

EARTHWATCH INSTITUTE FIELD REPORT

Project Title: Mammoth Graveyard

Principal Investigator: Dr Larry Agenbroad

Position/Affiliation: Director, Mammoth Site, Hot Springs, SD; Professor Emeritus, Northern Arizona University

Research Site: Mammoth Site of Hot springs, SD, Inc. Hot Springs, SD
43°25' N, 103° 32' W

Local Management Status of the Research site: Non-profit organization ownership: Mammoth Site of Hot Springs, South Dakota, Inc.; National Natural Landmark

Scientific names of primary species: *Mammuthus columbi*; *Mammuthus primigenius*;
Arctodus simus

Key Objectives:

To investigate the fossil rich sedimentary fill of an ancient sinkhole
To preserve paleontological specimens *in situ*.
Educate the general public about Pleistocene paleontology
Train Earthwatch participants in paleontological excavation
Produce research results in a timely, readable manner
Train future paleontologists

Data collection and results:

In the 2006 field season, we recovered (or left *in situ*) 51 new specimens. Approximately 50% of the sinkhole deposits have been excavated and researched since 1974.

To date, we have recovered 55 mammoths, and at least 29 species of smaller animals from the site, including:

- a short-faced bear, an American camel, a llama, and a wolf.
- 34 plant species have been identified, plus 18 species of mollusks, and three insect species.

Significance/Benefits of Research:

- The site contains *in situ* preservation and display of mammoth remains where they died or were deposited.
- The training of 27 years of students and Earthwatch participants.
- Generation of 59 professional abstracts or publications; two books, several television features,

- Comparison population for other sites/collections;
- Visiting scientists;
- Intern program;
- Distance learning programs and activities, school field trips and classroom activities on-site;
- A children's dig of simulated bones in a controlled area.

Project Development:

- Logistic challenges of the 2006 field season were the increased confinement of the 'floor' working spaces, as we proceed downward in a conical shaped deposit. The situation has been addressed by opening new portions of the bone bed fill and by removing items from prior seasons, to the preparation laboratory, so we can excavate beneath them.
- Additional methods have been increased use of the overhead crane to lift heavy loads of overburden and screen wash materials out of the excavation. (+20 feet of vertical lift).
- Coming field research will be patterned after the tried and tested methodologies developed over the past 32 years. We will open new, untested areas of the fill deposits. Improved EDM transit and ARCHINFO mapping programs.

Educational Opportunities:

- This project directly involves the following groups:
 - Local community: the project has the support of the Chamber of Commerce; local motels; restaurants; businesses, and tourism markets.
- Students: local students are hired as guides during the heavy tourist season.
- We have initiated an intern program for graduate students getting practical experience on-site, interacting with the public, gaining molding and casting techniques, laboratory skills, and field excavation.
- Early career scientists are encouraged by direct participation in an active excavation. We have generated scholarships for students and in-service teachers.
- Other groups include Elderhostel, national and international colleges and universities, Davidson Gifted Scholars program, Project Exploration for inner city youth.
- The Mammoth Site is a working exhibit and excavation. It is exposing and preserving a deposit of extinct fauna, in what was a natural hydrologic-geologic trap, selective for young male mammoths, plus an associated fauna. It is dynamic, changing each year, as the continuation of research is being conducted.
- The mammoth site has provided graduate students the completion of three Master's Degree theses, six published papers and at least 12 professional presentations.

Partnerships:

- The mammoth site has had collaborative relations with Northern Arizona University; AZ; Black Hill Institute of Geology; SD; Rapid City School of Mines,

SD; Natural History Museum of Rotterdam, NL; Santa Barbara Museum of Natural History, CA; La Brea Tarpits, CA; Augustana College, SD; and Casper College, WY.

- These institutions have provided discussions, preservation advice, publications, forums for research questions and goals, and formats for presentations.
- The project results will be used in on-going research and as training facilities for classes, field trips, etc.

Acknowledgements:

Earthwatch Institute has provided funding, publicity and excavation crew members for the mammoth site since 1976. It has helped raise the status of the excavation to a world-class facility and exhibit.

National Geographic Society provided partial funding from 1976-1983.

Northern Arizona University contributed support from 1980-1990.

PRELIMINARY REPORT of the 2006 Field Excavations at the Mammoth Site of Hot Springs, SD, Inc.

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Earthwatch Project: Mammoth Graveyard
Team I: July 2-July 16: seven Earthwatch participants
Team II: July 16-July 30: 11 Earthwatch participants

The Mammoth Site is a karst feature, a sinkhole, that held a thermal, artesian spring and pond. It served as a selective behavioral trap for young male mammoths about 26,000 years ago. To date, approximately 40-50 % of the sinkhole fill containing remains of mammoths and associated fauna has been excavated. We have discovered 55 mammoths and associated fauna.

Highlights in 2006

A total of 51 faunal elements were found, mapped and some of them removed to the laboratory. Skulls from earlier exposures were removed to the preparation laboratory (in 2004, 2005) to facilitate the excavation beneath those pedestals. A broken (occipital portion) of a mammoth skull was recovered beneath the 2004 location (in 2006). A pelvis and some smaller bones are also being exposed beneath the 2005 skull position. Nearly five tons of sediment was screenwashed to provide concentrate for microfauna remains.

Approximately 10 tons of overburden was removed from the sinkhole. The screenwash concentrate will be sorted over the winter months.

Objectives

1) The research is focused on excavation of a bone bearing sedimentary deposit within the confines of a sinkhole. The geologic-hydrologic natural trap was selective for young, male mammoths. Many of the remains are left *in situ*, in the position where the animal died, or was deposited approximately 26,000 years ago. Guided tours are provided for site visitors, who can examine the configuration and distribution of skeletal elements of more than 55 mammoths and associated fauna. The site is the largest collection of Columbian mammoths in North America. It serves as a population of locally derived animals with which to compare and contrast other mammoth deposits. In addition to mammoths, the site has produced the giant short-faced bear, camels, a llama, wolves and a variety of smaller animals. It is a natural laboratory for taphonomic studies.

With the 2006 field season, we celebrate the 32nd year since discovery of this unique repository.

2) The 2006 objectives were:

- a) To remove some of the undisturbed sediment fill of the sinkhole.
- b) To explore the north central limit of the site.
- c) EDM transit and ARCHINFO mapping of the bones.
- d) Water screen 10% of sterile fill and 100% near bone.
- e) Discover new faunal remains.

Methods

Once taught the methodology of excavation, pedestalling bone, etc. the team begins excavation. Once a bone is found, the team member has to try to identify the item, using a guide from a Stanley Olsen publication on the osteology of mammoths and mastodons. Once identified, exposed and pedestalled, the bone is mapped by an EDM transit. The EDM data is transferred to a computer which prints maps of the elements. Most bone is left *in situ*. Those removed to the laboratory are cast in plaster jackets for support and transit. Dental metrics and age of individuals are conducted, to provide an age-structure analysis of the mammoth population.

Results

As outlined in the preceding sections, a large amount of sediment was removed from the sinkhole fill. A good sample of these sediments was screenwashed for microfaunal remains. New material was identified, mapped and either left *in situ*, or transferred to the preparation laboratory. Whereas no new individuals were recovered in the 2006 season, new bone localities were found and await further detailed excavation.

Discussion

- a) The objectives for the 2006 season were well met. Not every team member found new bone, but they increased the chances for future teams, by removal of overburden. A new bone was discovered in the north-central area, which

has been sterile in the past three seasons. Overburden removal has begun in untested portions of the site.

- b) Future excavation will continue overburden removal. New bone has been located in this year's efforts. Detail work on known skeletal objects and the exploration of sediments underlying bones removed in 2004 and 2005 promise new discoveries for next season. Otherwise, the methodology and schedules will remain similar to the prior seasons.
- c) Leaving the fossil-subfossil material *in situ* has presented new challenges and methodologies in preservation and exhibition. The increasing visitation to the site has indicated this is becoming a tourist-scientist-educator destination, both nationally and internationally. The mammoth population represented at Hot Springs serves as a comparative collection for other mammoth localities, including the newly discovered Holocene mammoths of the Pribilof Islands, east of Alaska. We were visited by representatives from the Waco, TX site, for advice in creating a visitor facility there, similar to ours. They also wish to form a 'sister' facility for the mammoth site.

Publications

Publications/Presentations (Agenbroad) 2005-2006

2005

- a) Agenbroad, L. D. North American Proboscideans: Mammoths: the state of knowledge, 2003. *Quaternary International* 126 -128:73-92.
- b) Agenbroad, L. D., John R. Johnson, D. P. Morris, and T. W. Stafford, Jr. Mammoths and Humans as late Pleistocene contemporaries on Santa Rosa Island. In D. K. Garcelon and C. A. Schwemm (eds.) *Proceedings of the Sixth California Islands Symposium*. P. 8-12.
- c) Agenbroad, L. D. The Hiscock Site: late Pleistocene and Holocene paleoecology and archaeology of western New York state. (book review) *Ontario Archaeology* 74:53-55.
- d) Agenbroad, L. D. Resurrecting extinct megafauna. *Actionbioscience.com* website. 5 p.
- e) Agenbroad, L. D., John R. Johnson, D. P. Morris, and T. W. Stafford, Jr. Mammoths and Humans as late Pleistocene contemporaries on Santa Rosa Island. In D. K. Garcelon and C. A. Schwemm (eds.) *Proceedings of the Sixth California Islands Symposium*, Ventura, California, December 1-3, 2003. Institute for Wildlife Studies, Arcata, CA. p3-6.
- f) Agenbroad, L. D., and R. L. Symington. Short Papers and Abstracts: 2nd World of Elephants International Congress. Hot Springs, South Dakota. *Mammoth Site Scientific Papers* 4: 214 p.
- g) Agenbroad, L. D., and A. Brunelle. Dental comparisons for the Columbian mammoth (*Mammuthus columbi*) In L. Agenbroad and R. Symington, (eds.) *Short Papers and Abstracts: 2nd World of Elephants International Conference*, Hot Springs. *Mammoth site Scientific Papers* 4:1-3.
- h) Agenbroad, L. D., and K. M. Thompson. Bone distribution and diagenetic modifications at the Mammoth Site of Hot Springs, South Dakota, USA. Abstracts: Geological Society of America; 2005 Annual Meeting, Denver, CO.
- i) Agenbroad, L. D., and K. T. Thompson, Karst Features as animal traps: approximately 500,000 years of Pleistocene and Holocene fauna and Paleoenvironmental data from the Northern High Plains. U. S. Geological Survey Scientific Investigation Report 2005- 5160..p. 135-141.
- j) Mead, J. I., N. J. Czaplewski, and L. D. Agenbroad. Rancholabrean (Late Pleistocene) mammals and localities of Arizona. In R. McCord (ed.) *vertebrate Paleontology of Arizona*. Mesa Southwest Museum Bulletin 11:139-180.
- k) Shoshani, J., M. P. Ferretti, A. M. Lister, H. Saegusa, L. D. Agenbroad, D. Mol and K. Takahashi. On the relationships within the Elephantinae using hyoid characteristics. In L. Agenbroad and R. Symington (eds.) *Short papers and Abstracts: 2nd World of Elephants International Congress*, Hot Springs. *Mammoth Site Scientific Papers* 4:160-165.

- l) Suzuki, N., L. D. Agenbroad, J. Shoshani, A. Tikhonov, B. Buigues, and P. Lazarev. Computed tomography and 3D imaging analysis of anatomical structures of the Yukagir mammoth. International symposium, Nagoya, Japan.

2006

- a) Agenbroad, L. D. CSI: Hudson-Meng Site, Nebraska: the evidence for Alberta Culture artifacts in intimate association with Bison bones. (Poster) Island in the Plains Archaeological Conference, Deadwood, SD. May6-7.
- b) Agenbroad, L. D. The Hudson-Meng Bison Kill. Mammoth Site of Hot Springs, South Dakota, Inc. 18p.
- c) Agenbroad, L. D. Out of the Ice: recovery of the Jarkov Mammoth, Taimyr Peninsula, Siberia. Invited lecture for the Science Symposium, NASA Goddard Space Center, Maryland. April 2-3.
- d) Agenbroad, L. D. California Islands Pygmy Mammoths (*Mammuthus exilis*): their origin, age, size and extinction. Abstracts: Geological Society of America Annual Meeting 2006. Philadelphia.

Other accomplishments and benefits

- a) Teacher-student training:
- 1) 'Mammoth in a trunk' activity kits have been prepared for K-12 students and teachers, and are in nearly constant demand.
 - 2) Distance learning over SD television was initiated in 2004, and continues.
 - 3) Educators in colleges and universities have used mammoth site materials for in-service workshops, field trips, and on-site educational activities.
 - 4) The South Dakota State Fair has requested mammoth site involvement, with simulated digs. We were unable to comply in 2006 due to staffing problems.
 - 5) Merit badges for Boy Scouts and Girl Scouts have utilized Mammoth Site activities.
 - 6) Regional elementary schools regularly field trips to the mammoth site.
 - 7) College and university field schools regularly visit the mammoth site.
 - 8) Requested presentations on the educational opportunities developed at the mammoth site will be presented at the Geological Society of America annual meeting (Philadelphia) in October.
 - 9) Training of five graduate-post graduate interns.
 - 10) Conducting a Jr. Paleontology Excavation for 3-13 year olds using replica bones.

Acknowledgements

- a) Staff:
- Dr. Larry Agenbroad, Principal Investigator
Wanda Agenbroad, Logistics coordinator
Don Morris, Crew Chief
Kris Thompson, and Stephanie Lukowski: Bone bed curator-preparators/
secondary education
Rosalie Symington, EDM mapper ARCHINFO programmer
Brian Agenbroad, and A. Bataglia Screenwash

b) Visiting scientists:

Dr. J. Tregworthy, Principia College, IL w/ 12 students

Dr. A. Hannus, Concordia College, SD

Dr. A. Outram, University of Exeter, UK w/14 students

Dr. M. Guebert, Wheaton College, IL w/ 15 students

Dr. J. Hardy, Vice President, Chadron State College, NB

Dr. Greg MacDonald, National Park Service, CO

Dr. M. Leite, Chadron State College, NB

Dr. Mark Fischer, University of Northern Illinois, IL

Kathy Kamp, Grinnell College, OH

John Whittaker, Grinnell College, OH

Kelly Maebery, Briar Cliff University, IA

Dr. Mark Muniz, St. Cloud University, MN

Dr. Peter Calengas, Western Illinois University, IL

Sue Ware, Denver Museum of Nature and Science, CO

Dr. Calvin Smith, Baylor University, TX

Dr. Russell Graham, Pennsylvania State University, PA w/ 10 students