

The Howe Quarry Project

2017-2020, led by Emanuel Tschopp. A conservation and research program to reassess the remaining material from the Upper Jurassic dinosaur locality Howe Quarry in northern Wyoming.

A detailed report of the history and the conservation program during the recent Howe Quarry Project is published in the AMNH Novitates (Tschopp et al., 2020).

Keys for collection-associated data

A series of information and data was collected and associated with single bone fragments, entire bones, specimens, and the collection in general during the project. This document provides keys for labelling adhered to the fragments and bones themselves, and to the various spreadsheets produced during the project.

Labeling of fragments and bones

Problem: thousands of unprepared bone fragments stored in collection cabinets and crates. Field numbers and original crate numbers have been lost for most of the fragments and bones. Fragments housed in different collection cabinets sometimes derived from single bones, and bones housed in different collection cabinets were sometimes found to be different elements of a single skeleton.

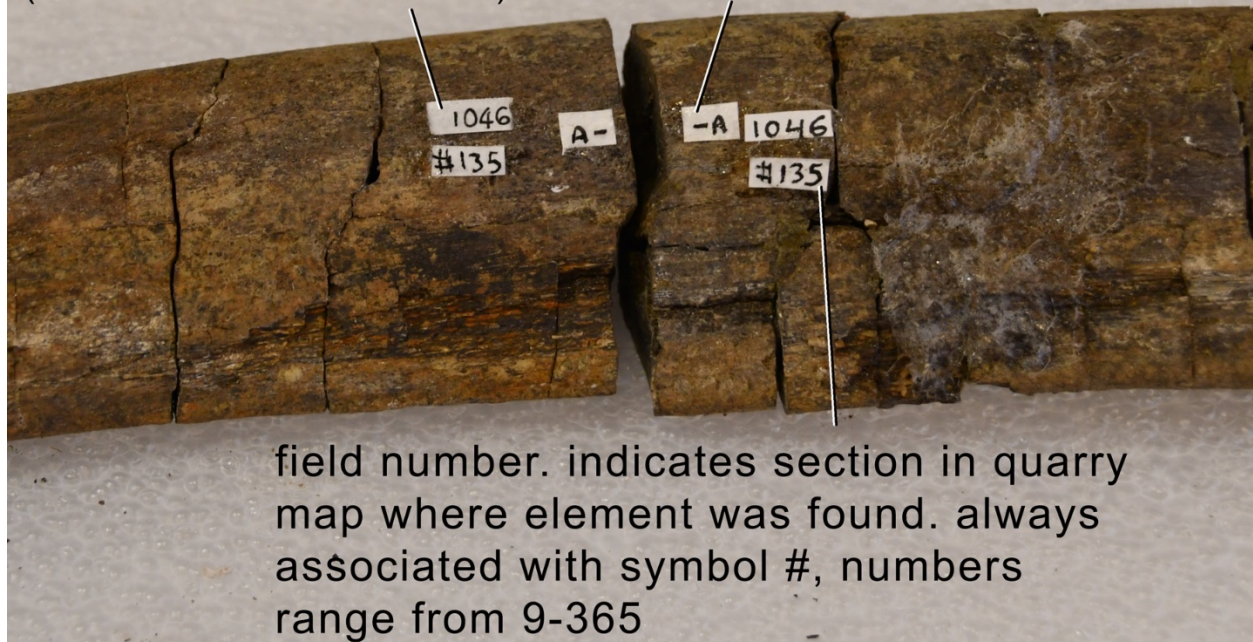
Solution: a number of paper labels were adhered to the fragments using Paraloid B-72 “sandwiches”, which indicate different collection-associated data (see also photo below). Labels were either printed with archival ink or hand-written with archival pens on archival paper. The labels were applied on a clean portion of the bone surface, where available, and can be detached easily by dissolving the Paraloid B-72 with acetone.

- Paper Label 1) number of **collection cabinet** in Building 20, Floor 7 where the fragment was housed before the project (*numbers ranging from 1041 to 1076, as well as 727*). Necessary to retrace curatorial history. Applied prior to mingling fragments from different collection cabinets to facilitate finding matches.
- Paper Label 2) **field number**. The most important label for research purposes! *Range from 9-365, always associated with the symbol #* in front of the two- to three-digit number (e.g., #156). Only known in bones that were still associated with at least part of the original plaster jacket. The number written on the jacket allows to trace the bones back on the map and to understand to which individual skeleton the bones belong.
- Paper Label 3) **bone ID**. Very rarely applied. Such a label was used to ID the bone in articulated feet, especially, in order to record the original location of every element once disarticulated. Photographic records are sometimes difficult to interpret, and small phalanges from the fore- and hind feet are often difficult to distinguish. Anatomical abbreviations (where used) follow Tschopp et al. 2015.
- Paper Label 4) **Articulation of breaks**. *Letter and a dash or arrow*. Fragments that were from a single bone, but didn't have clean, matching breaks to be glued together, or which would have become too long to store in a collection drawer, were kept separate. Every letter indicates a specific break, and the dash or arrow points towards the broken surface.

PAPER LABELS ADHERED TO HOWE SPECIMENS

door number of cabinet where fragment or bone was housed pre-2017 (can be 727 and 1041-1076)

label indicating break without clean fit: letter identifies break, dash (or arrow) identifies location of fit



Additionally, cataloged specimens were physically numbered with “AMNH FARB” and their respective specimen number (the lowest applied catalog number to recently prepared material is 33136). These numbers were written directly on a layer of Paraloid B-72 with archival white or black paint/ink and sealed with another layer of Paraloid B-72.

References

Tschopp, E., O. Wings, T. Frauenfelder, and W. Brinkmann. 2015. Articulated bone sets of manus and pedes of *Camarasaurus* (Sauropoda, Dinosauria). *Palaeontologia Electronica* 18:1–65.

Tschopp, E., C. Mehling., and M. A. Norell. 2020. Reconstructing the specimens and history of the Howe Quarry (Upper Jurassic Morrison Formation; Wyoming, USA). *American Museum Novitates*.

Spreadsheets

Several spreadsheets were produced and are work in progress to combine all the gathered information about every single bone found at Howe Quarry from both archival and paleontological/technical sources. Here’s a list of the spreadsheets, details for specific codes in the single sheets are given below (where necessary). Spreadsheets 1-4 are organized in the same way.

- Spreadsheet 1) Theory Total. Lists every single bone recovered or recorded at the quarry. Based on the quarry map and on personal observations of elements in the collections (not all bones from Howe Quarry were drawn in the map).

- Spreadsheet 2) Unknown Section. Bones reassessed during the Howe Quarry Project, which were not associated with the original jackets and thus field numbers.
- Spreadsheet 3) Map Ambiguity. Bones with field number, but which could not be unambiguously identified on the map because several bones of the same type were recovered in a single section.
- Spreadsheet 4) Incomplete section numbers. Bones associated with broken plaster jackets, where only a portion of the field number was preserved, so the actual location in the quarry cannot be restored with certainty.
- Spreadsheet 5) Cans pre-2017
- Spreadsheet 6) Cans post-2017
- Spreadsheet 7) non-AMNH specimens
- Spreadsheet 8) Measurements. These follow standard measurements and protocols
- Spreadsheet 9) Individual skeletons. Specimens cataloged in the past can include bones from different individuals, and bones from single articulated skeletons were sometimes cataloged with different numbers. This spreadsheet sorts out which bones from which cataloged specimen are in fact parts of single, articulated skeletons.

Spreadsheets 1-4

These four spreadsheets all have the same columns, so if additional information for specific bones turns up, the information about those bones can just be copied and pasted from one sheet into another. They are all saved as separate sheets within a single Excel file, which also includes spreadsheets 5-7.

Columns

Jacket number. Represents section where bone was found. In cases where bone was located in one or more sections, the jacket number usually corresponds to the section in which the largest portion of the bone was preserved. Some cases still remained ambiguous. Where the original jacket number could not be unambiguously inferred from location on quarry map or through preserved notes in the archives, possible alternatives are mentioned in various ways in the spreadsheet: Numbers (sometimes associated with letters) without brackets indicate high probability that this number was applied to the jacket; if the number is written within brackets, this probability is smaller. So, for instance:

- “9 or 30” indicates that the jacket could equally likely have been numbered with 9 or 30.
- “13 (or 34)” indicates that the jacket was most likely numbered 13, or less likely 34.
- “34?” indicates that the jacket was almost for sure labelled 34, but there is a slight possibility it bears another number.
- “(62 or) 42 or 63” indicates that the jacket was equally likely numbered 42 or 63, and less likely 62.
- “(28, 50, or) 49 indicates that the jacket was most likely numbered 49, and less likely either 28 or 50.

Bones. Identification of the bone either based on the quarry map, or the actual bone (if preserved).

Catalog number. AMNH FARB collection number. Bones reported on the quarry map, which were articulated with cataloged specimens, but could not be identified among the material in the collections so far, are listed in brackets (e.g., “(33158)”), so that if they turn up in future among the still unprepared material, they can be identified as being part of an already cataloged specimen, and they can be

incorporated in already existing catalog numbers. Some entries are followed by a question mark (e.g., "33668?"), which indicates that there is a cataloged bone of this type from this section in the collections, but there are too many of this type of bone in the section, so we are not sure which of these is the one that is still preserved. These ambiguously identified bones are also mentioned in Spreadsheet 3.

Main section. Section where the bone was found, or where the largest portion of the bone was in. Corresponds often (but not always) with the jacket number.

also in section. Sections, where smaller portions of the bones were located.

on map? Mentions if this particular bone is drawn on the map.

ambiguity on map. Specifies which bone this row is, of several bones of the same type are found in the same section(s). In Spreadsheet 3, this column indicates how many of this specific type of bone were found in the section, and provides additional information on which of those it could be.

found associated with. Identifies (semi-) articulated or associated specimens based on vicinity, size, and decay pattern as recorded in the quarry map.

Field notes (refer to "main section"; comments in square brackets added by E. Tschopp). Notes copied from archival documents.

visible in photo (number). Catalog numbers of historic photos from the 1934 excavation now housed in the archives, on which this particular bone can be seen.

Crate number. Number of the original crate, in which this bone was shipped to AMNH in 1934. Only rarely preserved. If there is more than one number, all of these numbers are equally possible. For some elements, it was possible to identify the original crate or at least exclude some options based on archival documents.

found at AMNH. Lists the bones that were identified as still present in the AMNH collections so far.

storage before 2017. Self-explanatory

storage now. Self-explanatory

Unpacked – time. Identifies the “phase” of unpacking and preparation of the specimen. There were three distinct phases: 1930s, in the years after the excavations, until Brown’s retirement; 2000s, after salvaging actions of neglected material from the Rifle Range; post-2017, the recent Howe Quarry Project.

number of pieces. In how many pieces is this bone preserved in the collections.

Taxon. Self-explanatory

Prepared by. Self-explanatory. Not always recorded for material prepared pre-2017.

Photographed. Name of Photographer(s).

Measured. Name of who measured the bones.

3D. Name of who scanned the bones in 3D, and how.

Histology. Name of who produced the histological thin-section.

Geochemistry. Name of who performed geochemical analyses.

Housing. Name of who created the housing (where known).

Numbered. Name of who physically numbered the specimen, IF the specimen was cataloged (where known).

Preparation comments. Any recorded materials used in the preparation, type of housing produced, and other potentially useful information for curatorial and conservation issues.

General comments. Comments regarding potentially important scientific information.

References. Scientific publications mentioning the specimen/bone.

Spreadsheet 5

Lists the contents of the collection cabinets before the conservation project started. Should be self-explanatory.

Spreadsheet 6

Lists the contents of the collection cabinets after the conservation project formally ended in April 2020. Material prepared during the Howe Quarry Project, which remained uncataloged was brought back to the original cabinets where they were taken out.

Cabinet. Self-explanatory

Repacked Crate (1990). Corresponds to letters given by E. Tschopp to crates repacked in the 1990s and stored in NSB 7 (see drawing). Some of these crates remain to be opened (crates H-O, state March 2020).

original crate(s). Number of original crate where reported. Some of the crates repacked in 1990 included bones from more than one original crate, which were stacked on top of each other and collapsed and telescoped into each other.

Drawer. Every drawer was given a name that corresponds to the content of the drawer. Each drawer was photographed. The lines in the table delineate the contents of single drawers.

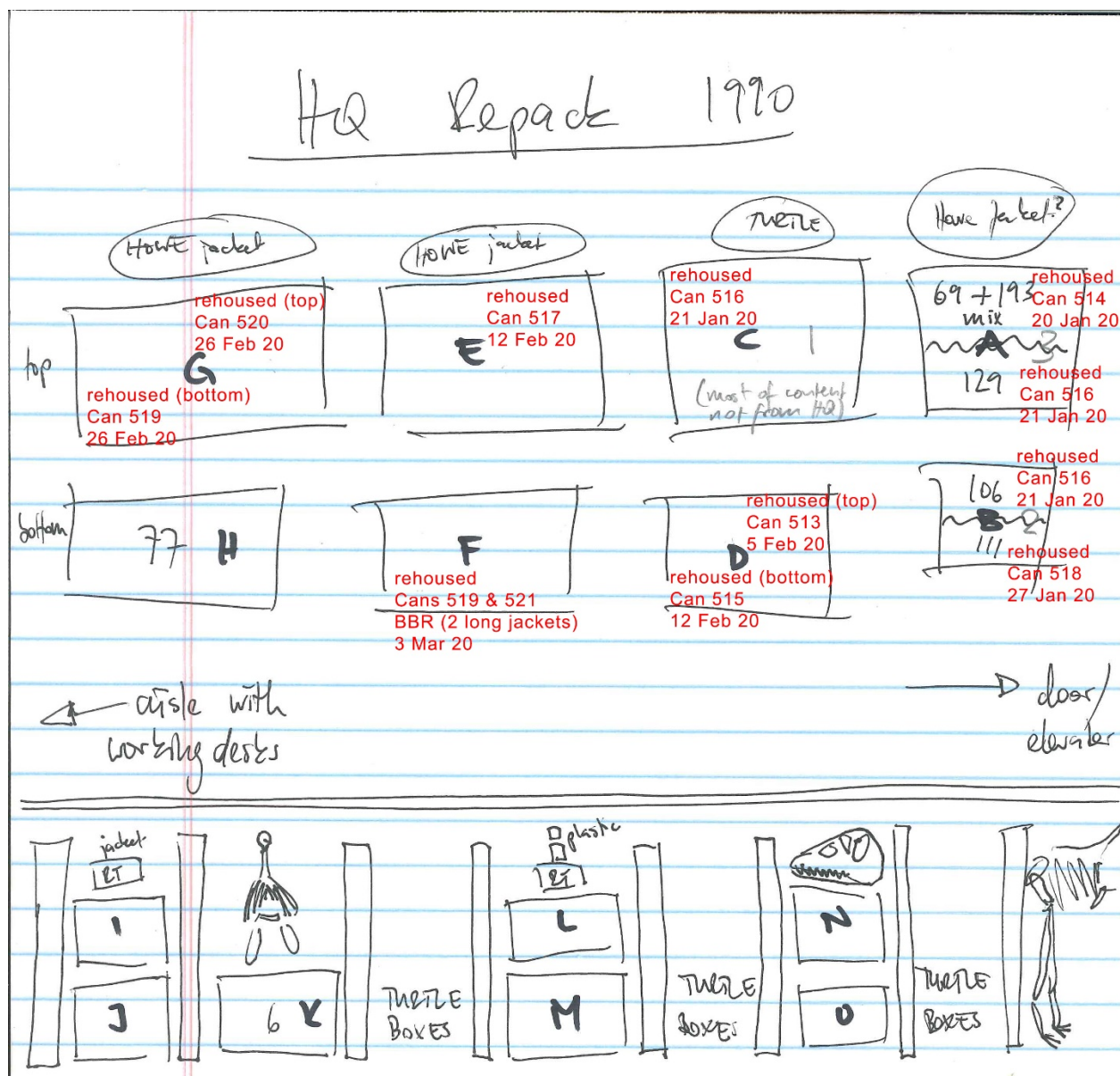
State. State of the bones in the drawer. Applies to the entire drawer.

Specimen numbers. Self-explanatory

Field numbers. Self-explanatory

Content. Content of the specimen, as identified by E. Tschopp (mostly). If more than one bone is mentioned in a single cell, these were all found articulated (unless the comment attached to it says otherwise).

Comments. Lists how many pieces the specimen consists of, as well as any other comment and/or observation potentially useful to identify the specimen or potentially matching fragments.



Spreadsheet 7

Lists additional material found at Howe Quarry by other institutions in the 1970s and 1990s.

Spreadsheet 8

Lists measurements of Howe Quarry specimens for scientific purposes.

Spreadsheet 9

List of individual skeletons. Clarifies which bones from which cataloged specimen were found articulated with each other. Skeletons were labeled with letters, and each skeleton received its own sheet within a combines Excel file. Skeletons are first divided into clearly articulated or associated parts, based on the quarry map, and potentially articulated bones. Within these two clusters, every single bone is listed, and they are sorted based on skeletal region (in the following sequence: cranial-vertebral-appendicular).

Skeleton. Self-explanatory

Bone. Self-explanatory

Catalog number. Self-explanatory

Main section. Where the bone was found, generally corresponds to the field number painted on the jackets (but not always).

Articulation. Only the immediately articulated bones are mentioned here. In most skeletons, several parts were found semi-articulated, but still clearly associated, so that referral of these sections to one individual skeleton is extremely likely.

Present? Is this bone preserved in AMNH FARB?

Location in collection. Self-explanatory

Historic photo. Number of the historic photograph from 1934, on which this particular bone can be seen.

Photographed. Name of the photographer of the scientific specimen photograph.

Measured. Name of who measured the specimen.

3D. Name of who scanned the bones in 3D, and how.