic for this 8 by 11 contingency table is, $\chi^2 = 1087.5$, which far exceeds the critical chi-square value of 112.317 at $p = 0.001$, with 70 degrees of freedom.

This value is large not because the variables in the table are overwhelmingly associated or because it is uncorrected for continuity (the effect of which is essentially negligible here) but because one category (debitage) is very large and chi-square is especially sensitive to sample size. We are justified, nonetheless, in concluding that the assortment of artifact categories among these 11 local assemblages is probably not entirely random and that it is worth examining their adjusted residuals. These are presented in table 11.6.

The size effect that debitage has on these values can be grasped by noting that where it (debitage) is more common than expected, all the remaining categories are almost invariably less common than expected, and conversely. Such information is useful in measuring the ratio of debitage to other categories but not in understanding the relationships between those remaining categories, which are masked by variation in this much larger one.

To reveal this variability, we can compute adjusted residuals for the same 11 local assemblages using only the 7 artifact categories other than debitage, as shown in table 11.7. The chi-square value of the overall distribution is $\chi^2 = 276.3$, $p < 0.001$, with 60 degrees of freedom.

Finally, table 11.8 combines the adjusted residuals for debitage (table 11.6) with the adjusted residuals for the other categories when debitage is excluded (table 11.7). To facilitate interpretation the local assemblages are regrouped by kind (surface scatters, buried deposits, and structures) and, where appropriate, age (late Cowhorn/Baker and Klondike).

Rather than ignore the six small local assemblages for which adjusted residuals were not calculated, table 11.8 enters information of a different kind for them. Because we have no basis for judging the probability of their observed distributions, in these six cases the values given are directions (i.e., positive or negative) that indicate whether in one of these local assemblages a category is proportionally more or less common than in all 17 local assemblages combined (cf. table 11.5). As with

TABLE 11.7
Adjusted Residuals for Major Artifact Other Than Debitage in Local Assemblages of N > 400

Unit	Milling-stones	Owens Valley Brown Ware	Projectile points	Simple bifaces	Roughouts	Unifaces	Cores
Midden II:							
Surface	−2.45	−0.47	−1.16	3.17	1.49	−1.29	−0.98
0–10 cm	1.24	5.63	−2.20	−0.56	−2.38	−2.39	−0.39
20–50 cm	1.84	−3.00	0.78	2.83	−1.34	−0.26	−1.36
Structure 9	1.31	5.69	−0.55	−2.20	−1.93	−1.76	−1.09
Structure 10	−0.14	1.09	1.42	−0.07	−1.32	−0.20	−0.88
Structure 12	1.28	5.29	−0.52	−1.54	−3.80	−0.99	0.28
Midden III:							
Surface	−1.94	−1.03	−0.94	−2.36	3.38	1.99	2.02
0–60 cm	−2.05	−4.70	1.50	1.89	1.80	4.04	−2.60
Structure 16	0.46	−3.14	1.64	1.01	−1.74	1.14	1.83
Midden IV:							
Surface	−1.40	−0.90	−0.37	−2.57	3.37	−0.86	4.22
0–50 cm	2.41	−2.29	1.02	−1.33	2.12	−0.68	−0.85

$\chi^2 = 276.3$, df = 60, $p < .001$.

the adjusted residuals, the values for debitage are computed over all eight artifact categories and values for the remaining seven categories were computed only among themselves, that is, excluding debitage. These directional values carry much the same meaning as adjusted residuals of less than 1.96.

INTERPRETATIONS

Before going further it is worth reviewing some of the tentative conclusions reached in earlier chapters about the basic kinds of activities represented by local assemblages within the site. In particular, our analysis of debitage suggested that surface scatters might represent activities that, because they produced objectionable debris or would have disrupted, or been disrupted by, activities occurring in more centrally located areas, were segregated toward the margins of each midden. The buried cultural deposits, on the other hand, presumably represent activities that occurred in the more central locations.

It was also argued from several lines of evidence that Midden I might differ in function from Middens II and III. The last two were evidently intensively used as places of residence, plant processing, and tool manufacture and repair, while Midden I was apparently used only as a place of occasional residence, perhaps during brief periods of ritual seclusion. Middens IV and V also seem to differ from Middens II and III. To judge from the assemblage we recovered, Midden IV was used intensively, yet it is very small and lacks structures. Midden V is smaller yet, and its archaeological assemblage is vanishingly small, even though it exhibits a fairly deep, if artifact-poor, cultural deposit. All of this implies that Middens IV and V were used for a much more restricted range of activities than either Midden II or III. At both Midden IV and V these included plant processing and, at Midden IV, tool production and repair.

The six excavated structures were also divided according to inferred function. Structures 7, 9, and 3 were all classified as dwellings, but Structures 7 and 9 were more regularly occupied than Structure 3, which is in keeping with the suggestion that the latter was occupied only during short periods of seclusion. Structures 10, 12, and 16 were all exceptional in one way or another. It was tentatively suggested that Structure 12 might be a sweathouse, Structure 16 a workshop or storehouse, and Structure 10 a workshop or cookhouse.

MILLINGSTONES: As indicated in table 11.8, millingstones tend to be concentrated in the

TABLE 11.8
Adjusted Residuals or Directional Values for Major Artifact Categories in All Local Assemblages at Crater Middens

Unit	Millingstones	Owens Valley Brown Ware	Projectile points	Simple bifaces	Roughouts	Unifaces	Cores	Debitage
SURFACE SCATTERS								
Midden I: Surface*	+	+	−	−	−	−	+	−
Midden II: Surface	−2.45	−0.47	−1.16	3.17	1.49	−1.29	−0.98	−4.72
Midden III: Surface	−1.94	−1.03	−0.94	−2.36	3.38	1.99	2.02	−7.86
Midden IV: Surface	−1.40	−0.90	−0.37	−2.57	3.37	−0.86	4.22	−12.69
Midden V: Surface*	+	−	−	−	+	+	+	−
BURIED DEPOSITS								
Klondike								
Midden I: 0–10 cm*	−	−	+	−	−	−	−	−
Midden II: 0–10 cm	1.24	5.63	−2.20	−0.56	−2.38	−2.39	−0.39	−4.75
Midden IV: 0–50 cm	2.41	−2.29	1.02	−1.33	2.12	−0.68	−0.85	−0.69
Late Cowhorn/Baker								
Midden II: 20–50 cm	1.84	−3.00	0.78	2.83	−1.34	−0.26	−1.36	4.74
Midden III: 0–60 cm	−2.05	−4.70	1.50	1.89	1.80	4.04	−2.60	14.34
Undated								
Midden V: 0–40 cm	−	−	−	−	+	−	−	+
STRUCTURES								
Structure 3*	+	−	−	+	−	+	−	−
Structure 7*	+	+	−	−	−	−	−	−
Structure 9	1.31	5.69	−0.55	−2.20	−1.93	−1.76	−1.09	−12.63
Structure 10	−0.14	1.09	1.42	−0.07	−1.32	−0.20	−0.88	4.21
Structure 12	1.28	5.29	−0.52	−1.54	−3.80	−0.99	0.28	−3.76
Structure 16	0.46	−3.14	1.64	1.01	−1.74	1.14	1.83	−1.49

Notes: As described in the text, adjusted residuals for categories other than debitage are calculated only among those categories, while those for debitage are calculated over all categories. Asterisks (*) denote assemblages consisting of fewer than 400 pieces for which the directional values indicate whether the observed value is proportionally greater or lesser than the mean for the category when all 17 assemblages are combined. Adjusted residuals for which the associated probability is less than 0.05 are shown in boldface.

buried deposits of Middens II and IV and in Structures 9 and 12. They are scarce in surface scatters and in the buried deposit of Midden III. Since most of these grinding implements are fragmentary, their distribution cannot be linked with plant processing directly. It is more reasonable to assume this distribution is partly a result of patterns of refuse disposal, partly a result of the manufacture and repair of millingstones, and partly a result of activities in which millingstones were useful as fragments—stone-boiling, for example. Of these three, however, only the last would seem to fit with the tendency for these specimens to occur near centers of diverse activity and in certain structures and not in more peripheral settings, where we might reasonably expect refuse dumping and the fabrication and repair of heavy stone implements.

On the other hand, that millingstones are poorly represented in the buried deposit of Midden III need not indicate the absence of activities in which recycled fragments were used. On the contrary, millingstones are scarce in all contexts at Midden III (at least they are nowhere abundant), which suggests that relatively little milling activity took place there at any time and thus that there were very few millingstone fragments lying about to be recycled. This, in turn, suggests a basic difference in function between Midden II and Mid-

den III extending throughout the occupation of Crater Middens.

CERAMICS: To an even greater degree than millingstones, the ceramics recovered from Crater Middens are small fragments no longer useful for their original purpose, which was probably as cooking vessels. Unlike millingstone fragments, however, apart from the occasional specimens that were obviously recycled as scrapers (i.e., worked sherds), which are excluded from consideration here, these sherds do not appear useful for any particular task and are presumably refuse. Their distribution is not, however, concentrated in areas where we would expect refuse to accumulate had it been conscientiously collected and dumped. Sherds tends to occur in structures and central activity areas and not in marginal areas, which are in this sample represented by surface scatters. It is evident, therefore, that sherd waste was not considered sufficiently objectionable to be carefully gathered up and disposed of, although the larger fragments may have been saved and recycled. Accordingly, it is reasonable to assume that the distribution of ceramics marks locations where vessels broke during the preparation of food.

Of course, the dearth of sherds in the buried deposits of Cowhorn/Baker age (specifically in Midden III and the lower portions of Midden II) carries no special implications about the presence of food preparation because in Owens Valley (as in eastern California generally) the widespread manufacture and use of ceramics is limited to the Klondike phase. That sherds are so scarce in the buried Klondike component of Midden IV is clearly more telling in this regard and suggests that cooking of the kind that required earthenware vessels may have rarely occurred there. If this is so, then the abundance of millingstone fragments just noted for Midden IV may not reflect stone-boiling but some other activity—the production of millingstones, for example. This would in turn imply some kind of functional differentiation between Middens II and IV during the Klondike phase, the former perhaps being characterized by activities normally considered camp chores, the latter by a more specialized range of activities such as the manufacture and repair of certain kinds of implements. Similarly, that sherds are so poorly represented in Structure 16 and so well represented in Structures 9, 10, and 12 would seem to imply some sort of function differentiation between it and them.

PROJECTILE POINTS: Like both millingstones and ceramics, the projectile points found at Crater Middens are largely unserviceable fragments. Presumably most are pieces that broke during manufacture or that were discarded when hunting gear was repaired. Once again, there is no evidence that these artifacts were systematically collected and disposed of since they are not common in any of the surface scatters and it follows that in general their distribution marks locations of craft activity, not refuse dumps. During the Cowhorn/Baker phase this activity evidently concentrated in the central areas of Middens II and III and during the Klondike Phase in Midden IV and Structures 10 and 16 (at least if we assume that the deposits of all structures are predominantly attributable to the Klondike phase even though some were probably occupied before that). By the same token, this kind of activity seems to have been systematically excluded from the central area of Midden II and, less certainly, from Structures 9 and 12 during the Klondike phase. In short, the distribution of projectile points suggests functional distinctions between different areas of activity in the Klondike phase but not in the Cowhorn/Baker phase.

SIMPLE BIFACES: This is yet another category that consists largely of fragments lacking any further utility. Most of them were probably trimmed from larger sections being drastically reshaped or were simply discarded when attempts to resharpen or reshape them proved futile. Either of these interpretations would suggest that bifaces are predominantly debris resulting from moderately heavy stoneworking, their distribution marking either locations of that activity or places where its refuse was dumped. It is difficult to distinguish between these possibilities from the data presented in table 11.8, which shows simple bifaces to be common in the surface scatter of Midden II, the buried deposits of the Cowhorn/Baker phase, and Structure 16, and rare in the surface scatters of Middens III and IV, the buried deposits of the Klondike phase, and in Structures 9, 10, and 12.

That simple bifaces are infrequently found

in most structures suggests, as we might expect, that heavier forms of stoneworking seldom occurred there or that when they did the refuse was removed and dumped elsewhere. The relative abundance of simple bifaces in Structure 16, on the other hand, might reflect caches of fragments set aside against the possibility of future shortages of raw material, particularly since there is some evidence of specialized biface production associated with that feature.

Elsewhere, the distribution of these bifaces suggests differences in the location and intensity of heavier stoneworking between the Cowhorn/Baker phase and Klondike phase. During the Cowhorn/Baker times, this activity evidently occurred in central locations at both Middens II and III, although it may also have taken place or its refuse disposed of at the margins of Midden II, as simple bifaces are unusually abundant in the surface scatter there. Evidence for this activity in the succeeding Klondike phase is limited to the surface scatter of Midden II and even this is equivocal since at least some of that local assemblage must belong to the Cowhorn/Baker phase, though not necessarily the simple bifaces. In other words, the kind of heavy stoneworking that produced biface fragments as refuse is evidently more characteristic of the Cowhorn/Baker phase than the Klondike phase. It would further appear that to the extent it was present, this activity was physically segregated from others during the Klondike phase but not the Cowhorn/Baker phase, when it was concentrated in the central parts of Middens II and III.

ROUGHOUTS: The roughouts from Crater Middens are often complete and evidently represent specimens considered too flawed or oddly shaped to be finished into points, knives, or drills. Like bifaces, therefore, their distribution should mark locations of heavier stoneworking or places where refuse from this activity was disposed. Unlike biface fragments, however, which reflect the terminal stages of tool rejuvenation and recycling, roughouts reflect the early stages of that production cycle.

The distributions presented in table 11.8 suggest that this kind of activity was particularly important at Midden III during the Cowhorn/Baker phase and at Midden IV during the Klondike phase. In each case, roughouts are common in both the central midden deposit and in the outlying surface scatter, suggesting that tool production was carried out in both kinds of locations, i.e., in central and marginal settings. It is conceivable, of course, that the roughouts in both these surface scatters reflect the presence of refuse dumps, not locations of tool production, but this seems unlikely given that there is little evidence for the systematic collection and disposal of other kinds of refuse, including biface fragments (at least during the Cowhorn/Baker phase), which seem no less objectionable than roughouts.

At Midden II, roughouts occur only in the marginal surface scatter, suggesting that in both the Cowhorn/Baker and Klondike phases primary tool production was deliberately segregated from activities that occurred in its central area. Once again the argument that this reflects patterns of refuse disposal is not telling since evidence of this activity is lacking for other categories. Similarly, that roughouts are conspicuously lacking in the assemblages of all structures seems better explained by arguing that primary tool production seldom took place inside them than by arguing that this reflects only careful housekeeping.

Taken as a whole, the distribution of roughouts suggests firstly that throughout the occupation of Crater Middens primary tool production was deliberately segregated from the central area of Midden II and tended to concentrate instead at its margins and in both the central and marginal parts of Midden III (Cowhorn/Baker) and Midden IV (Klondike). This once again suggests basic distinctions of function between Midden II, on the one hand, and Middens III and IV, on the other.

It is worth noting that this segregation appears to have been more severe than that which characterized the reshaping and recycling of bifaces, an activity that is relatively well represented in the central deposit of Midden II—at least during the Cowhorn/Baker phase—and is better represented in the center than at the margins of Midden III. That is, bifaces seem to have been more frequently reshaped and reworked in the same places where other activities occurred than the initial reduction phases of stone tool production. It also appears to be the case that the dominant modes of stoneworking dif-

fered through time at Crater Middens: Klondike phase stone tool production is characterized by a standard reduction sequence in which roughouts are finished into tools. Cowhorn/Baker phase production included the reduction of roughouts into finished tools but featured in addition the recycling of bifaces.

UNIFACES: A large fraction of the unifaces found at Crater Middens retain at least some degree of utility and it is likely that their distribution corresponds to locations where bone, stone, wood, hide, sinew, and fiber were processed. The distribution shown in table 11.8 suggests that these activities were characteristic of only Midden III and elsewhere relatively unimportant. Since unifaces are common in every context at Midden III, that is, in the marginal surface scatter, the central midden, and in Structure 16, it is reasonable to assume that the activities they represent were more or less confined to this Midden throughout the occupation of Crater Middens and in this sense indicate a basic functional distinction between Midden III and the other parts of the site. This distinction may have been somewhat less pronounced in the Cowhorn/Baker phase, however, since unifaces are only slightly less common than we would expect by chance in buried deposits of that age in Midden II. Since this is so and since unifaces are exceptionally abundant in the Cowhorn/Baker deposit of Midden III it would also appear that the activities in which unifaces were used were relatively more important during the Cowhorn/Baker phase than in the Klondike phase. In short, the distribution of unifaces suggests differences in activities between different parts of the site occupied contemporaneously as well as temporal differences.

CORES: Most of the cores found at Crater Middens are presumably discards of little further value, so their distribution might reflect either locations of heavy stonework or locations of trash disposal. As we have repeatedly noted above, however, there is very little evidence that trash of other kinds was systematically collected and disposed of and it seems unlikely that cores alone would receive such treatment.

Presuming, then, that they identify areas of heavy stonework, the distribution of cores at Crater Middens suggests that this activity was largely confined to the margins of Middens III and IV. It is difficult to date any of the surface assemblages but it might be ventured that cores in the scatter of Midden III represent Cowhorn/Baker stonework, and those in the scatter of Midden IV, Klondike stonework, since those are the principal periods of use for those Middens, respectively.

Cores also occur in substantial numbers in Structure 16 but in that instance are perhaps better interpreted as items cached against the possibility of shortages of raw material, since caches of other kinds (chert bifaces, millingstones) were noted in that feature and it is unlikely in any case that heavy stoneworking would take place in a covered structure of any sort. If we accept this explanation, it would appear that core reduction was more restricted in location than stonework of other kinds, perhaps because this task entailed at least some risk of injury to standers by; a similar argument is used to explain the peculiar distribution of cores at Pinyon House.

DEBITAGE: In theory, the distribution of this chipping waste should reflect locations of stone tool production and repair or places where refuse from these activities was dumped. With respect to the latter, however, there is little evidence that other categories related to stoneworking (e.g., bifaces and roughouts) were systematically collected and disposed of and it is unlikely that this kind of behavior is responsible for the distribution of debitage observed at Crater Middens. However, the observed distribution of this category (table 11.8) is at odds with what we would expect given the distribution of the other categories that can be linked to stone tool production. In particular, unlike roughouts and unifaces, debitage is conspicuously scarce in all surface scatters. It is also rare in buried deposits of the Klondike phase and all structures except Structure 10. Indeed, debitage is exceptionally abundant only in the buried deposits of the Cowhorn/Baker phase.

In accounting for these patterns, note firstly that the distribution of debitage shown in table 11.8 reflects flake counts, not flake weights. Because of this and because mean flake weight is between two and three times greater for surface scatters than buried midden deposits, the lack of debitage in the surface scatters is more apparent than real. That is, debitage is

probably an important constituent of all surface scatters, appearing to be rare only because of its greater mean size. This is consistent with the notion that the debitage in surface scatters derives primarily from the earlier stages of lithic reduction, i.e., heavy stonework, which is as we would expect given the other categories that are well represented in these scatters (e.g., roughouts and cores). Similarly, the debitage in the more centrally located buried deposits represents later stages of reduction and retouch, that is, light stoneworking, hence its greater numerical representation and smaller size.

It remains to be explained why debitage should be so much more common in the buried deposits of the Cowhorn/Baker phase and in those of the Klondike phase and, similarly, why it is so common in Structure 10 and yet so uncommon in all other structures.

That lithic debris is typically rare in structures makes a certain amount of sense since many steps in stone tool production produce large quantities of objectionable debris and would be disruptive to other activities occurring in the same cramped quarters. It is likely that certain kinds of light stonework, especially the retouching of knives and points, were routinely performed inside dwellings but these produce relatively little waste, which might have been swept out or caught on a mat or hide and disposed of elsewhere. Given this, we might account for the large quantity of debitage in Structure 10 in two ways. First, this waste might be refuse collected elsewhere and dumped here. If this were true, however, we might reasonably expect that other structures would exhibit debitage in similar quantities, which they do not. Second, it might be that stoneworking was more commonly carried out Structure 10 than in other structures, that is, that it differs from them in function. This is consistent with our earlier suggestion that Structure 10 might be a workshop. Further, since in mean weight the debitage from Structure 10 is virtually identical to the debitage from buried midden deposits, it would appear that stonework in this feature centered on retouch rather than primary reduction. Projectile points are particularly abundant in Structure 10 and thus it might be that hunting gear was replaced and repaired here.

There is lastly the problem of explaining why debitage is so much more abundant in buried deposits of the Cowhorn/Baker phase than in buried deposits of the Klondike phase. Recall that debitage is so numerically superior to other categories that this means in effect that during the Cowhorn/Baker phase there is simply more debitage than there ought to be given the quantities in which other categories occur and, similarly, that in the Klondike phase there is less debitage than there ought to be given the total of all other categories combined. One way or another this implies a change in technology in which production debris decreases relative to finished products.

One might argue that ceramics were made for the first time during the Klondike phase and that their addition simply makes debitage appear to be relatively less abundant in that phase. Were this so, however, we would expect that where ceramics are relatively more abundant than expected, debitage ought to be less abundant than expected and a glance at table 11.8 shows that this is not true.

Since debitage is waste from stone tool production and since worked stone artifacts constitute 70 percent of the combined total of all categories other than debitage, it is perhaps more reasonable to consider this phenomenon as one primarily reflecting shifts between finished or worked stone artifacts and unmodified debris. Data presented in table 11.5 tend to support this view: the ratio of debitage to other items of chipped stone is substantially higher in buried deposits of Cowhorn/Baker age in Midden II (57.1:1) and Midden III (69.9:1) than in buried deposits of Klondike age in Midden II (39.7:1; it would be 45.4:1 if we included Structure 10, where as we have said light stoneworking is concentrated during this phase in this Midden) and Midden IV (38.5:1).

One way to explain this would be to argue that some innovation in pressure or percussion technique made it possible for Klondike phase stoneworkers to produce greater numbers of finished products from a given amount of material than Cowhorn/Baker stoneworkers. While it is true that Klondike phase points (Cottonwood and Desert Side-notched) are smaller than Cowhorn/Baker phase points (Elko/Rose Spring/Eastgate) the difference is probably not large enough to account for the

observed change in the ratio of worked stone to waste stone (debitage). It is possible that there are similar differences of size between other kinds worked stone made during these two periods, but no such differences were obvious when the collections were analyzed, so this does not seem likely.

The only other plausible explanation for the pattern is that relative to the total number made at Crater Middens, more worked stone artifacts were lost or discarded at other locations—in the field or at other sites—during the Cowhorn/Baker phase than during the Klondike phase. That is, this change does not reflect a change in lithic technology but a change in settlement technology: the kind and degree of lithic production remained unchanged from Cowhorn/Baker to Klondike times but the manner in which the products were used differed to the extent that more of them ended up at other sites in the Cowhorn/Baker phase than in the Klondike phase. This assumes that the quantity of worked stone artifacts imported to Crater Middens was never very large in comparison to local production, which is reasonable given evidence just cited that stoneworking was an important activity at the site.

In regional perspective, the shifting ratios between worked stone and waste stone are particularly important in understanding changes in the manner in which the occupants of the central settlement of Crater Middens made use of plant and animal resources within a larger exploitation area. These data suggest that during the Cowhorn/Baker phase this was frequently accomplished by means of satellite settlements—temporary camps or, as Binford calls them, field camps—at which tools brought from Crater Middens were used, expended, and discarded. During the Klondike phase, on the other hand, there was less use of such satellite camps, presumably because trips made for resources were shorter both in time and distance traveled. In short, the settlement pattern became more centralized, the patterns of land use more intensive.

SYNOPSIS OF SITE HISTORY

COWHORN/BAKER PHASE (0 B.C./A.D.–A.D. 1300): The evidence now in hand indicates two loci of occupation during the Cowhorn/Baker phase: Midden II and Midden III. We cannot date the surface scatters in either location but it seems reasonable to assume that they represent this occupation at least in part. In addition, Structures 10 and 12 in Midden II and Structure 16 in Midden III were probably occupied at this time but since they were subsequently cleaned and reused in the Klondike phase their assemblages provide no clues as to the nature of their use in the Cowhorn/Baker phase.

The distributions shown in table 11.8 suggest that the central portion of Midden II was used as a place of food preparation and light stoneworking. This, in combination with the plant macrofossils, the abundance of structures, and the size and diversity of the bedrock milling assemblage found there would suggest it was a focal point of residential activity. A combination of light and heavy stonework and perhaps other tasks that produced objectionable debris, such as butchering, evidently occurred at the margins of Midden II where they would not interfere with those taking place at its center.

Activities at Midden III, on the other hand, revolved more around tool production. Light and heavy stoneworking and the processing of wood, hide, and fiber took place in both marginal and central locations, while the heaviest stoneworking was confined to the marginal locations. Plant macrofossils and portable and bedrock milling equipment are present in only limited quantity, suggesting that food processing, and therefore residential activity, was far less important here than at Midden II.

In sum, the Cowhorn/Baker phase settlement of Crater Middens consisted of two activity loci, one characterized by food processing and residential activities, the other by production activities of various sorts.

KLONDIKE PHASE (A.D. 1300—HISTORIC PERIOD): At least four parts of Crater Middens were occupied during the Klondike phase but in only two cases, Middens II and IV, was this occupation intensive. Except for Structure 16, Midden III seems to have received only sporadic use. Likewise, Midden I was inhabited only occasionally, primarily in connection with the occupation of Structure 3. In addition, Structures 7, 9, 10, and 12 seem to have been regularly used throughout the Klondike phase.

The central area of Midden II was almost

exclusively used for routine domestic chores that included cooking and other steps of food preparation. A large and diverse bedrock milling assemblage and an abundance of plant macrofossils indicate that seed processing was one of the more important of these activities. On the other hand, light stoneworking, which had taken place in this central area during the Cowhorn/Baker phase, was in the Klondike phase relegated to Structure 10, which may have been a male workshop. Somewhat heavier stoneworking was confined to outlying margins of this locality, where it is reflected in the surface scatter. At least two dwellings, Structures 7 and 9, and possibly a sweathouse, Structure 12, were also occupied.

It is apparent from all this that the Klondike phase occupation of Midden II centered around its use as a place of domestic residence and that this occupation was sufficiently intensive to require conscious segregation between tasks that might otherwise have disrupted each other. As we have just seen, some of these occurred in separate structures or at the margins of Midden II; others however were carried out at entirely different locations. In particular, it would appear that Structure 16 at Midden III was used as a storehouse. It seems likely, further, that in part the tools and debris from stone, wood, hide, and fiber processing represented in the surface scatter of Midden III represent Klondike phase activity that revolved around this structure.

Midden IV was also a center for Klondike phase craftwork. Both light and heavy stonework evidently took place in its central area but the heaviest stonework was evidently confined to the margins around it. The central area also exhibits a small but diverse range of bedrock milling equipment and yielded reasonably abundant plant macrofossils, so some food must have been prepared. All the same, ceramics are very scarce and dwellings are entirely absent, so it seems better interpreted as a place where meals were occasionally cooked and eaten, perhaps snacks prepared by those working there, rather than as a place of residence.

There is lastly evidence that Midden I was sporadically used. It lacks a well-defined central area, its surface scatter is exceedingly sparse, and its bedrock milling assemblage quite small. Indeed the only discernible concentration of material is in Structure 3, which was not well built yet was clearly a place of residence. All of this suggests that Structure 3 was the focal point of activity in Midden I and that nearly as much of this activity took place within that structure as immediately outside. As already noted several times this would suggest the use of this midden and this structure by those seeking ritual seclusion—perhaps expectant families if ethnographic practices apply.

The Klondike phase settlement of Crater Middens, then, consisted of a residential center, two other entirely separate locations of more specialized craft activity, and possibly a third one reserved for those in need of ritual seclusion.

SUMMARY

Excluded from this simple historical model of occupation at Crater Middens are the unexcavated structures at Middens I, II, and III, of which at least four appear to be regularly occupied dwellings, and the surface scatter and buried deposit of Midden V. Whatever their age and exact manner of use, these guarantee that many of our inferences about the nature and distribution of activities are more simple than they ought to be. On the other hand, it is unlikely that they would fundamentally alter our understanding of how different parts of the site were used. The presence of two more scattered residences (Structures 1 and 2) at Midden I would not, for instance, be sufficient to cause us to interpret it as a center of residential activity because they do not appear to have been occupied with any regularity and because Midden I lacks other characteristics associated with such centers. Likewise, the presence of the two additional residences (Structure 5 and 8) at Midden II and two more (Structures 14 and 17) at Midden III would not change how we view the relationships existing between these two areas even though it might suggest slightly more residential activity at Midden III than has been inferred. Finally, whatever it actually is, Midden V is clearly not a place of residence or craftwork, and thus does not bear on our basic inferences regarding the distribution and intensity of these activities. Indeed, the only plausible suggestion—more

correctly, guess—that can be offered with regard to Midden V is that it was used as a latrine, which would explain why its organically rich buried deposit is so lacking artifacts of any kind.

POPULATION: It is difficult to estimate the total population at any given time, especially since so many structures remain unexcavated and the dating available for the others is rather crude. If we assume that all six structures interpreted as regularly occupied dwellings were in use during the Klondike phase, and further assume that each housed a family of five individuals, the total population living there in that phase would be somewhere in the vicinity of 30 individuals. This figure is in keeping with the combined population of 200 individuals that are thought to have been residing in four or five neighboring villages in the vicinity of Big Pine in early historic times (Steward, 1938a: 50, fig. 7; 1933: 237, map 2).

No estimate can be offered of population during the Cowhorn/Baker phase but it was presumably smaller than in the Klondike phase if the relative sizes of these two assemblages are any indication. Moreover, that the degree of spatial segregation between activity areas is greater in the Klondike phase than the Cowhorn/Baker phase suggests that the resident population was larger in the former than the latter. This follows from the argument that the potential for confusion and conflict between activities increases exponentially with group size so that the degree of segregation between different kinds of activities in some sense measures population size.

SEASONALITY: Plant and animal remains and the kind and number of features and artifacts present suggest that Crater Middens was occupied essentially year-round from the late Cowhorn phase until the site was abandoned at the close of the Klondike phase. It might be argued that by themselves the plant remains are equivocal on this point, but marmot remains assure residence sometime between the beginning of March and the end of July, that is, warm-season occupation, just as the structures with interior hearths are presumptive evidence of winter or cold-season occupation. Of course, occupation could have been in the cold-season one year and warm-season the next, but this seems unlikely given the size of the artifact assemblage and the degree of midden development at several places within the site, all of which imply regular and intensive occupation.

SUBSISTENCE: As with seasonality, the details of subsistence patterns at this site remain beyond our grasp but the overall pattern is reasonably clear: plants and small animals dominated the diet. Seeds plants, of course, were clearly important as attested by plant macrofossils and the extensive collection of manos and bedrock and portable millingstones. If we are correct in our interpretation of battered cobbles, however, root plants must have been very important as well, although we cannot estimate their relative importance to seeds. Neither can we do more than guess about the ratio of plant food to animal food in the diet. Plant foods, particularly seed foods, were far more important than meat in the aboriginal diet (Steward, 1938a: 52), however, and this matches with the size and diversity of the groundstone assemblage as compared with that part of chipped stone assemblage that can be linked to hunting and butchering.

The faunal assemblage is so sparse and fragmented that it is further difficult to estimate which animal taxa were most frequently taken and consumed, but here again the overall impression is that in this respect the ethnographic pattern applies and that small game was more important than large game. Jackrabbits and in somewhat lesser quantity cottontail seem to have been at least regular elements of the diet. One suspects that gophers, mice, rats, and other small vertebrates were also eaten but for these burrowing taxa it is difficult to distinguish natural from cultural bone in our faunal collections so we cannot be sure how important they were. The case is much the same for artiodactyls since very few specimens were identifiable. Included among these, however, are representatives of the three ungulates one would expect on the basis of ethnographic accounts: *Ovis, Odocoileus,* and *Antilocapra.*

Within this broad pattern there are at least two temporal changes worth noting. Firstly, our flotation samples suggest that seed procurement may have been more intensive in the Klondike phase than the Cowhorn/Baker phase. In particular, samples securely attributable to the latter contain fewer seeds of

fewer species than those that can be securely linked to the Klondike phase. This may only be an artifact of differences in the kind of activities that occurred in locations where samples can be securely dated but it is, nevertheless, consistent with the lesser importance of milling equipment in assemblages dating to the Cowhorn/Baker phase. Secondly, although there is very little of it, ungulate bone is clearly concentrated in deposits of Cowhorn/Baker age rather than Klondike age. One would not want to make too much of this but we might tentatively suggest that large game was proportionally more important than small game in Cowhorn/Baker times than Klondike times, which is consistent with the observation that projectile points are more prominently represented in deposits of the Cowhorn/Baker phase than in those of the Klondike phase.

SITE FUNCTION: From all the above it is clear that the aboriginal groups residing at Crater Middens used this settlement as a central place within their regional subsistence-settlement system (cf. Struever, 1968; Winters, 1969) and that this pattern holds for occupation during both the Cowhorn/Baker and Klondike phases, that is, from roughly 0 B.C./A.D. until it was abandoned sometime around A.D. 1870. It would seem that throughout this time the site was occupied almost year round, though its inhabitants must often have left to make trips to distant locations and stayed away for periods of varying length. It would follow that food was stored at this location for consumption during the winter and that it was a place of production and repair for many, probably most, of the equipment used in food procurement and processing and the facilities used for convenience in daily life both at this settlement and at smaller and more temporary ones afield. Granted, not all of this has been conclusively demonstrated but it is the most reasonable interpretation of the data in hand.

DISCUSSION

Assuming that Crater Middens was the center of a larger subsistence-settlement system, it would follow that changes observed in the composition of its archaeological assemblage should potentially reflect not only changes in its function but, in effect, changes in the larger subsistence-settlement system of which it was a part. We previously noted one change of this kind: the increase in the ratio of worked stone to waste stone that occurred in the Klondike phase. It was argued that this resulted from a decrease in the use of satellite settlements or temporary camps, which caused fewer tools to be lost or expended at those locations. This, in turn, suggests that in comparison to those of the Cowhorn/Baker phase, the Klondike settlement patterns were more centralized in the sense that Crater Middens grew in importance relative to other settlements and at the same time that resources available close at hand grew in importance relative to those farther away. Other differences in the composition of archaeological assemblages of the Cowhorn/Baker phase and Klondike phase are consistent with this interpretation.

SCHIST MILLINGSTONES: We have already commented that the appearance of a distinctive type of schist millingstone obviously designed for ease of transport suggests a change in seed procurement during the Klondike phase. These implements imply an exploitative pattern in which there were very short stays at locations not likely to be reoccupied and hence where milling equipment could not be cached in advance. This might be contrasted with a pattern in which milling equipment was stocked at temporary camps centrally located in areas where seeds were generally abundant from year to year, from which short collecting expeditions were made. In the Klondike phase it would appear that these short trips emanated from Crater Middens rather than from satellite sites, suggesting more intensive exploitation of a smaller area than in the Cowhorn/Baker phase.

ANODONTA SHELL: In a similar vein, we also noted that fragments of freshwater shell, probably *Anodonta* sp., are common only in deposits of the Klondike phase. This suggests either more intensive use of resources close at hand *or* an exploitative pattern in which resources previously gathered and processed at temporary riverine camps were now gathered and brought back to Crater Middens daily. Either interpretation would be consistent with the more intensive and centralized exploitative patterns we have here associated with the Klondike phase at Crater Middens.

LARGE VERTEBRATES AND SMALL SEEDS: The

decrease in the importance of large vertebrates and increase in the importance of seed plants in the Klondike phase seem also to be related to the distinctive exploitative patterns characterizing this phase. Both tend to indicate that the residents of Crater Middens were more closely tethered to this settlement during the Klondike phase than the Cowhorn/Baker phase and that as a consequence resources available near it (seed plants) were used more intensively than those in more distant locations which required the use of temporary settlements (large vertebrates). Surface survey of the Big Pine transect led to much the same conclusion (Bettinger, 1977a, 1982a), suggesting that Klondike phase hunters restricted their activities to the areas surrounding occupation sites. Since neither deer nor mountain sheep are available in any number within this area during the summer, their importance in the diet necessarily decreased, while seed resources, which were available in abundance, coincidentally increased.

CHERT BIFACES AND BEADS: Finally, in a broader sense, it can be argued that the specialized production of large green chert bifaces that began during the Klondike phase is also explicable by this growing pattern of centralization and intensification. Expertly fashioned from high-quality stone obtained in the Last Chance Range on the east side of Eureka Valley, these bifaces are not particularly common in the collection obtained from Crater Middens even though the waste from their manufacture constitutes nearly half of the debitage generated during the Klondike phase. This would suggest that the final products of this industry—the bifaces—were primarily intended for trade. Most groups in the Great Basin occasionally bartered in craft products or raw materials of one sort or another (Steward, 1938a: 44–45) but, as Bettinger (1982b, 1983; Bettinger and King, 1971) has argued, in Owens Valley regular trade between landholding districts was essential: it afforded a means by which resource surpluses accumulated in one district could be transferred to another district short on resources. In these transactions, edible resources (e.g., seeds and pine nuts) were exchanged for fixed-value bead money that could subsequently be reexchanged for edible resources should shortages arise within the district. Thus, a district enjoying a resource surplus one year could "bank" that surplus in the form of bead money and use it to offset future resource shortages.

The use of bead currency, however, was not merely confined to exchanges of this sort, but extended to payments of bridewealth and the purchase of craft products (Steward, 1941: 250; Chalfant, 1933: 87). In this sense, the late prehistoric economy of Owens Valley may be said to have been nascently monetized. Further, some districts, perhaps those that more consistently faced local resource shortages, specialized in certain kinds of craftwork and in this manner augmented their stock of beads. The Big Pine and Fish Springs districts, within which Crater Middens lies, were especially noted for this practice, principally in regard to the production of ceramic vessels by specialists (Steward, 1933: 266). It is reasonable to conclude that this was a response to lesser or more erratic productivity of resources within those districts or lesser access to raw materials or routes important in trans-Sierran trade, which was the parent source for virtually all shell and stone bead money.

If this is so, then it would be equally reasonable to assume that the specialized production of chert bifaces at Crater Middens was another means by which currency could be obtained. Some support for this argument is provided by the distribution of shell and stone beads and shell bead refuse, which tend to be concentrated in deposits of the Klondike phase and, more importantly, in Structure 16, where several nearly complete chert bifaces were found, suggesting its use by specialists in this craft.

Given these circumstances, we can link the specialized production of chert bifaces at Crater Middens to settlement centralization and exploitative intensification by arguing that:

1. As the inhabitants of Crater Middens foraged more intensively over less and less space, annual fluctuations in resource productivity grew relatively more severe as a simple effect of sampling error: the smaller the area exploited, the greater the relative annual fluctuation in local resources.

2. To counter these fluctuations formalized exchange relationships were established with neighboring groups in which food resources were traded for fixed-value currency.

That such exchanges were possible at all would tend to indicate that the trend toward settlement centralization and exploitative intensification was not limited to Crater Middens but extended throughout Owens Valley generally, motivating the participation of neighboring groups interested in countering their own resource fluctuations.

3. Perhaps in comparison to adjacent areas, central Owens Valley—and in particular the area regularly used for hunting and gathering by the inhabitants of Crater Middens—was lower or more erratic in productivity or was less favored as a base for trans-Sierran trade. This made it necessary to engage in various craft activities and by this means obtain bead money that could be used in resource exchanges or in various other kinds of transactions conducted between different villages or districts—payments of bridewealth, for example. The production of ceramic cookware by specialists was clearly one such craft and it is thinkable that the production of chert bifaces was similarly inspired.

IMPLICATIONS

It is our primary point that Crater Middens was the central place for a larger subsistence-settlement system, that as such it reflects changes that occurred in that larger system, and that its archaeological assemblage is best understood from that perspective. Thus when in the Klondike phase Crater Middens grew more important as a base of plant and animal procurement, this signaled a more general restructuring of settlement and subsistence patterns that profoundly affected the manner in which the inhabitants of this site articulated with the area they regularly used for hunting and gathering.

A second, less obvious, point is that the changes occurring in this larger subsistence-settlement system must have in turn been responsive to changes occurring within Owens Valley, and perhaps central-eastern California, as a whole. Certainly, the trend toward more centralized settlement patterns and more intensive exploitative patterns inferred from evidence obtained at Crater Middens makes sense only if one assumes that some circumstance acted to require them, since as we have seen they were in a sense disadvantageous, bringing greater risk of local resource shortage; that similar changes in settlement and subsistence apparently happened elsewhere in Owens Valley at the same time (Bettinger, 1982a: 65–69) makes it clear that these circumstances were regional rather than local in scope.

Following Bettinger (1977a, 1978a, 1982a, 1982b, 1983; Bettinger and King, 1971), it is reasonable to suggest that unfavorable balances between population and resources might be at work here. In theory, either an increase in population or a decrease in available resources stemming from from environmental or climatic change might account for the shifts observed in subsistence and settlement by making travel less profitable (settlement centralization) and requiring the use of a broader range of resources (exploitative intensification; Bettinger and Baumhoff, 1982). Acting alone, however, it is unlikely that either population increase or climatic change or both would bring about lasting realignments in aboriginal settlement and subsistence of the kind that have been suggested for Owens Valley. This is so because there is no evidence of continuous climatic deterioration in eastern California during the periods in question (Bettinger, 1978a: 38) and because we would ordinarily expect demographic pressure to be relieved by emigration.

On the other hand, the geographical and locational peculiarities of Owens Valley make it something of a special case (Bettinger and Baumhoff, 1982: 497; Bettinger, 1982b: 125–126, 1983: 55): the Sierra Nevada bar any possibility of emigration to the west and vastly contrasting environments discourage it to the north and south. Further, that Owens Valley is somewhat more favored with resources than surrounding areas would lead us to expect that during periods of unfavorable climate, populations would retreat to it, magnifying the effects of even minor changes of environment. Given these special geographical circumstances, it is reasonable to argue that regional imbalances between population and resources precipitated by population increase and by climatic change might have triggered the changes in subsistence and settlement patterns observed in late prehistoric times at Crater Middens and other localities in Owens Valley.

CHAPTER 12. SYNTHESIS, INTERPRETATION, AND IMPLICATIONS

Prior chapters present and interpret archaeological data from three by now familiar sites, Pinyon House, Two Eagles, and Crater Middens, treating each separately and on its own terms. This final chapter joins these data in a synthetic interpretation of the late prehistory of central Owens Valley and considers some theoretical and methodological implications of this synthesis.

The first section concerns the temporal and functional relationships between Pinyon House, Two Eagles, and Crater Middens. Of immediate importance here is whether it is justifiable to argue that these three settlements represent mutually complementary aspects of the same local subsistence-settlement system. In the absence of more telling evidence—a study of decorative styles, for example—this argument rests on very simple observations about raw material use, craft specialization, spatial proximity, and degree of contemporaneity. The last makes it clear that the matter of the functional relationships between these sites cannot be entirely divorced from the matter of their temporal relationship.

A second part of the chapter examines possible explanations for the poorness-of-fit between obsidian hydration dates and dates obtained by other means in the course of this study and why this phenomenon varies in degree between Pinyon House, Two Eagles, and Crater Middens. This is attributed to the scavenging of older sites for tools and raw material, a behavior reflecting indirectly the more general relationship between tool demand and tool supply at each site. This relationship is further examined by means of tool completeness curves, a midrange archaeological index that seeks to link variability in the condition of stone tool assemblages to variability in tool supply and tool demand within a subsistence-settlement system.

The third portion of this chapter considers the relevance of what has been learned from these three sites to our understanding of prehistoric cultural developments in Owens Valley. Central to this is a critical evaluation of earlier models of aboriginal settlement and subsistence developed on the basis of surface surveys.

The fourth and concluding section more briefly considers the broader implications of archaeological research in Owens Valley with regard to three issues: (1) the utility of regional surface surveys; (2) the relationship between natural resources and the development of the distinctive adaptation of the ethnographic Owens Valley Paiute; (3) the spread of Numic-speaking peoples within the Great Basin.

TEMPORAL RELATIONSHIPS

Radiocarbon assays and time-sensitive artifacts reported earlier convincingly demonstrate that Pinyon House, Two Eagles, and Crater Middens were most intensively occupied between A.D. 600 and early historic times and that at least in this limited sense are contemporaneous. Obsidian hydration rim measurements, on the other hand, would extend this interval at least another 600 or so years into the past for all three sites. They further suggest a considerable slackening of occupation at Two Eagles after A.D. 600. Certain patterns of aboriginal behavior discussed below seem capable of explaining why in these cases the obsidian hydration dates are systematically more ancient than dates suggested by accompanying points and radiocarbon assays. For the moment, however, we note only that the hydration rim measurements obtained from these sites are similar in range and to that extent indicate contemporaneity. Apart from this there is so much uncertainty surrounding the obsidian hydration process that it would be foolish to accept these measurements and reject the calendric dating indicated by more reliable sources—projectile points and radiocarbon assays—which place most intensive occupation of these sites between A.D. 600 and historic times. In sum, the bulk of these archaeological assemblages apparently belong to the Baker and Klondike phases and the bulk of our functional interpretations refer primarily to these phases.

The record prior to A.D. 600 is more difficult to interpret. Pinyon House may have been used as a pinyon camp as early as A.D. 300, and before that as a hunting camp, perhaps as long ago as 3000 B.C. Two Eagles was evidently occupied to at least some extent between 1200 B.C. and A.D. 600 but the nature of that use cannot be ascertained with any certainty and may have had little to do with the intensive seed processing that subsequently characterizes this site. Crater Middens was clearly in use by 0 B.C./A.D. and was probably by then a permanent or semipermanent village. It may have been used as early as 2200 B.C., almost certainly on a more temporary basis since there is only scanty evidence of this early occupation, certainly not enough to warrant the inference that it was at this time a base camp.

FUNCTIONAL RELATIONSHIPS

Granting that Pinyon House, Two Eagles, and Crater Middens are essentially Baker and Klondike phase settlements, it is not assured that all three or any given two of them were in use simultaneously during either phase as would be true had they constituted functionally complementary aspects of a single subsistence-settlement system. Of course, it is in some respects unreasonable to expect to assess this kind of relationship chronologically, firstly because this far exceeds the precision of the dating methods at our disposal here and secondly because in a more general sense such relationships can never be satisfactorily shown with temporal data, i.e., showing two sites to be fully contemporaneous would not establish a functional relationship between them. Unfortunately, in this case we have very few alternative criteria for judging this. A comparative study of stylistic patterning in ceramics or in chipped or ground stone implements is certainly out of the question given our currently limited understanding of formal variability in these artifact categories. Some more promising alternatives are discussed below.

RAW MATERIAL USE: OBSIDIAN: All three sites lie within the boundaries of an area previously identified by Bettinger (1982b) as being characterized by high frequencies of Fish Springs obsidian. He argued that this represented a prehistoric aboriginal territory equivalent in scale to ethnographic district territories of the Owens Valley Paiute (Steward, 1933: 304–305). Debitage samples from Two Eagles and Crater Middens examined as part of his study exhibited high frequencies of Fish Springs obsidian commensurate with those observed at other sites within this vicinity. This material was less common at Pinyon House yet was better represented there than glass from any other source and, as has been shown here, is the only source commonly occurring as cores. To the extent that inferences about prehistoric territoriality drawn from the sharply demarcated distribution of Fish Springs obsidian are valid, this commonality among the three sites substantially increases the probability of functional relationships between them.

CRAFT SPECIALIZATION: CHERT BIFACE PRODUCTION: Because it is of apparently limited distribution in Owens Valley, the specialized production of large bifaces made of Eureka Valley chert is another trait useful in assessing the likelihood of some sort of economic, and hence functional, tie between these sites. Evidence of this activity at Pinyon House and Crater Middens strongly supports the idea these two sites were related in this manner during the Klondike phase. Two Eagles, on the other hand, lacks any indication of this industry. If we are correct, however, this probably reflects the dearth of productive craft activity there and should not be taken as evidence that its inhabitants did not engage in this industry elsewhere.

SPATIAL AND TEMPORAL PROXIMITY: Perhaps as telling as any of the above is that with less than 16 km separating all three, if Pinyon House, Two Eagles, and Crater Middens were occupied at the same time it is almost inconceivable there would not have been some sort of functional relationship between them. The only circumstance that might preclude this would be that of intervening territorial boundaries and, as noted above, the one ethnographic boundary that seems to have been present encloses all three within the same territory. This being so, the question of functional relationships once again turns on temporal relationships, i.e., the degree of contemporaneity between these sites. We cannot offer any conclusive evidence in this

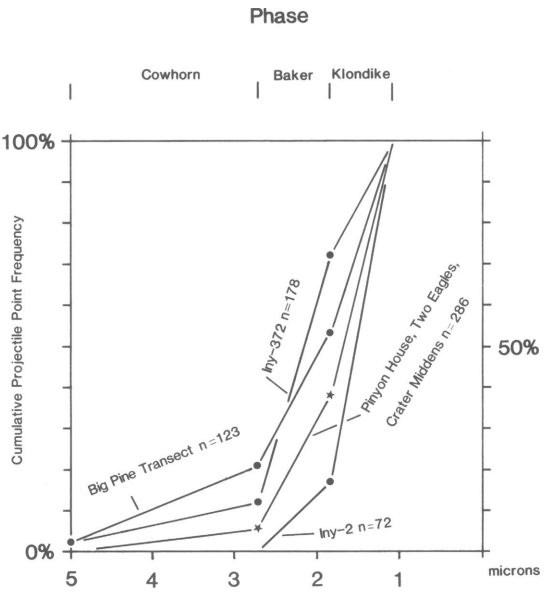

Fig. 12.1. Cumulative frequency distributions of time-sensitive projectile points by phase from Pinyon House, Two Eagles, Crater Middens, 1972 Big Pine Transect survey (Bettinger, 1975a); Cottonwood Creek (Iny-2); and Rose Spring (Iny-372). Bottom scale shows equivalent obsidian hydration measurements for Fish Springs obsidian according to the formula $Y = 800.3X - 831.2$, where X is the hydration rim measurement in microns and Y is the age of the sample in years before present (1950).

regard, but collections of time-sensitive projectile points from Pinyon House, Two Eagles, and Crater Middens tend to support the notion that they are very closely related in time and thus reasonably likely to be functionally related.

As noted in chapter 9, the proportional distribution of these artifacts is by phase virtually identical among the three sites considered in this volume. This is graphically illustrated in figure 12.1, which plots the cumulative frequency of points from these sites. Further, as noted in chapter 3, the proportional distribution of points at Pinyon House is nearly identical to that noted for pinyon camps located during the 1972 survey of the Big Pine transect. Likewise, the proportional distribution of points by phase at Crater Middens (cf. chap. 9), and in only slightly lesser degree at Two Eagles (cf. chap. 6), is quite similar to the distribution of points from Desert Scrub occupation sites found during this same survey. In other words, the history of occupation appears to be the same not only for all three of the sites excavated in this project but also for their functionally equivalent counterparts throughout central Owens Valley.

What is perhaps equally important, however, the temporal distribution of projectile points at these three central Owens Valley residential sites is perceptibly different from the distribution obtained by the 1972 surface survey of the Big Pine transect, the cumulative frequency curve for which is also shown in figure 12.1. It is likewise different from the cumulative frequency curve of points obtained from the Cottonwood Creek (Iny-2; Riddell, 1951) and Rose Spring (Iny-372; Lanning, 1963) sites in southern Owens Valley, both of which are evidently lowland occupation sites (cf. fig. 12.1).

It would appear, then, that the similarities of chronology between Pinyon House, Two Eagles, and Crater Middens, and other pinyon camps and occupation sites in central Owens Valley distinguish them from sites of other kinds in the same area and from sites of similar kind in adjoining portions of Owens Valley. It is reasonable to assume that this similarity reflects the participation of these pinyon camps and lowland occupation sites within a localized subsistence-settlement system active in central Owens Valley between A.D. 600 and early historic times.

DISCUSSION: It is pointless to seek evidence of more specific functional linkage between Pinyon House, Two Eagles, and Crater Middens—to ask, in effect, whether they were used by the same people. Indeed, this can seldom be demonstrated satisfactorily with archaeological data and certainly not with the kind of data we have here. Given their spatial proximity, degree of contemporaneity, similarity in raw material, and (at least in the Klondike phase) craft specializations, however, it is eminently reasonable to believe that this might be so or at least that those who occupied these sites knew each other. At minimum, it seems justifiable to assume that if the peoples who used Pinyon House did not also use either Two Eagles or Crater Middens they used other settlements of similar

kind, the same being true of the latter two with respect to each other and Pinyon House. It does little harm, therefore, to summarize the functional roles played by these sites as though they had been used by the same people as part of one system, understanding that this is a heuristic device and not demonstrated archaeological fact. We term this hypothetical entity the Crater Middens subsistence-settlement system. We will assume that this system operated within the 750 km^2 section of central Owens Valley (Bettinger, 1982b) distinguished by sites with distinctively high frequencies of Fish Springs obsidian comparable to those characterizing Pinyon House, Two Eagles, and Crater Middens. We would further expect that, as in late precontact times, this territory was probably shared between several such systems each centered at a lowland village similar to Crater Middens (cf. Steward, 1933).

CRATER MIDDENS SUBSISTENCE-SETTLEMENT SYSTEM (A.D. 600—Historic Period)

As the name suggests, we would have Crater Middens be the permanent central and most important place in this imaginary subsistence-settlement system. The core group of this system, consisting of perhaps 30 individuals divided among six families, normally occupied this settlement virtually yearround, using it as a focal point for plant and animal procurement and resource storage from spring through fall and as their usual place of winter residence. It was, further, the basic location in which virtually the whole range of craft production occurred and, hence, the place from which raw materials for craft production were sought and to which these materials were more or less continuously imported. This craftwork was undertaken in greatest volume during the winter and on a regular but less predictable basis during the remainder of the year. The bulk of this effort was directed toward the production of personal gear and household furniture, but during the Klondike phase some men, perhaps specialists, engaged in the production of large chert bifaces for trade.

It is difficult to estimate the proportion of the diet obtained by hunting and gathering from this base settlement, but a reasonable guess would be that these activities accounted for at least half of the lowland plants and large vertebrates and substantially more than half of the small vertebrates consumed annually. Of the lowland plants both seeds and roots were important, the bulk of them evidently being obtained from dryland, rather than wetland, habitats. Small vertebrates presumably obtained by bow and arrow, snares, and less frequently by communal drives, were evidently more common elements of the diet than large vertebrates, which were presumably obtained by individual hunters and infrequently by communal drives. River shellfish were also consumed in small quantity.

The remaining portion of lowland plants and substantial numbers of both large and small vertebrates were obtained from temporary lowland camps established during the warm season by individual families taking advantage of resource concentrations some distance from Crater Middens. Many of these camps lasted only a day or two and were seldom reoccupied in consecutive years. Locations typically favored with abundant resources locally or strategically placed for the procurement of such resources were, however, visited more frequently, for longer periods, and at least occasionally by groups larger than the nuclear family.

Two Eagles, a little more than 11 km northeast of Crater Middens, was one such place. Perennial springs presumably made this spot an ideal base for hunters and gatherers engaged in resource procurement in the arid foothills of the Inyo Range east of Crater Middens. Multiple rude pole-and-brush structures show it was occupied by groups varying in size from one to as many as five nuclear families for periods subtantially longer than was the ordinary temporary camp.

As its artifactual assemblage illustrates, plant procurement was of overriding importance. Seeds gathered in quantity here, and perhaps in the course of overnight trips made to other places nearby, were only lightly processed to prepare them for transport back to Crater Middens, where they were stored for winter use. Hunting was a regular activity but hunters here were in a sense disadvantaged from the start because Two Eagles was itself

located in precisely the choicest spot for ambushing game.

Since resource procurement was the principal motivation for occupying this site, only tools for which a need was foreseeable were brought along and very little raw material was imported for making new ones. What little craft production took place during periods of spare time centered on equipment maintenance and repair. Such careful planning and economizing was, of course, central to the success of such expeditions but it also had its price: on some occasions seed procurement so delayed departure from Two Eagles that tools and material stocks brought as personal gear were exhausted well before the return trip to Crater Middens, where they could be replenished from caches.

It is reasonable to assume that while in residence at Two Eagles, some hunters seeking deer daily worked their way eastward into the Inyo Mountains, perhaps as far as the site of Pinyon House, which is a little more than 5 km to the northeast. The opportunity to gauge the condition of the ripening pinyon crop was undoubtedly an important benefit of these trips. By early fall, scouting reports obtained in this manner and from individuals traveling to and from villages east of the Inyo Range allowed for a reasonably accurate estimate of the size, whereabouts, and date of maturation of the pine nut crop.

At Crater Middens, this information was matched against the quantity of food that had been set aside against winter needs and, with allowances for lowland resources still to be taken, a decision was made regarding whether there would be any attempt to collect pine nuts, where this would be done, and how long residence would last at the pinyon camp. Planning of this sort dictated the kind and quantity of gear that would be carried to harvest locations. Pinyon House, a little more than 16 km northeast of Crater Middens, was evidently favored as a location for the procurement of nut crops in the lower reaches of the very northern end of the Inyo Range. Resident groups traveling here from Crater Middens might have ranged anywhere from one to three or more nuclear families and may have been joined by related families from nearby lowland villages in central Owens Valley.

The unreliability of pine nut production by individual groves (cf. Thomas, 1973) assures that Pinyon House went unoccupied in the majority of years and that when residence did occur it normally terminated with the end of the harvest, lasting from as little as four to as many as ten weeks, the latter being unusual. This pattern would characterize years when the nut crop was comparatively small or lowland food stores comparatively large. At these times as much of the crop as could be conveniently transported was probably moved to Crater Middens and the rest left at Pinyon House to be retrieved later that winter or in the following one.

When occupation was kept short in this way, temporary structures—the circular brush windbreak or simple lean-to—sufficed for shelter and privacy. It is reasonable to assume, however, that in addition to these makeshift affairs any lodges left standing from previous occupations might have been cleaned out and used.

During even the shortest of these occupations hunting was probably a part of the daily routine for men. Apart from this, however, and a little craftwork—primarily tool repair, the bulk of productive effort centered on the gathering and processing of the nut crop.

With longer occupations more effort was expended in hunting and, in more pronounced degree, craftwork. This was most noticeable in years when the pinyon crop was comparatively large relative to the quantity of food stored at Crater Middens. Occupation would then have lasted as far into the winter as nut caches would allow and at least sometimes into spring. The more sturdy conical or gabled lodges at Pinyon House were used on these occasions. Hunting must have taken on greater importance at these times as a means to stretch cached food that might be needed later in the winter. Further, craftwork that would normally have been done during the slack winter period at Crater Middens—the making of new and the repairing of old gear—was in these years done at Pinyon House, the necessary tools and raw materials having been brought there from Crater Middens in anticipation of this winter-long occupation. As at Crater Middens, at least part of this craftwork included the production of large chert bifaces intended for trade.

As winter ended, any remaining inhabitants at Pinyon House, abandoned that settlement and moved to Crater Middens to begin the annual cycle of hunting and gathering.

TEMPORAL CHANGE: Except for the specialized biface production that appeared during the Klondike phase at Pinyon House, neither that site nor Two Eagles provides any detectable evidence of change in function during the principal periods of occupation from A.D. 600 to historic times. This may only reflect our limited control over time in these assemblages. Alternatively, it is thinkable that pinyon procurement of the kind represented at Pinyon House and seed procurement of the kind represented at Two Eagles did not allow for a great deal of functional variability beyond the range of situational alternatives we have noted for these sites.

In contrast to Pinyon House and Two Eagles, there is at Crater Middens evidence of at least one far-reaching functional change that affected not only this site but the basic structure of what we have termed the Crater Middens subsistence-settlement system. This change, which took place during the Klondike phase, was signaled by the more frequent use of Crater Middens as a base of plant and animal procurement and, by inference, the less frequent use of smaller, more temporary settlements for those purposes. With the growing role of Crater Middens, settlement patterns became more centralized and exploitative patterns more intensive. A slight decrease in the use of large vertebrates observed in the faunal remains and a slight increase in the use of seed plants observed in macrofossils extracted by flotation seem to reflect this change. A more dramatic increase in the amount of *Anodonta* shell and the appearance of light, portable schist millingstones are also evidently related to this shift. As explained in chapter 11, the schist millingstones suggest greater centralization in settlement patterns, the *Anodonta* shell either settlement centralization or more intensive use of local resources.

The transformation of the Crater Middens subsistence-settlement system was probably not an isolated phenomenon. It is better regarded as indicating that by the beginning of the Klondike phase the aboriginal population living within Owens Valley had grown so dense that the amount of foraging space available to groups residing in lowland villages was small enough to be readily accessible from those villages, thus decreasing the utility of more temporary settlements. At least some more distant resources, however, still required the use of ancillary settlements. In the case of Crater Middens these included Pinyon House and Two Eagles and probably other pinyon and seed procurement camps.

As the Crater Middens subsistence-settlement system and others like it grew more centralized and their exploitative patterns more intensive, they also grew more vulnerable to fluctuations of resource availability, particularly if they were operating within the smallest and least productive tracts of land. It is possible that regularized exchange relationships involving transactions of food for fixed-value bead money, which offered a means of compensating for this, originated at this time. Subsistence-settlement systems of the preceding Baker phase, however, were also comparatively centralized and therefore also vulnerable to such fluctuations. Thus it is more probable that this form of exchange first developed in the Baker phase and simply grew more important as centralization and intensification proceeded during the Klondike phase. It seems clear in any case that the cumulative effect of these processes was more strongly felt in the Klondike phase, for it was then that some individuals at Crater Middens began to manufacture chert bifaces for trade, presumably to offset chronic shortfalls in local resource production. The production of ceramic vessels, which likewise first began during the Klondike phase, may have been another trade motivated craft specialization at Crater Middens, especially since trade seems to have inspired the highly localized emphasis on ceramic production by specialists in the vicinity of Big Pine in late precontact times.

THE PROBLEM OF OBSIDIAN HYDRATION: SYSTEMATIC ERROR OR SYSTEMIC BEHAVIOR?

Throughout this study age estimations given by obsidian hydration disagree with those given by both radiocarbon and time-sensitive artifacts: at all three sites, obsidian hydration

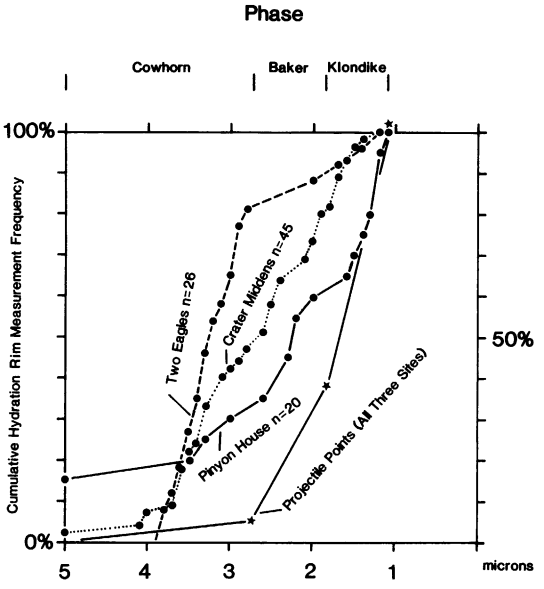

Fig. 12.2. Cumulative frequency distributions of obsidian hydration rim measurements from Pinyon House, Two Eagles, and Crater Middens, and time-sensitive projectile points by phase from all three sites pooled as shown in figure 12.1. Rim measurements are translated into calendar years according to the formula $Y = 800.3X - 831.2$, where X is the hydration rim measurement in microns and Y is the age of the sample in years before present (1950).

rim measurements suggest a chronology of occupation significantly more ancient than suggested by other evidence. This is graphically illustrated in figure 12.2, which plots the cumulative frequency curve for the hydration measurements from each site against the cumulative frequency curve for the sample of time-sensitive projectile points recovered from all three sites combined. At Pinyon House the discrepancy was laid in part to sampling error and at Two Eagles in part to fast-surface hydration rates and in part to artifact scavenging. Potential errors in the hydration rate employed were rejected as a sufficient explanation of the conflict in dating at Two Eagles. Beyond noting its presence and suggesting explanations for certain readings at odds with other evidence, no attempt was made to address the inequity of the dates at Crater Middens.

The shape of the cumulative frequency curves for the hydration dates from these sites (fig. 12.2) are such that it is unlikely systematic errors in effective hydration temperature can account for their differences. Discounting the 20 percent from each site with rims greater than 3.6 μ, the distributions have essentially a common point of origin (at 3.6 μ) and common point of termination (ca. 1.2 μ) so that a very complex transformation would be needed to bring them into line with each other.

If the problem is not in the mechanics of the hydration process, it might conceivably, be one of sampling. That is, the difference between the cumulative hydration curves might be an artifact of the manner in which the sample from each site was chosen. Sampling error, however, while it might account for some of the differences in hydration dates between sites, probably cannot explain why the dates for all three are consistently more ancient than they ought to be in view of the radiocarbon dates and time-sensitive artifacts that accompany them.

At this point, it would seem that we must concede either that our obsidian hydration dates suffer from errors of rate formula, assumed temperature, and sampling procedure in combination too complex to be straightened out or that some altogether different process is at work. With respect to the latter, it is thinkable that the hydration dates are more or less correct and that for some reason the obsidian debitage found at these sites is consistently older than the occupation of the sites themselves while still being a consequence of those occupations.

As previously suggested for Two Eagles, the scavenging of old sites for usable flakes and tools would skew hydration dates in just this way. And since scavenging ought to vary in degree according to the demand relative to the supply of tools, sites ought to differ in this respect according to their function, just as the three sites in question here, which served different functions, vary in the degree to which their hydration dates are skewed from the distribution we would expect. The question remaining, then, is whether in relative amount of skewness the distribution of hydration dates from these sites agrees with the patterns of scavenging we would expect given our understanding of the Crater Mid-

dens subsistence-settlement system and its implications for the supply of and demand for stone tools at the three different sites.

TOOL SUPPLY AND DEMAND IN THE CRATER MIDDENS SUBSISTENCE-SETTLEMENT SYSTEM: A lengthy examination of this matter is well beyond the scope of this discussion. We will examine only a few simple generalities. One of these is that, all other things being equal, we would expect stone tool supply to be highest in places of winter residence and lower in places occupied in other seasons. This is so firstly because a great deal of productive activity requiring the use of tools occurred during the winter months, in anticipation of which tools and raw material to make tools would have been stockpiled. It is so secondly because a substantial fraction of winter activity was devoted to the production of tools intended for use during the remainder of the year. This would have similar consequences with respect to tool and raw material supply.

The same kind of reasoning would also suggest that, *cet. par.*, places occupied for long periods and as residential centers would be better supplied with tools and raw materials for tools than more temporary settlements. The difference here, however, would be less pronounced than the seasonal one just noted since surplus production is not involved or is at least less important. Together these criteria would suggest tool supply was high at both Pinyon House and Crater Middens and low at Two Eagles. Being occupied for longer periods and as a spring, summer, and early fall base camp, Crater Middens would be better supplied with tools than Pinyon House. Note that these distinctions refer to supply in an absolute rather than relative sense, i.e., the total quantity of tools.

Patterning in tool demand shows many of the same relationships: places occupied in the winter, for long periods, or as base camps would have the highest demand for tools; places occupied in other seasons, for short periods, and as places of exploitation more than as places of residence have the lowest demand for tools. Assuming this is so, then both Crater Middens and Pinyon House would have had greater demand for tools than Two Eagles and demand for tools would be substantially higher at Crater Middens than at Pinyon House.

With the above in mind, consider the relationship of demand to supply at each site: supply and demand are both high at Crater Middens, both low at Two Eagles; supply is high at Pinyon House by virtue of its winter occupation but since it is not occupied at other times, demand is only moderately high. In short, of the three sites, we would expect Pinyon House to have the lowest relative demand for tools and hence the least motivation for artifact scavenging. Crater Middens and Two Eagles are both more likely to have been periodically short on tools and thus their inhabitants would have been more prone to scavenging. Further, as we have seen, periodic inequities between demand and supply are potentially greater at Two Eagles, where occupation occasionally outlasted tool supply, than at Crater Middens, where tools and raw materials were stockpiled and periodically replenished. Accordingly, we would expect scavenging to be more prevalent at Two Eagles than at Crater Middens.

If scavenging conformed to these patterns in the Crater Middens subsistence-settlement system, and if scavenging is responsible for the observed anomalies in obsidian hydration dating for Pinyon House, Two Eagles, and Crater Middens, we would predict that the cumulative frequency curve for hydration dates from Pinyon House would most closely conform to the curve suggested by other sources of information. The curve for Two Eagles would least closely conform to this curve and the curve for Crater Middens would fall somewhere between those two. These are precisely the relationships shown in figure 12.2. There is at least some reason, then, to believe that our difficulties in using obsidian hydration arise not from problems of sampling nor from problems with the method itself but from incorrect assumptions about the nature of aboriginal technology, in particular the extent to which it relied on scavenged material.

MORE ON SUPPLY AND DEMAND: TOOL COMPLETENESS

Of late, a great deal of effort has been expended in the development of standardized archaeological measures useful in distinguishing settlement categories of widely vary-

ing types (Thomas, 1983; Chatters, 1985; Kelly, 1985). In many of these, the importance of the relationship of tool supply and tool demand is clear, or at least implied. The very basis of forager/collector dichotomy of Binford (1980), for example, can be seen as an argument about where and under what conditions tools are made relative to where they are used. This explains the signal importance Binford assigns to curation and caching. To the extent that scavenging is determined by the relationship between tool supply and tool demand, it should be useful in making this kind of categorical distinction between settlement types. The presence and degree of scavenging, however, is often difficult to establish. We would not, for instance, have been led to suspect the degree of the practice apparently found here without the accompanying study of obsidian hydration, which was undertaken for an altogether different purpose and would not have been undertaken at all had not obsidian been present. An alternative measure of this supply/demand relationship would, thus, be useful. In the present case, it would further serve as an independent test of the proposition that scavenging accounts for the anomalies in obsidian hydration dating.

We have noted several times that some tool categories found at these sites are dominated by trash: pieces no longer useful for their original purpose. At the same time, at each site there are generally at least a few more complete items representing these same categories: pieces still useful for the purpose originally intended. It is logical to assume that the ratio of trash to useful items at any site, including the ones here, ought to be a function of the relationship of supply and demand and therefore vary predictably between sites of different kinds depending on their situation with respect to tool demand and tool supply.

The principal obstacle in making assessments of this kind, of course, lies in the means for distinguishing useful items from trash. That items may vary in the degree to which they are trash, i.e., in terms of their amount of remaining utility, further complicates the matter. The approach here is a very simple one: artifacts retain utility in direct proportion to their completeness. An intact item is far more likely to be useful than one that is a small fragment of the original it represents, and the more fragmentary it is, the less useful it is likely to be.

Artifact weight would be one way of measuring this. Simply put, we might argue that a site characterized by lower mean weights of chipped stone artifacts retains less utility than one with higher mean weights. Since it is reasonable to assume, however, that within one tool category the mean weight of wholly intact items might vary vastly with site function, weight is less useful when considering the relative utility remaining in assemblages of widely varying kind.

An alternative possibility is to treat completeness more qualitatively. We might argue, for instance, that for most categories of chipped stone, items that can be measured for length, width, and thickness are more complete than those that can be measured for only width and thickness, which are, in turn, more complete than those that can only be measured for thickness. Were the situation as simple as this, a straight-forward calculation of the proportion of items measurable for length, width, and thickness to those measurable for width and thickness (but not length) and those measurable only for thickness would roughly measure the amount of trash in a given category of chipped stone.

However, this approach does not readily accommodate certain kinds of fragments: it is clear that an artifact measurable for width and thickness will generally be more complete than one measureable for only thickness but not so clear whether it is more complete than one measurable for length and thickness or length alone (the remaining possibility—a tool measurable for length and width but not thickness—seems highly unlikely). One could solve this by calculating the proportion of the original represented by a fragment, but this would be difficult in many cases. More to the point, such information is not widely available for many extant studies, including this one, and not likely to be collected except in rare circumstances where the situation specifically calls for it. We opt here for a more practical, if somewhat less pure, measure relying on data more commonly collected and reported in the archaeological literature.

This measure requires only that we make

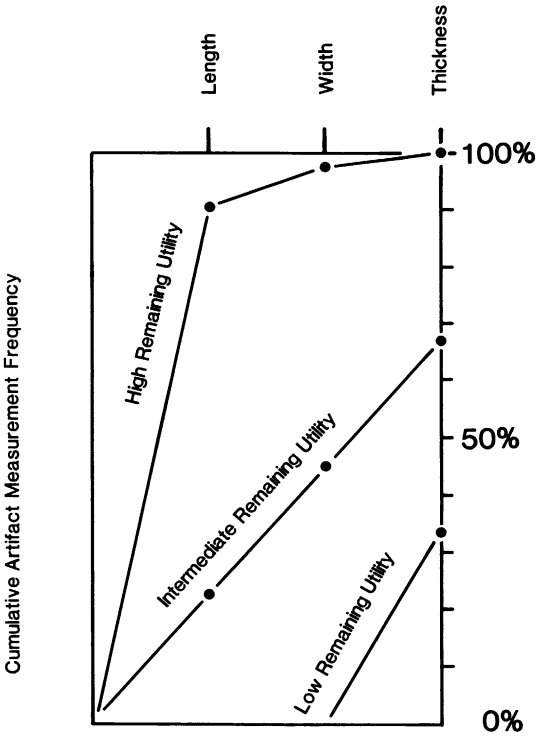

Fig. 12.3. Hypothetical completeness curves for an assemblage with high remaining utility, an assemblage with low remaining utility, and an assemblage that is intermediate in this respect.

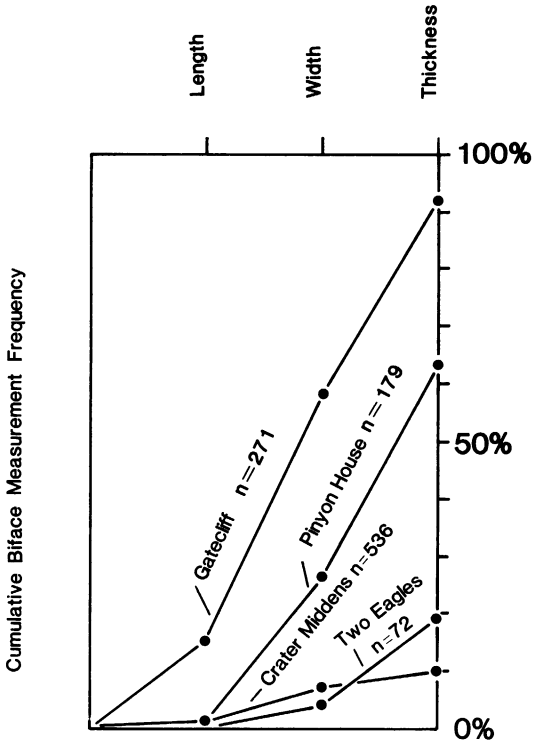

Fig. 12.4. Cumulative completeness curves for bifaces from Pinyon House, Two Eagles, Crater Middens, and Gatecliff Shelter.

certain reasonable assumptions about the completeness of fragments measurable for certain dimensions: that items measurable for length are likely to be measurable for width and thickness also, and that items measurable for width are likely to be also measurable for thickness. As we noted as a possibility above, any large collection of stone tools generally includes at least some specimens that defy these expectations: specimens measurable for length but not width, and so on. In the main, however, most specimens of most categories in most collections follow the expected pattern. This is why it is nearly always true that more chipped stone artifacts of any given category can be measured for thickness than width and for width than length (this is true of all the major chipped stone tool categories from the sites considered here, for instance).

Presuming that artifact dimensions are related to completeness in this manner permits us to draw for any given category a cumulative frequency curve of completeness in which the proportion of items measurable for length is at the left end of the curve, followed by the proportion of items measurable for width and, successively, thickness, and finally in which the proportion of items not measurable at all is at the right end of the curve. The amount of utility remaining (or vice versa, the amount of trash) in a collection of tools of given kind may be said to be measured by shape of this curve. In other words, an assemblage for which most items are measurable for length, width, and thickness retains more utility (contains less trash) than one in which only some items are measurable only for thickness and successively fewer still for width and thickness, which in turn retains more utility than one in which only some items are measurable for thickness. These hypothetical relationships are illustrated by completeness curves in figure 12.3.

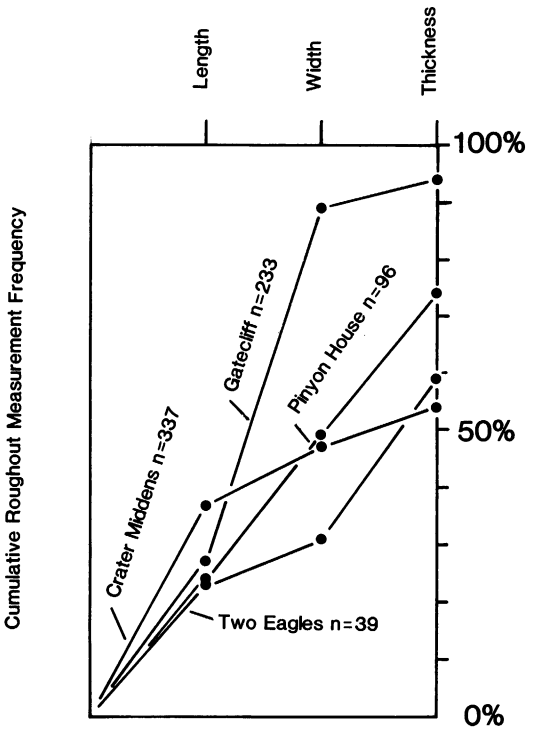

Fig. 12.5. Cumulative completeness curves for roughouts from Pinyon House, Two Eagles, Crater Middens, and Gatecliff Shelter.

Since the utility remaining in an assemblage is inversely correlated with the ratio of tool demand to tool supply—the lower the demand, the more utility left unused—then, provided we have correctly characterized the demand/supply ratios for Pinyon House, Two Eagles, and Crater Middens, their curves ought to mirror the patterns of scavenging we have inferred from obsidian hydration because scavenging, too, is directly related to demand/supply ratios (but directly rather than inversely). We confine our analysis here to just two categories, bifaces and roughouts, that are reasonably well-represented across all three sites and which, owing to their manner of use, should be sensitive to shifting demand/supply ratios. The cumulative completeness curves for both categories at each of the three sites are shown in figure 12.4 (bifaces) and figure 12.5 (roughouts).

The completeness curves for bifaces conform almost exactly to our expectations regarding demand/supply ratios at the three sites. As predicted, the utility remaining in this category is much higher at Pinyon House than either Crater Middens and Two Eagles, which are virtually identical in this respect. The suggestion that remaining utility should be somewhat higher at Crater Middens than Two Eagles is not supported by these data, perhaps because demand far outstripped supply at both sites. For all three sites the completeness curve for bifaces is lower than the completeness curve for roughouts. This would appear to follow from the proposition that finished bifaces are more useful than roughouts, which may or may not eventually prove workable into useful tools. Accordingly, bifaces ought to be more exhaustively reworked and recycled than roughouts. Thus it might be argued that for a given site the amount of utility remaining in its bifaces might be equivalent to the amount of utility remaining in its roughouts even though the completeness curves for the two categories would be different.

The completeness curves for roughouts show a pattern similar to that of bifaces: the remaining utility for this category is again higher at Pinyon House than at either Crater Middens or Two Eagles. In this case, however, all three curves exhibit rather different trajectories, hinting that something more than simple utility might be involved. Of particular interest, note firstly that the curve for Crater Middens is steeper initially and flatter subsequently than the curve for Pinyon House. Note also that the curve for Two Eagles is identical to that for Pinyon House in the first and third segments and identical to that of Crater Middens in the second and fourth segments.

If they are to be trusted, these contrasting curve trajectories suggest our three sites differ with respect to the amount of utility remaining in roughouts depending on their degree of completeness: there is apparently more utility remaining (and hence lower demand with respect to supply) in whole than fragmentary specimens at Crater Middens. At Pinyon House, on the other hand, utility does not seem to vary with degree of completeness (i.e., its curve is straight) and is therefore less for complete specimens and greater for incomplete specimens than at Crater Middens. The curve for Two Eagles is a mixture of the

curves for Pinyon House and Crater Middens. It shows lower utility in the most complete specimens (those measurable for thickness) than Crater Middens, and lower utility in specimens of intermediate utility (those measurable for width) than Pinyon House.

These relationships make sense if it is recalled firstly that Crater Middens is much closer than either Pinyon House or Two Eagles to the source of Fish Springs obsidian, from which the vast majority of these roughouts were made, and secondly that all roughouts carried to Pinyon House and Two Eagles were probably brought from Crater Middens, the staging area for trips made to those sites. As the place at which small blocks of material were initially worked into roughouts, Crater Middens should be characterized by higher frequencies of rejects considered unworthy of any further attention. This explains the higher frequencies of complete roughouts at Crater Middens than at either Pinyon House or Two Eagles: only pieces considered of at least marginal utility were carried to the latter two. Thus it is not in fact greater utility but actually lower utility that is represented by the large proportion of complete roughouts found at Crater Middens.

Turning to the incomplete roughouts, there is clearly greater utility remaining in those found at Pinyon House than those found at Crater Middens, which is in accord with the lower demand/supply ratio we have argued characterizes the latter relative to the former. As we would also expect given its relative high demand/supply ratios, in specimens measurable for width Two Eagles exhibits about the same amount of utility as Crater Middens. Curiously, Two Eagles exhibits greater utility than Crater Middens in specimens measurable only for thickness, which is not as we would expect. Presuming it is not a quirk of sampling (a possibility here since the sample of roughouts from Two Eagles is relatively small, $n = 39$), one plausible explanation for this is that beyond some point the reduction of roughouts into tools was undertaken only under specific circumstances to meet rather specialized needs. It is thinkable, in other words, that the small pieces into which roughouts could be broken were useful in a particular task or tasks that occurred at Crater Middens but not Two Eagles.

DISCUSSION AND IMPLICATIONS: Throughout this volume and especially in this last chapter much of our analysis has been couched in terms of the subsistence-settlement system, particularly the imaginary Crater Middens subsistence-settlement system and roles played by Pinyon House, Two Eagles, and Crater Middens in that system. As perhaps is natural, in the course of these discussions we have often referred to these roles in terms of the specific settlement type each site might represent, as though our interpretive problem was principally one of site taxonomy. Nothing could be farther from the truth. Nevertheless, it is somehow easier to envision the complex processes at work in any adaptive system in terms of concrete entities (settlement categories, for instance) that capture some of the more salient qualities of the processes in which we are interested than to deal with those processes solely as abstractions. This exacts a heavy cost in particularization, i.e., it necessarily draws attention away from general processes and toward particulars.

To some extent, this kind of particularizing is useful—essential, in fact. All the same, it is essential not to lose sight of the more general processes responsible for the formation of specific archaeological assemblages.

The establishment of working linkages between such general processes and specific assemblages is, in modern parlance, the work of midrange research. Our concern here with the relationship between tool supply and tool demand is in pursuit of drawing the archaeology of Pinyon House, Two Eagles, and Crater Middens into this larger arena of general midrange processes. To do so, we have tried to show how relationship of supply and demand can vary within a specific subsistence-settlement system, to show how this can be measured objectively by noting degree of scavenging and by means of completeness curves, and to show how it might affect certain categories in unsuspected ways (as in the relationship between scavenging, age-composition in debitage, and obsidian hydration dating).

This line of inquiry is not entirely without benefit when it comes to particularizing interpretations: the measures developing out of it are clearly useful in making distinctions

between various settlement categories established previously for Owens Valley and central eastern California (cf. Bettinger, 1982a). Nonetheless, the advantage of these measures lies in their generality, particularly in their potential for comparative application.

To illustrate this potential using the completeness curve developed here, consider this curve when drawn for bifaces and roughouts at the central Nevada site of Gatecliff Shelter (Thomas, 1983). Since the categories defined by Thomas for that assemblage are not identical to the ones defined here, to do so we must merge the Gatecliff *roughouts* and *rough percussion blanks* to obtain a grouping similar to our *roughouts* and merge his *fine percussion blanks, pressure flaked bifaces,* and *finished bifacial knives* to obtain a grouping similar to our *bifaces.* The completeness curves drawn for these groupings at Gatecliff (figs. 12.4, 5) are substantially higher than for the corresponding categories at any of the three sites in Owens Valley. We may presume from this that the amount of utility remaining in the Gatecliff assemblage is substantially higher than at any of the Owens Valley sites. Note also that despite this, the remaining utility represented by the complete Gatecliff roughout (sensu this study) is comparable to that for the same category at Pinyon House and Two Eagles. The latter would suggest that, as at those sites, the majority of roughouts recovered at Gatecliff had been brought there from another site, where expeditions to Gatecliff were staged, where supplies of raw material were initially worked into roughouts, and where unpromising roughouts were discarded. This interpretation is for the most part compatible with Thomas's characterization of the lithic industry at Gatecliff and with his interpretation of the role of that site in a larger settlement system.

Turning to the unusually high utility that overall characterizes the Gatecliff bifaces and roughouts, it is improbable that this is purely an effect of demand/supply, although that might be involved in some degree. More likely it reflects the depositional regime at Gatecliff, which periodically covered the site with talus, rooffall, and silts, removing the opportunity to scavenge material from all the assemblages deposited prior to each such event. To the extent that this explains the difference between the completeness curves for Gatecliff and those for our Owens Valley sites, which were not subject to the same depositional process and thus more subject to scavenging, it is a measure of the extent to which scavenging must have characterized all hunter-gatherer systems in the Great Basin and presumably other parts of the world as well. Note that this scavenging is not the kind in which a group returns to scavenge its own debris, or even the debris of the preceding generation. Given the inferred periodicity of debris flows at Gatecliff, it can be inferred that scavenging would have had to occur over periods generally longer than 200–300 years to account for the difference in utility remaining in the assemblages found at that site and those found in Owens Valley. In other words, these data suggest that once formed, archaeological sites become a kind of natural resource used by succeeding generations of hunter-gatherers long into the future. The implications of this for the interpretation of archaeological assemblages are clear: long-term scavenging is likely to have affected the composition of many, perhaps most, archaeological assemblages, particular where soil development is comparatively slow.

IMPLICATIONS FOR EARLIER MODELS

Over the past 14 years, I have frequently written about the prehistoric human ecology of Owens Valley and in doing so have set down on paper some rather specific propositions regarding the nature and timing of certain adaptive changes that seem to have occurred there. Some of these were developed largely on the basis of theory (Bettinger and King, 1971); others sought to account for evidence collected during the course of our surface surveys in the Big Pine transect. I undertook the excavations reported here as a means of testing the viability of these various propositions and it is now time to evaluate them in light of evidence that has been presented.

In a large sense, it is not only interpretations of Owens Valley prehistory that are at issue, but also a very popular and evidently successful program of archaeological research in which surface surveys figure prominently

as a means of studying regional prehistory. Surprisingly, central Owens Valley is one of the few places in which surface survey and model-building has been followed by excavation to verify the conclusions developed from surveys. Perhaps this is because the process is terribly costly in time and effort and because it is difficult to maintain interest in any small area long enough to accomplish the necessary research. In any case, out of the existing literature that deals with Owens Valley, five propositions seem crucial.

PROPOSITION ONE: STABILITY IN BASIC ADAPTIVE PATTERN THROUGH TIME: An initial conclusion drawn from the surface survey was that in basic structure, prehistoric adaptation in Owens Valley had not changed over the period for which data were available. By this it was meant that between 3500 B.C. and historic times lowland base camps had been the center of most activity year-round and that lowland plants and animals—the plants more than the animals, had dominated the diet. This was envisioned to contrast with an alternative subsistence pattern in which pinyon camps and the pine nut were more important, as they seem to have been in the Reese River of central Nevada, for example, or to one in which the settlement pattern was less permanent and more mobile, as the one in Reese River seems to have been. This did not mean, as some were inclined to believe, that no change had occurred, only that such changes had not affected the permanency of settlement and the basic nature of subsistence. The data presented here are largely silent on this matter, yet for other reasons the proposition no longer seems viable and it is worth explaining why.

Two sites, Stahl (Little Lake; Harrington, 1957) and Rose Spring (Lanning, 1963), figured heavily in the interpretation of settlement stability in the Inyo-Mono region between 3500 B.C. and A.D. 600. It was argued that both were permanent villages similar in function to the one inferred here for Crater Middens. It now seems equally probable, if not more probable, that both are simply base camps seasonally occupied by groups that freely foraged over a wide area at other times of the year. In short, they are probably not of the same kind as Crater Middens.

Without Stahl and Rose Spring, the argument for stability in settlement patterns in Owens Valley between 3500 B.C. and A.D. 600 rests largely on two surface sites located in the Big Pine transect. The dating of these sites by time-sensitive artifacts and obsidian hydration rim measurements is quite tenuous, all the more so given the weight of interpretation they must bear when Stahl and Rose Spring are discounted. If they too are discounted, it cannot be argued that Owens Valley settlement patterns in the interval 3500 B.C. to A.D. 600 resembled the more sedentary ones that followed. The more reasonable argument (Bettinger et al., 1984b) would now portray settlement patterns prior to A.D. 600 as more mobile and less settlement-tethered than thereafter. This would be consistent with other evidence, e.g., Bettinger and Baumhoff (1982) in keeping with the idea of more freely ranging groups. It would indirectly imply at least some differences in subsistence patterns as noted by Bettinger and Baumhoff (1982), in particular a more important role for large game and preferred plant resources earlier in time. Both of these changes, however, had been suspected on the basis of evidence accumulated in the surface survey.

PROPOSITION TWO: LOWLAND VILLAGES SHIFTED LOCATION FROM RIVERINE TO DESERT SCRUB SETTINGS BETWEEN 1200 B.C. AND A.D. 600: Because this proposition implies that settlement patterns remained basically unchanged and merely shifted position at this time, it is probably false for reasons just noted. Discounting this implication, the proposition would hold that a settlement system of the ethnographic type localized around large permanent villages in Desert Scrub settings first appeared sometime between 1200 B.C. and A.D. 600 (the earlier date was wrongly cited as 1500 B.C. in Bettinger, 1977a). As we have seen, Crater Middens clearly supports this latter, modified proposition. That the same change in settlement pattern may characterize other parts of Owens Valley is suggested by Iny-2 (Riddell, 1951) and Iny-30 (Basgall et al., 1986), two major villages in Desert Scrub settings in southern Owens Valley. Both appear to have been occupied intensively for the first time sometime after 1200 B.C. and probably after A.D. 600. Likewise, all three villagelike settlements that have been excavated in Long Valley (Basgall, n.d.;

Jackson, 1985; Burton, 1985) seem to have been established around A.D. 600, suggesting that this same settlement shift may extend beyond Owens Valley to adjacent portions of the Inyo-Mono region.

Quite clearly, more than a simple change in settlement patterns is indicated by these data. Given their prior absence in the archaeological record, the appearance of permanent or semipermanent villages between 0 B.C./A.D. and A.D. 600 suggests that seasonal movements had become more spatially confined and therefore that resource use had become more intensive within smaller local areas.

PROPOSITION THREE: INTENSIVE PINYON PROCUREMENT BEGAN AFTER A.D. 600 IN CENTRAL OWENS VALLEY: This was perhaps the most unexpected and certainly one of the most controversial conclusions arising from the surface survey of the Big Pine transect. For many, the pine nut was so important to Great Basin subsistence in ethnographic times it was scarcely conceivable that aboriginal survival would have been possible without it. For others, the weight of our surface evidence was insufficiently convincing given the implications of the argument, which, as noted above, was at odds with the received wisdom.

Only hinted at in earlier works (e.g., Wissler, 1922; Kroeber, 1939), the pivotal conceptual importance of the pine nut to theories of Great Basin adaptation clearly originated with Steward, for whom this plant captured all the essential qualities of the Great Basin environment. The unpredictability (and, paradoxically, occasional superabundance) of the pinyon crop was used to illustrate among other things, his explanations for seasonal transhumance (1938a: 20), the absence of social ties beyond the nuclear family (1938a: 233), and the lack of land ownership (1983a: 254) in the Great Basin.

Against this background, the suggestion that the pine nut had remained relatively unimportant in central Owens Valley until perhaps A.D. 600–1000, was neither well received nor widely believed. The data, however, allowed no plausible alternative interpretation. It was reasonable enough to argue that central Owens Valley might be somehow unusual in this regard or that we had simply succeeded in drawing an unrepresentative sample. All the same, the data indicated that in comparison to sites of other kinds occurring in the Inyo Mountain uplands, principally temporary hunting camps, pinyon camps were young; none could be shown on the basis of our evidence to predate A.D. 600.

To the extent that Pinyon House is representative of other pinyon camps in central Owens Valley, this proposition is supported. True, the occupation of Pinyon House may have begun as long ago as A.D. 300, but this is only slightly older than the date originally proposed and the age of the sample in question (UCR-1108) may not in fact represent the initial occupation of the site but only the death of a tree later used in one of the first structures built there.

As noted, various sources of evidence support this proposition elsewhere in the Inyo-Mono region (Bettinger, 1982a). In addition to these, recent surface surveys as nearby as Deep Springs, just east of the Big Pine transect (Michael Delacorte, personal commun.) and as far away as the Walker River (David Rhode, personal commun.) and the Mono Basin (Pippin, 1980) have lent further weight to what is quite clearly a regional, rather than local, pattern (but see Hall, 1983: 219).

Two recent developments make the latency of pinyon procurement in central Owens Valley seem less of an anomaly than when first we proposed it. For one, we now know the singleleaf pinyon pine (*P. monophylla*) migrated to many parts of the Great Basin only recently. That human occupation of the Great Basin in many places preceded the appearance of the pinyon pine by several thousand years makes it easier now to accept the idea of lifeways not dependent on it. Of course, this has little direct bearing on the tardiness of pinyon exploitation in central Owens Valley, where the pinyon pine was present long before aboriginal groups used it intensively. Recent theoretical developments, however, have made this, too, more understandable. In particular, models of hunter-gatherer subsistence and settlement (e.g., Bettinger, 1980c; Bettinger and Baumhoff, 1982) firmly grounded in microeconomic theory have shown how exploitative patterns—specifically the number and kind of items included in the diet—are likely to shift in response to changes in the abundance of preferred resources, i.e., re-

sources the caloric return of which is high relative to caloric investment. These models suggest that as the abundance of these resources declines less preferred resources are likely to be included in the diet. Thus, it is reasonable that the appearance of intensive pinyon procurement in central Owens Valley around A.D. 600 marks the point at which growing populations or diminishing resources made it economically feasible for aboriginal groups to engage in pinyon procurement (cf. Bettinger, 1976; Bettinger and Baumhoff, 1983).

PROPOSITION FOUR: THE IMPORTANCE OF LARGE GAME DIMINISHED IN THE DIET AFTER A.D. 1000: This derived from the observation that temporary camps evidently used for hunting showed little evidence of having been occupied after A.D. 1000. From this it followed that thereafter hunting had been generally staged from base camps (lowland villages and pinyon camps). A pattern of this kind would have made deer and mountain sheep relatively less accessible during the warm season and the proportional contribution of these taxa to the diet would have shrunk accordingly. The inference was consistent with ethnographic accounts that suggested large game had been a relatively minor component of the diet and that hunters most often worked out of villages or pinyon camps (cf. Steward, 1933: 239; 1934: 429; 1938b: 191–192).

The only relevant evidence generated in this study is the decrease in the ratio of debitage to chipped stone implements noted during the Klondike phase at Crater Middens. This implies greater centralization of activity at that site and consequently more intensive use of the resources in the surrounding area. Floral and faunal remains recovered at Crater Middens lend at least some support to this idea. Other evidence consistent with this phenomenon as it pertains to patterns of hunting specifically can be found in Bettinger (1982a). In combination, the data presently in hand strongly support the argument as originally presented.

As with the pinyon procurement, it can be argued that the shift in hunting patterns was the result of declining resources or increasing populations that made long hunting treks less economical than they had once been (Bettinger and Baumhoff, 1982). The explanation originally offered, that curtailment of long-distance hunting was demanded by large-scale irrigation which competed for labor during the summer months, remains a possibility. We have yet, however, to generate any substantive information regarding the antiquity and extent of the practice anywhere in Owens Valley (but see Lawton et al., 1976). Since we might regard irrigation itself as a response to dwindling resources or growing population, whether that specific practice or the more general phenomenon of relative resource scarcity caused hunters to restrict their seasonal movements to the vicinity of base camps is perhaps academic.

PROPOSITION FIVE: THE LATE PREHISTORY OF CENTRAL OWENS VALLEY (3500 B.C. TO HISTORIC TIMES) IS CHARACTERIZED BY INCREASINGLY INTENSIVE PATTERNS OF RESOURCE USE: For reasons that have been explained, at least four prehistoric developments noted above lend support to this general proposition directly or indirectly: (1) the appearance of such permanently occupied lowland villages as Crater Middens in the Desert Scrub community of central Owens Valley between 0 B.C./A.D. and A.D. 600; (2) the inception of pinyon procurement at about A.D. 600, documented by Pinyon House and other pinyon camps in central Owens Valley; (3) the curtailment of long-distance hunting sometime after A.D. 1000 and A.D. 1300; (4) increased tool/waste ratios at Crater Middens after A.D. 1300.

In addition to these, in the sense that it necessarily implies greater localization in plant procurement, the appearance of such seed camps as Two Eagles around A.D. 600 is also suggestive of settlement centralization and subsistence intensification. Likewise, at Crater Middens the developing industry in chert biface production, the growing presence of shellfish, and the appearance of highly portable schist millingstones in different ways all underscore the same trend at about A.D. 1300.

The period between A.D. 600 and 1300, then, saw radical changes in settlement and subsistence patterns in central Owens Valley. To the extent that we understand them, earlier settlement patterns probably involved greater seasonal mobility and were far less

centralized (cf. Bettinger et al., 1984b) and earlier exploitative patterns were probably less intensive and more reliant on large vertebrates and a more carefully selected suite of plants. This implies that with respect to the resources available, regional population was at this time low enough that groups were able to circulate freely between resource concentrations within Owens Valley and probably adjacent areas as well. Accordingly, as local resources were consumed, it would have been more profitable to shift residential location than remain in place and exploit the better resources in diminishing quantity or the more abundant but lower quality ones still untouched.

A fundamental restructuring of these patterns at A.D. 600 is signaled by the appearance of such large lowland villages as Crater Middens, such pinyon camps as Pinyon House, and such centralized seed procurement stations as Two Eagles. All three settlement categories denote a more spatially restricted pattern of seasonal movement and a more extensive use of resources within smaller areas. There is at least some archaeological evidence suggesting that the distinctive territorial system noted ethnographically in Owens Valley also developed at this time (Bettinger, 1982b). If so, then it would follow that many other elements of the ethnographic pattern probably appeared simultaneously. These would include intervillage exchange and inherited political authority (i.e., chieftanship), which were essential in maintaining the territorial system (Bettinger, 1982b). Developments between A.D. 600 and 1300, including craft specializations and greater localization in hunting and seed procurement, would seem to be variations on these basic trends of centralization and intensification. With these additions, late prehistoric lifeways in the vicinity of Big Pine differed very little from those Steward would later record for the Owens Valley Paiute.

It is clear, then, that as originally proposed, resource intensification is a basic characteristic of Owens Valley culture history between A.D. 600 and historic times. It is equally clear, therefore, that this phenomenon in large measure accounts for many of the distinctive features that set the adaptation of the Owens Valley Paiute apart from adaptations embraced by other aboriginal groups in the Great Basin.

As we have noted at several junctures, the origins of this settlement centralization and subsistence intensification might be explained as responses to either growing populations or dwindling resources. In theory, both ought to reduce incentive for movement and increase incentive for more exhaustive use of localized resources. Since, however, both centralization and intensification were not particular events but rather trends, persisting and becoming stronger with time, it would seem more likely that growing population is the better of these two alternatives. Changes in regional climate undoubtedly affected resource availability and may well have precipitated certain changes in behavior. Yet insofar as the present record of paleoclimate is telling, these changes lack the relentless directionality that so clearly characterizes the record of adaptive change in Owens Valley.

THE LARGER IMPLICATIONS OF THIS STUDY

THE EFFECTIVENESS OF SURFACE SURVEY: In 1964 Binford published a paper entitled, "A consideration of archaeological research design," in which he proposed probabilistic surface surveys as a first step in doing regional research. Thomas (1973) and, on a more limited scale, O'Connell (1975) and Weide (1974) were the first to apply the method successfully in the Great Basin; the Owens Valley project followed shortly after those three. Since then regional surveys have been undertaken throughout the Great Basin (cf. Thomas, 1986). There have been, of course, many in other parts of the United States as well.

In the Great Basin case, it has seldom been that conclusions derived from these surface surveys have been subsequently tested by excavation. Thomas, for instance, was unable to locate any sites in the Reese River with deposits deep enough to excavate. O'Connell had no problem in finding sites to excavate but as his survey was not, strictly speaking, probabilistic, and generated a sample of material that was ambiguous with respect to chronology, it was difficult to evaluate the observed discrepancies between conclusions arising from it and those arising from exca-

vation. Of the other projects, either excavation did not follow the survey (e.g., Hatoff, 1974) or the results of the survey and subsequent excavations have yet to be published (Aikens et al., 1979). Thus, the Owens Valley Project affords us one of our first opportunities to observe how regional surface surveys perform when used as a means of inferring prehistoric adaptation in the Great Basin.

Many inferences about prehistoric settlement and subsistence patterns drawn on the basis of surface surveys of the Big Pine transect tend to be confirmed by our excavations and by research subsequently conducted elsewhere in Owens Valley and adjoining areas. These include conclusions regarding: (1) the centralized nature of settlement and subsistence patterns *after* (but not before) 0 B.C./A.D.; (2) the appearance of villages in Desert Scrub settings between 1200 B.C. and A.D. 600; (3) the latent inception of pinyon procurement; (4) the cessation of long-distance hunting after A.D. 1000; (5) intensification of resource use through time.

Our most serious error of interpretation lay in the belief that lowland villages had been present prior to 1200 B.C., which in turn led us wrongly to propose continuity in basic adaptive patterns from 3500 B.C. to historic times. Arguably, this might have been avoided had we been more cautious in our interpretations, yet no concrete alternative proposal seemed as well supported by the data. We adopted what seemed to be the most promising scenario. This had the advantage of being sufficiently specific that it could be subsequently tested and rejected, as we have now done. In this sense, it seems far better to draw more rather than less specific conclusions—provided that the investigator intends to put his hypotheses to some sort of independent test and the preliminary nature of the hypotheses is understood.

The regional survey of Big Pine transect allowed us to develop a model of regional prehistory that was remarkably accurate overall. We erred on many specific points but the general results were far better. This is not to say that were the project there to be done over, we would do it exactly as before. It is to say, however, that it is scarcely conceivable that the Owens Valley Project would have been possible at all without the aid of some kind of regional surface survey. In a more general sense, it can be reasonably contended that for the Great Basin archaeologist it is (or ought to be) the regional survey rather than the excavation that is *the* basic tool of research.

NATURAL ENVIRONMENT AND ABORIGINAL ADAPTATION: For Steward (1938a: 236) and for many others since Steward (e.g., Eggan, 1980) it is the abundance of resources available in Owens Valley that explains the peculiar economic, social, and political features that so clearly distinguish its aboriginal groups from others elsewhere in the Great Basin. In brief, this argument runs that with so many resources available within such a small area, it was possible to settle in permanent villages, lay claim to specific tracts of land or territories, and form district organizations headed by individuals with inherited roles of leadership (chieftains). The reliability of resources within these territories made it possible, further, to accumulate surpluses, and thus engage in trans-Sierran and intervillage trade, and to cooperate in communal projects within the district. In contrast, elsewhere in the Great Basin the necessary resources were lacking and accordingly none of these behaviors developed.

Before any fieldwork had been done, I held that this view was untenable: resources in Owens Valley might well have allowed these patterns to develop but did not in and of themselves explain them (Bettinger and King, 1971). Without speaking to this issue directly, I have taken pains throughout the preceding discussions to show why this is so. In particular, I have tried to make it clear that the special features we associate with the Owens Valley Paiute have not always been present but developed as a consequence of what I have termed "intensification," a trend that finds no clear expression in settlement and subsistence patterns until perhaps the beginning of the Christian era.

The resources, on the other hand, have for all meaningful purposes been present throughout the Holocene or, failing that, since the beginning of the Middle Holocene at 5000 B.C. (J. O. Davis, 1982). These resources have surely varied in abundance over time as a consequence of climatic changes. Yet just as surely these variations cannot have been so

severe as to fundamentally change the nature of that environment, especially given its topographic relief. There is, moreover, nothing in the paleoclimatic record to suggest that resources ought to have been substantially more abundant after 0 B.C./A.D. than they had been prior to that. And there is certainly nothing in that record to suggest resources grew continually more abundant during the Christian era, thus accounting for the succession of elaborations in settlement and subsistence patterns noted earlier, just as we have noted that record does not suggest continual deterioration during that span. In short, the argument that environment explains the adaptation we see in Owens Valley ethnographically leaves much to be desired. The environment was a necessary but certainly not sufficient condition for the development of this adaptation. It may have made sedentism possible when the necessary conditions arose, but it is those conditions not the environment that explain sedentism (slightly different variations on this theme appear in Bettinger, 1978a, 1982b, 1983).

If the traditional explanation by abundance is set aside, what remaining alternatives are there? At risk of repeating the point too often, population growth coupled with environmental and social circumscription continue to be the most viable means for explaining the peculiarities of aboriginal life in Owens Valley. As noted at various points above and elsewhere (e.g., Bettinger and King, 1971; Bettinger, 1982b), sedentism, territoriality, intervillage trade, fixed-value bead currency, chieftainship, and other notable features of the Owens Valley Paiute system make sense not as responses to abundance but rather as responses to shortage and the need to accommodate a population with a diminishing quantity of resources. It is conceivable, of course, that such shortages might arise wholly as a consequence of climatic change, but as we have said there is no record of directional changes of climate that might account for the succession of settlement and subsistence changes observed in Owens Valley. Population growth seems the only viable alternative.

As we have portrayed it here, then, sedentism in Owens Valley is not a reflection of local affluence. On the contrary, it signals that groups had become confined to areas small enough to be efficiently worked from a central village and a few outlying satellite camps. In ethnographic times, to travel farther than that meant encroaching on the territory held by others. Witness the account of A. W. Von Schmidt, who visited the Owens Valley Paiute in 1856 and observed that despite the resources available there (among others, antelope, jackrabbits, seeds, pine nuts, and fish) that, "The families being divided off and each having his own hunting ground causes some to go without food for days" (Chalfant, 1933: 122). To be sure, some areas were unowned but these lay far from the permanent village and trips there always risked the possibility that other groups had already taken the bulk of what was available.

There is no direct evidence regarding population size or distribution through time in Owens Valley, or anywhere else in the Great Basin for that matter. We would presume, nevertheless, that by 0 B.C./A.D. the population in Owens Valley and central eastern California was dense enough that sedentism and territoriality were economically viable alternatives to seasonal transhumance—in effect, concessions to diminishing resources and growing populations. It is possible that this was a simple result of local and regional population increase, perhaps triggered by a short period of environmental decline (Bettinger, 1976). This possibility is made more probable given that Owens Valley is richer in resources than adjoining areas, as a consequence of which we would expect regional populations to gather there during periods when climate caused resources to be in short supply. Under these circumstances a situation can be envisioned in which sedentism and territoriality might have spread rapidly once a single group laid claim to a specific tract of land, thereby obstructing free movement of others over the landscape, and requiring them, in turn, to claim territories of their own. That is, settlement and subsistence patterns in Owens Valley may have changed little despite population growth prior to 0 B.C./A.D., when they quickly crystallized into fundamentally different form as population passed some critical threshold.

Our point is this: one cannot understand settlement and subsistence patterns in Owens

Valley with reference to its resources alone. The very term "resources," after all, implies the presence of some complimentary population of consumers. It is this consuming population, especially the changing size of that population, that accounts for the distinctive ethnographic adaptation of the Owens Valley Paiute. This, it turns out, is a fatal flaw of the Desert Culture hypothesis of Jennings (1957), which contends that given stability of environment and technology, the structure of aboriginal adaptations in the Great Basin remained essentially static between 10,000 years ago and the present. If we are correct in our assumptions about the relationship between population density and adaptation, such stability in adaptation would necessarily imply basically unchanged levels of population over this time, which seems unlikely.

In most general terms, the situation in Owens Valley is perhaps best conveyed in the "marginal value theorem" of Charnov (1976) which holds that as resource availability within a habitat declines, the length of time spent foraging in a specific place should increase. It is, thus, resource scarcity and not resource abundance that explains sedentism and territoriality. This simple observation has larger implications for theories of hunter-gatherer mobility and the origins of settled village life (cf. Bettinger and Baumhoff, 1982). It suggests in particular that many aspects of settlement and subsistence that seem to vary as the result of environment (cf. Binford, 1980) also vary as a consequence of population density. Note, for example, the similarities between the forager/collector continuum of Binford (1980) which has been explained primarily in environmental terms, with the traveller/processor continuum of Bettinger and Baumhoff (1982) which has been explained primarily in demographic terms (see also Binford, 1980: 17). Since both population and environment may be involved, it is reasonable to ask those who have attempted to demonstrate cross-cultural correlations between environment and settlement patterns to show that they have not instead demonstrated correlations between those patterns and population density (see Orans, 1975, for a discussion of cross-cultural tests of functional propositions).

THE NUMIC SPREAD: In 1958 Sydney Lamb reasoned that the distribution of Numic-speaking peoples in the Great Basin strongly implied a recent homeland in southeastern California, from whence these peoples had spread rapidly northward and eastward into the Great Basin. Kroeber (1925) had earlier argued the reverse: that these Shoshonean speakers had developed in the Great Basin and spread into California. Kroeber (1959), however, quickly endorsed Lamb's hypothesis, which was clearly superior to his own.

Linguists since Lamb (e.g., Miller, 1966; Goss, 1968; Fowler, 1972) have provided additional data in support of his hypothesis, the only dissenting view being that of Goss (1977), whose suggestions are "less than helpful" (Bettinger and Baumhoff, 1982). Unfortunately, neither Lamb nor any other of these linguists had any convincing suggestions regarding the motivation or circumstances of this spread. The reality of the so-called "Numic spread" is accepted at least tacitly by many archaeologists (D. Madsen, 1975; for a dissenting view see Lyneis, 1982), but they, too, have been largely unable to offer any plausible account to explain how Numic-speaking peoples might have been able to enter and so quickly spread through the Great Basin, which had clearly sustained aboriginal populations since the end of the Pleistocene.

In recognition of this problem, Bettinger and Baumhoff (1982, 1983) recently put forth a model in which it is held that Numic peoples were successful in territorial expansion because they foraged more intensively for a broader range of resources within smaller areas than did the (Prenumic) hunting and gathering groups they ultimately replaced. Bettinger and Baumhoff characterize the Numic economic pattern as being in broad terms more reliant on small seeds and less reliant on mobility (an example of what they term "processor strategies") than the Prenumic pattern, which is seen to have been more reliant on large game and wide-ranging group movements (an example of "traveller strategies"). Since Bettinger and Baumhoff posit Owens Valley as the likely source of innovative adaptive strategies leading to the Numic spread, the data that have been presented here are germane to their hypothesis.

Our interpretation of these data agrees with the Bettinger and Baumhoff model on several

key points. In particular, many features of settlement and subsistence that distinguish Numic adaptive patterns in the Bettinger and Baumhoff model are precisely the ones shown here to distinguish the trend toward intensification in central Owens Valley between A.D. 600 and 1300. These features include more centralized and less spatially mobile patterns of settlement confined within diminishing tracts of land and more exhaustive and catholic patterns of subsistence. Following linguistic estimates, Bettinger and Baumhoff place the initial spread of Numic-speaking peoples at about A.D. 1000, squarely within the interval of intensifying resource use in Owens Valley. In this sense, it is not difficult to see how this intensification might be historically related to the Numic spread, provided we accept the Bettinger and Baumhoff interpretation of that phenomenon.

In another sense, however, the possibility of such a historical connection seems contradicted by myriad specific differences between the native lifeway in Owens Valley and lifeways elsewhere in the Great Basin—particularly those in settlement pattern and social organization—that have traditionally been the source of so much comment. From this perspective, it is difficult to understand how the former might have given rise to the latter, which seems so different. This emphasis on contrasts, however, would seem to overlook basic similarities in settlement, subsistence, and organization. For instance, if we discount irrigation in Owens Valley (which must have been a recent development and for which, in any case, there are parallels elsewhere in the Great Basin), in technology and exploitative practices, both general and particular, the similarities are striking. Allowing for minor differences of local environment, the same resources were obtained in the same way throughout the Great Basin, Owens Valley not excepted. This implies that intensity of resource procurement was essentially uniform across the region, in the absence of which one would expect differences in both technology and resource selectivity (i.e., breadth of diet).

Given the above, a situation is easily envisioned in which, once population densities and, in turn, exploitative intensity, reached critical thresholds in Owens Valley, emigration into areas traditionally ignored or used only sparingly would have become increasingly attractive during periods of resource shortage. Where these were occupied, this expansion would have been made possible by competitive advantages inherent to the intensive exploitative practices that had developed in Owens Valley but not elsewhere (see Bettinger and Baumhoff, 1982). Repetition of this cycle from area to area—always away from areas of intensive resource use toward areas of more casual resource use—would produce a fanlike distribution of Numic-speaking populations operating at similar levels of exploitative intensity across the Great Basin comparable to that observed historically (see Bettinger and Baumhoff, 1982).

Given their similarities in subsistence and technology, the differences in settlement pattern and social organization between Owens Valley and the rest of the Great Basin seem all the more obvious. Yet even here there are some fundamental commonalities. Indeed, without stretching the data too far it is possible to interpret certain of these as preadaptive features that developed with settlement centralization and exploitative intensification in Owens Valley and proved advantageous in the subsequent Numic spread. In particular, apart from their aforementioned competitive advantages, exploitative patterns akin to those practiced in Owens Valley would have allowed emigrating Numic groups to operate successfully for at least short periods in very small tracts of land. Lacking this capability, it is conceivable that such a spread might have been slowed or halted altogether where resource patches were small and widely separated as a consequence of geography or the distribution of hostile populations.

In a like sense, the family band organization that figured so prominently in the ethnographic Great Basin adaptation (Steward, 1938a) is foreshadowed by the trend toward settlement centralization we have noted in Owens Valley. Key to both is that males and females, though engaged in different kinds of activities, nearly always maintain daily residence at the same settlement. In the family band system, the husband forfeited advantages in hunting to camp with his wife (cf. Steward, 1938a: 254). This in part reflects a

general scarcity of game and their consequently minor place in the diet, the regular isolation of the nuclear family during its annual round, and, perhaps at least in part, reticence to leave a woman alone and undefended for any length of time in a region where abduction by force was an accepted form of acquiring a wife (e.g., Steward, 1938a: 109, 140–141, 144, 151, 160, 195, 214). The potential defensive advantages with respect to the last may have been critical whenever Numic-speaking family bands encroached on lands traditionally held by others during their spread across the Great Basin. In all these respects the coresidence of husband and wife—the family band, in effect—may be said to have conferred adaptive advantages given other elements of subsistence, population, and technology that characterized the late prehistoric pattern throughout most of the Great Basin.

As we have noted in the Owens Valley system, men and women also routinely maintained residence at the same settlement. This was not for defense but for convenience evolved ultimately from a more centralized and partitioned use of space: both husband and wife operated within a territory that for the most part could be easily reached from a single settlement. The essence of this residential pattern is captured in the distribution of late prehistoric projectile points (Cottonwood and Desert Side-notched). These are almost never found archaeologically save in association with a structure or grinding implement of some kind. Earlier projectile points, on the other hand, especially those of Elko series, habitually occur without accompanying structures or grinding implements, often in isolated scatters best interpreted as temporary hunting camps. Too, where we have been able to locate and date them, grinding assemblages contemporaneous with these Elko points seem at least occasionally not to be accompanied with much in the way of hunting implements, projectile points in particular; these presumably represent temporary plant procurement camps (e.g., Bettinger et al., 1984b).

All of this suggests a pattern of settlement and subsistence very different during Elko times (i.e., the Cowhorn phase) than Cottonwood/Desert Side-notched times (i.e., the Klondike phase): specialized task groups for hunting and for gathering are much more common to the former than the latter, in which hunting and gathering were conducted from the same settlement. As explained above, the shift from the former to the latter is a basic feature of adaptive intensification in Owens Valley. It is in these terms that evidence of an identical shift at about A.D. 1000 elsewhere in the Great Basin (e.g., Bettinger and Baumhoff, 1982; Thomas, 1982) strongly supports the idea of the family band as a late prehistoric innovation attributable to the spread of Numic speakers from central eastern California.

Neither sedentism nor territoriality spread beyond Owens Valley with Numic-speaking peoples. It is altogether conceivable, however, that more basic behaviors (e.g., intensive exploitative practices and centralized residential patterns) that arose hand-in-hand with territoriality and sedentism in the course of adaptive intensification were elementary to the settlement and subsistence patterns of Numic peoples and in large part account for their successful expansion. It is these basic features that are shared between Owens Valley and the rest of the Great Basin ethnographically.

It is from these perspectives, then, that it is reasonable to argue that in the patterns of changing settlement and subsistence in Owens Valley we see the roots of the Numic expansion and the very origins of the ethnographic pattern Steward (1938a) was to so eloquently describe and explain. This is perhaps fitting, for the roots of Steward's own interest in aboriginal life in the Great Basin grew out of his early schooling in the Owens Valley area and it was in Owens Valley that he began his career as a Great Basin ethnographer.

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