

Proposal for Continuation of a Multiyear Study on the Taphonomy of
Vertebrates from the Upper Cretaceous Lance Formation on the Hanson
Ranch, Roxon, Wyoming

Submitted by

Arthur V. Chadwick, Ph.D.
Professor of Geology and Biology
and
Lawrence Turner, Ph.D.
Professor of Physics and Mathematics
Southwestern Adventist University
Keene, TX 76059

Proposal to Hanson Research Station

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Abstract:

This document is a proposal to continue the development of our study on the taphonomy of vertebrate remains in the Lance Formation at the Hanson Ranch. We are proposing to expand the work at our main quarry site and to extend the scope of the study with limited exploratory work at other sites in the area. Continued work at the main quarry site will enable us to develop a large enough volume for accurate and detailed analysis of the taphonomy in that area. Our mapping of bones in outcrop has revealed much about the extent of the bone layer. As this work continues we propose to open additional exploratory quarries to sample the outlying areas of the single bed that appears at this time to contain the major vertebrate deposits on the Ranch. This proposal is presented as a four-year continuation of the original proposal for which annual progress reports will be made to the Board.

The main study area, now partially covered by a modular, semi-permanent physical shelter will continue to be the focus of our research. The shelter will continue to provide a base for our seasonal operations. Because of the value of the structure, we will continue to excavate around the perimeter of the shelter except when weather conditions require working the deposits under the shelter.

We are proposing to continue to work with and utilize various groups of students and teachers who may desire to participate in the research, as the Board has suggested. We will seek to coordinate and cooperate with groups of students and staff from a variety of institutions including, but not limited to Southwestern Adventist University. We will continue to offer the classes we have taught in the past. We are and will continue to be in contact with various members of the board who have expressed an interest in bringing groups to the site as plans progress for the coming seasons. Following the completion of a successful three-day minicamp for youth this season, we will, with board approval, seek to foster further activity of this type.

Introduction and Historical Review

The Hanson Research Station in Roxon, Wyoming is dedicated to the scientific development of one of the finest Upper Cretaceous fossil localities in the world, in the context of a Biblical understanding of earth history. This unique blending of a philosophy of great (and mostly unexploited) potential for explaining earth history, with a world-class vertebrate site, makes the Station unique in the world.

There are several approaches that could be taken to continue development of the site as an educational resource as well as a paleontological and geological treasure in harmony

with the goals of the HRS. Remaining central to the purposes of the Station are the twin goals of educating our youth and the educators of our youth in a scientifically sound, Biblically consistent view of earth history, and of developing the scientific potential of the Station and of the site. Therefore we are proposing a continuation of our research plan allowing the training of college students and teachers in the fundamentals of a Biblically based view of earth history, while continuing our scientific studies at the site. The experiences of the past seven years have reaffirmed our convictions that this goal continues to be realistic.

Previous researchers in the Lance and in other dinosaur bone beds have explained the presence of extraordinary accumulations of dinosaur bones using a standard polemic that is all too familiar. "Dinosaurs had favorite crossing points on the Cretaceous river that deposited the Lance sediments. Some of the animals drowned while crossing the river and their remains were trapped in the first bend in the river downstream from the crossing, where they subsequently were buried in river sediments and preserved." This unchallenged hypothesis, used not only with respect to the Lance, but also for other deposits worldwide, continues to prevent scientists from carefully considering alternative models, including catastrophic ones. As we have advanced in unraveling the history of these Lance beds, we are seeing evidence that is increasingly incompatible with this scenario. The vertebrate deposit is in a relatively homogeneous mudstone, not river sand. The bones appear within the mudstone consistently about one meter below the contact with overlying sandstone and persist downward over an interval of less than one meter. The bones occur in a normally graded bed, with larger bones below smaller ones within the unit. There is also a taphonomic overprint such that bones are sorted by type (i.e. toe bones at top, etc.) that is curious and as yet not fully understood. The disposition of the bones in the mudstone requires that the mud and bones were deposited together as a catastrophic unit. Although we have not yet examined the basal contact of the unit, the upper contact with the sandstone in the area of the quarry appears to be flat lying and conformable. Our continued research will allow us to address other important concerns about the deposit and the bones contained within it. As we progress in our understanding, we anticipate satisfactory answers to many questions about the history and deposition of the bones and of the Lance Formation itself.

The research of the past four seasons has continued to expose bones not affected by weathering. The disposition of the bones appears to be random within each quarry by bone type, clearly not what one would anticipate from an accumulation from a carcass or from subsequent scavenging. The unweathered bones demonstrate the animals died and became disarticulated at a different site prior to being transported *en masse* to the present locality, and that for most of the bones, there was little time for exposure and weathering prior to transport and burial. This will enable us to draw conclusions about the preburial condition and history of the bones distinct from any modern influences. Our technology for preserving data on the bones still leaves us far ahead of other workers in taphonomy. We have also developed techniques and facilities for curating the bones that assure they will be prepared carefully and accurately and preserved for whatever future purposes they may be needed. We have presented the results of our research each year at professional meetings.

The Proposal

We are proposing a continuation of our taphonomic study of the bone bed for an additional four years. We propose to continue to focus on the Main Quarry region where we are presently working to develop a comprehensive picture of the taphonomy of the deposit as a whole. At the same time, we are proposing to continue to open small exploratory quarries in peripheral areas of the deposit in the interest of seeking to learn whether the data obtained in the Main Quarry are explanatory for the deposit as a whole.

We also propose to continue to explore the boundaries and extent of the bone bed over the area of exposure on the Ranch and to begin a systematic general reconnaissance and high resolution mapping of the Ranch with the intent of cataloguing occurrences and conserving potentially valuable resources. We are also interested to determine whether other outcrops containing bone may be extensions of the Main Quarry bed, and if other bone beds may be represented on the Ranch. All of this will be connected with our attempts to establish some kind of stratigraphic framework for the bonebed and for the Lancian sediments on the Ranch.

Research Procedure and Considerations

Quarry Work. We propose to continue our excavations through the bone bed in the Main Quarry area, extending across the cleared surface from both sides. We also propose to continue development around the sandstone mass south and east of South Quarry into the area of Teague Quarry with the intent of elucidating the relationship of the sediments and the bone layer in that sedimentologically interesting area.

In order to further delimit and characterize the bone bed we are proposing to extend our small exploratory quarries to more distant regions of the bone bed, working outward from the central axis of the Main Quarry site. The sites chosen will be based upon criteria already established:

1. The site must be relatively accessible. Since supervision and data collection will necessitate frequent visits to the site by the P.I.s, the site must be located near an existing access or within reasonable hiking distance.
2. The site must be excavatable without removal of substantial overburden. This means it cannot be at the base of a high cliff. This normally will necessitate working through a weathered slope to the bone layer.
3. The site should generally be one that displays significant fossil material at the outcrop. If there is virtue in preserving materials weathering from outcrop, this virtue should be maximized in the choice of a site. However, in distal regions, this may not be the case, and excavation there will be particularly relevant to the geometry of the deposit.
4. The sites should be broadly distributed so that we can reach conclusions with the broadest possible applicability.

The procedures will be similar to those used in opening the West Quarry this past season where we began excavation by laying out a precisely gridded area peripheral to and west

of the Main Quarry axis. The original site was quite flat lying, necessitating exposing fossil materials down slope of the bed during establishment of a drainage for the site. These materials were documented and removed (as part of the overall excavation) even though they were outside the grid in order to permit excavation of the gridded quarry without creating a hole. After completion of the site, the site will be restructured in order to minimize impact on the remaining bone layer and on the ecology of the area.

The opening of these exploratory sites is critical to our mission of understanding the origin and history of the bone layer. It would be risky to base general conclusions on a single site or on surface data, no matter how it is developed. Using the GPS technology and careful reconstruction of the taphonomy at these sites, we will be able to draw firm conclusions on the general nature of the deposit that will answer the question regarding whether the deposit represents an accumulation “in the bend of a river”, or whether this deposit represents a mass catastrophic layer, or something else.

We are further proposing to continue and extend our exploratory surveying designed to increase our understanding of the history and taphonomy of the site and the stratigraphic relationships of other bone-containing outcrops on the Ranch. Using the high precision GPS tools we will be able to know the precise relationship in space between bones at various localities and we anticipate being able to define, map, and characterize potential stratigraphic marker beds on the Ranch. As a result, we can anticipate conclusions for a much larger area than just the bone bed in the vicinity of the quarry site.

As in our previous research efforts, we will continue to guard carefully the data acquired in the process of the proposed research. All bones and other significant artifacts encountered in the quarrying process will be recorded, collected, cleaned, stabilized and curated with the goal of maintaining the high standards of data preservation we have applied to the other research done at the Ranch. We are in the process of developing a new database engine and interface to make the data we are collecting more readily accessible over the internet, facilitating the process of data auditing, as well as data analysis by individuals who may wish to interact with the data in a variety of ways. This coterie includes board members who may wish to audit the state of the research, as well as other investigators with approved access who may want to test hypotheses or otherwise query the data. Insofar as I am able to discern we are at present the only scientific facility in the world with significant holdings with all of our specimens on-line and accessible over the internet. We intend to continue to pursue this standard.

Site Closure. Under this proposal, we will continue to protect bone material exposed during quarrying activities but not removed from the ground during the season, with a layer of straw and a polyfilm tarp. We will construct drainage so that runoff is directed away from the quarry area, and fence off areas where potential damage could result from grazing. Upon completion of any secondary sites we will further seek to restore the area so as to discourage damage to bones not yet exposed.

We will endeavor to leave the facilities in at least the condition in which we found them. Any damage caused by the activities associated with the conducting of this research, or by individuals under our jurisdiction will be our responsibility. An accounting of the

disposition of funds associated with the proposed program at the ranch will be submitted to the board at the completion of the summer activities.

Liability

All individuals involved in the proposed project will sign a statement of personal responsibility supplied by the Hanson Ranch Field Station before the beginning of the project at the Ranch.

Qualifications of the P.I.s

A. Chadwick. I have been involved in excavation projects at the Station for eight years. During this time I have been responsible for the supervision and preparation of specimens from the Ranch, as well as supervising and managing groups involved in the work. Together with Dr. Turner, I have initiated development of techniques for cataloging and displaying the HRS collection on-line. We have also developed techniques for accurately recording the size and shape and 3-dimensional position of the bones, and for linking these with photographs of the bones so the quarried bones can be seen in their original positions. This work has been the subject of two presentations at the national meetings of the Geological Society of America and two presentations at the international meetings of the Society of Vertebrate Paleontologists, with a third scheduled for this fall.

My formal training in vertebrate paleontology was at University of California under a recognized authority in that field (M.O. Woodburne) and I have been and continue to be a member of the Society of Vertebrate Paleontologists. I have had considerable experience in taphonomic studies in other localities as well, including an on-going research project on fossil cetaceans in Peru that is the subject of a continuing series of publications.

L. Turner. My doctorate is in an area of astrophysics. During my career I have taught physics, computer science, and mathematics. I was the founding chair of the Computer Science Department at Andrews University and presently part of the administration of Southwestern Adventist University. I have been involved with the excavation projects at the Hanson Research Station since 1999. During this time I have been involved in leadership on the project and in the development of the GPS aspects of the research. I presented a paper on our research at Hanson Ranch as the senior author in 2000 at the Geological Society of America meetings. I am a member of the Society of Vertebrate Paleontologists, where I have been contributing author on two papers and primary author on a third.