Field Report from Quarry Excavation at the Hanson Ranch Field Station, Roxon, Wyoming.

Season of 2000

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The 2000 Field Season:

The field season of 2000 was ambitious, fruitful and promising. Our class commenced on May 28 and ended on June 23. The group included seven high school and middle school teachers, six college students and three faculty, including Dr. Larry Turner, and Dr. Lloyd Willis, a Palestinian Archaeologist interested in field methods for preservation of bones and mapping. In addition, we were joined by Scott and Dee McLellan and family and by David and Kim Pervis from Dallas for several days.

Initial site work was begun prior to the arrival of the group under the supervision of Al Bollwerk. Early and continued efforts by Al and others were necessary ingredients in our success. Larry Turner traveled to the site a week early to assist Al in preliminary site preparation work. This work was carried out according to the proposal submitted to the Board for this field season, and involved building a road to the site and lowering a portion of the area adjacent to the Ridge 4 quarry site to within one meter of the level of bones found in the quarry site. In adition, the construction of the framework for the Ark shelter had begun prior to the arrival of the group.

Procedure:

During the first week, major effort was focused on the construction of the Ark. The location for the shelter was immediately adjacent and south of the original quarry site (figure 1). Four of the more experienced students were given responsibility for aiding in construction of the Ark. A second group, including our most experienced preparator, was assigned to a salvage site south and east of the old quarry where a femur and connected tibia had been unearthed prior to our arrival. A third group was assigned the task of assessing the depth of the bonebed in the lower reaches of the old quarry. The fourth group consisted of the staff. Turner was responsible for quarry supervision, while I was responsible for directing the scientific aspects of the project. These assignments were retained for the duration.

All mapping was done using high-resolution GPS equipment made by Javad Positioning Systems. A base station was occupied using five permanent benchmarks established previously at the site. A level and stadia rod were used to determine relative elevations for each of the benchmarks and these values along with the easting and northing values of the benchmarks were used to establish a precise position for the base station. All other points were determined relative to this point. The Javad equipment enabled us to routinely measure vertical and horizontal dimensions to within a centimeter.

When bone was encountered, the approximate heading of the long axis of the bone was determined and the excavation was extended to expose the bone. The bone was then pedistaled, given a permanent museum number, measured and photographed. The excavator made a detailed drawing of the bone. GPS data were next taken from the bone. These consisted of from one to numerous determinations outlining the general shape and dimensions of the bone. For small objects, such as teeth, only a single point was taken. For small bone fragments, two points, delimiting the long axis were recorded. For large bones such as ribs or ischia, numerous points were taken over the surface of the bone. Finally, the bone was either stabilized and removed, or if needed, was cast with plaster and burlap over aluminum foil and removed from the quarry. Relationships between clusters of bones were documented prior to removal of any of the bones. Excavation was generally paced far ahead of bone removal, to allow relationships to be visualized and for the benefit of visitors.

In camp, the GPS data and the digital photos were downloaded to a laptop. The data were converted to a form useful in Arcview GIS and photos were stretched to fit the GPS data using the image extension of Arcview. The three-dimensional image was next added to the 3-D view of the site in its proper GPS position using the 3-D extension of Arcview. In this way the entire assemblage of fossils was reconstituted in the computer. Subsequent manipulation of the quarry site 3-D view enabled analysis of the relationships between bones to be easily accomplished.

Results:

Depth of quarry. The first determination we made was the bottom of the bone layer in the original quarry. Beginning at the northern margin of the old quarry site below the large hadrosaur femur removed at the end of the 1999 season (HRS00001), and extending northward, we carried out excavation of several trenches to test for the presence of bone below that level. In most areas the depth of the femur represented the lowest elevation containing bone. Below this elevation, we found in the quarry area, a layer containing numerous well-preserved molluscs. Near the east wall of the quarry there were two bones recovered that were very poorly preserved and badly shattered. These bones, at 1243.23 meters represent the lowest elevation of any recovered bones in the old quarry area. The shelly area occurred in a fairly broad zone just below this at 1243.11 - 1243.21 meters.

Thickness of quarry layer. The highest bones considered part of the mudstone layer (a few fragments were encountered in the overlying sandstone) occurred at 1244.2 meters. The layer containing bones is thus approximately one meter thick at this locality.

Types of bones encountered. The proponderance of bones found this season were again those of *Edmontosaurus*. In the old quarry site, we uncovered a large scapula and the attached coracoid, an ulna, several associated ribs, a large femur and an associated fibula and possibly associated tibia with more ribs. Nearby were a pair of ischia and a humerus. One of the most significant finds to come out of the excavation this summer were two

sacral regions composed of eight or nine fused vertebrae. One of these sacral regions, transported as a block, and not yet prepared, was associated immediately with a femur-tibia-fibula complex. Both of these sacral regions and the associated leg bones appear to be those of *Triceratops,* although this will not be known with certainty until preparation has been effected. One triceratops tooth was found in this area, although its exact location was not obtained. Near one of these sacral regions, the lower jaw of a hadrosaur was found along with a second, smaller hadrosaur scapula and other skull bones. Near the other, a humerus and rib were found. These bones lay directly adjacent to the covered site.

In the south quarry, an articulated femur-tibia-fibula complex was excavated. Near it were a matched pair of scapulae, the beak of a triceratrops, the jaw of a hadrosaur and other skull bones. On the south end of the quarry several associated ribs were uncovered adjacent to a humerus, ischium and pubis. The central part of the site has not yet been lowered to the level where the majority of the large bones lie. A mammal tooth and several *Nannotyrannus*/*Troodon* teeth were recovered from this site, as well as some fragmented avian bones.

Condition of bones. The bones we recovered this year varied considerably in quality dependent upon two factors. The bones found late in the season that had been under the cover of the ridge sandstone, were well preserved, and generally free from the kinds of degradation associated with surface exposure and root damage. The last bone of the season, a humerus preserved without fracture, came from the deepest corner of the quarry. This suggests that as we proceed working to the south under the Ark structure, the bones will be in excellent condition.

Bones at the south (salvage) site were generally not well preserved (though still far better than the Derstler bones we have been working with), because the site lies along the natural slope of the hillside, and all bones were subjected to intense weathering and biodegradation prior to excavation. Several very promising bones, perhaps portions of a skull were completely disintegrated by plant growth.

Considerations. The research project undertaken this summer has yielded valuable information about the death and subsequent history of the remains of dinosaurs buried in a mudstone in the Lance Formation. While considerably more work must be done before final conclusions can be reached, it is becoming increasingly certain that these accumulations of bones do not represent the remains of "…a herd of hadrosaurs that was crossing a river; some of them drowned and were carried down to a crook in the river where the bones accumulated." Nor are they the results of accumulations of bones of old hadrosaurs in a burial ground. The bones are in a very unnatural array of several species of dinosaurs that include large and small individuals of the same species. They give every evidence of having been transported to the site of burial along with the mud matrix in which they are suspended.

The techniques we have developed for restoration of taphonomic relationships after the bones are removed from the quarry has enabled us to preserve far more data than any

technique previously used. We are now able to view the quarry as if the dirt had been removed from around the bones, leaving the bones in their precise 3-D positions. We can examine the size distribution of the bones and compare the horizons and the depth of the bone bed from place to place. Ultimately this will, I believe, reveal that the bones were transported *en masse*, perhaps as part of a debris flow. If the present relationships are typical, the larger bones appear to be near the bottom of the layer, and the smaller bones appear to be ordered upward, as in a graded bed. This itself would require some form of sorting and transport that could not have resulted from bones accumulating at a crook in a river. I believe future work will enable us to reach firm conclusions about the nature and history of the taphonomy of these animals.

Quarry closure. At the end of the season, all remaining exposed bones were cast or otherwise stabilized, removed and transported to Keene for preparation and curation. The quarry surface in the old quarry site was left without protection, as the digging had progressed to the margins of the Ark, and there appeared to be adequate ground cover for bones in the remaining exposed portions of the quarry. The south quarry site was likewise cleared of all exposed bones. Here too, the remaining horizontal surfaces appeared to have sufficient thickness of mudstone above the bone layer to adequately protect them over the winter. The region cleared by the bulldozer is covered by a few centimeters of sandstone and no less than a meter of mudstone. This is adequate to prevent the growth of most roots and should occlude damage by frost or rain as well. This is true for the quarry site within the Ark as well.

Conclusions. This summer represented a watershed in the history of the vertebrate research activities at the HRS. A road was completed to the quarry site; an attractive, functional, permanent structure was constructed in the area of active research; competent and trained personnel were employed in the digging process; the results were recorded permanently in a manner that permits the distribution of fossils to be accessed for future reference; the bones were preseved in superior condition and will be available for research and study, casting or whatever procedures are determined by future directions at HRS. I cannot adequately express my appreciation for the work Al contributed to the successes of this summer. Quite simply, without his self-sacrificing efforts to arrange for the preparation of the site and for making it accessible, our research season would have been a failure. Many others also contributed to this success, including the Hanson family and Larry Turner. Thanks.