

# EARTHWATCH INSTITUTE ANNUAL FIELD REPORT

**Project title:** Mammoth Graveyard  
**Date Report completed:** 11/28/07  
**Report completed by:** Larry D. Agenbroad

Dear Earthwatchers,

I apologize for the delay in sending of a letter of "Thanks" for your efforts as part of the Earthwatch Teams 2007! You were good crews and we accomplished some neat results.

Significant discoveries were made, including the 56<sup>th</sup> mammoth (by tusk count), and our total species count for the site is 85 species (34 of plants, 18 of mollusks, 3 of insects and 30 mammals... mammals, NOT mammoths). Even if you found a lesser bone, remember: you were the first human being to ever see it!

Thanks to all of you for your funds, part of your lives, your labor, comradeship, and participation in the 2007 Mammoth Hunters Teams! You have joined a small, elite group... Mammoth Hunters of North America. Again, thank you for your participation in the 2007 season.

Best wishes to you all

Larry D. Agenbroad, Director  
Mammoth Site

**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:

- b) In the 2007 field season, we recovered (or left *in situ*) 78 new specimens.
- c) Approximately 50% of the sinkhole deposits have been excavated and researched since 1974.
- d) To date, we have recovered 56 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 3 insect species.
- e) The recognition of non-mammoth trace fossils, such as the bird track found in 2007.

### Significance/Benefits of Research:

a) The site contains *in situ* preservation and display of mammoth remains where they died or were deposited. Excavation of the site has provided: training of 28 years of students and Earthwatch participants; generation of 75 professional abstracts or publications; 2 books; several television features; participation in 6 international conferences; a comparison mammoth population for other sites/collections; and numerous visiting scientists. The 2007 visitation included: intern program (8 students); distance learning programs and activities (46 students); school field trips (475 students) and classroom activities on-site (1417 students); a children's dig of simulated bones in a controlled area (2478 children); and substantial public visitation (>110,000 individuals).

Locally, the site brings income to the service businesses, such as the motels, grocery stores and gasoline stations, plus other attractions within the local area. Nationally, we are recognized as the premier mammoth locality for visitors, research, and information. Internationally, we participate in conferences and symposia, plus we have hosted 4 international scientific symposia.

b) Sustainability for extinct fauna is a moot point; however, we are setting standards for *in situ* preservation and exhibit of large paleontological fauna. We also serve as a 'clearing house' for discoveries anywhere in the world, via e-mail.

### Dissemination of Results

#### b) Scientific Papers:

- a) Mol, D., J. Shoshani, A. Tikhonov, B. van Geel, S. Sano, P. Lazarev, G. Boeskorov, and L. Agenbroad. The Yukagir Mammoth: brief history, 14 C dates, individual age, gender, size, physical and environmental conditions and storage. *Scientific Annals, School of Geology, Aristotle University, Thessaloniki, Greece. Special Volume 98:299-314. (2006)*
- b) Shoshani, J., M. Ferretti, A. Lister, L. Agenbroad, H. Saegusa, D. Mol, and K. Takahashi. Relationships within the Elephantinae using hyoid characters. *Quaternary International. Vol. 169-170:174-185. (2007)*
- c) Agenbroad, L. Santa Rosa Island, California: A Case for the first human presence and mammoth extinction as a synchronous event. *In* A. Stenger and A. Schneider, (eds.) *Proceedings of the International Science Conference: Science in Archaeology. Houston, TX. P. 190-200. (2007)*
- d) Agenbroad, L., and B. Huckell. The Hunting Camp at Murray Springs. *In* C. Vance Haynes, Jr. and B. Huckell (eds.) *Murray Springs, a Clovis site with multiple activity areas in the San Pedro Valley, Arizona. University of Arizona Press. Anthropological Papers No. 71:146-169. (2007)*

- e) Agenbroad, L., G. Haynes, E. Johnson, and M. Palombo (editors) World of elephants 2: Selected Papers from the 2<sup>nd</sup> Congress, Mammoth Site of Hot Springs. Quaternary International vols. 169-170:1-202. (2007)

**c) Presentations: (abstracts)**

- a) Agenbroad, L. California Islands Pygmy Mammoths (*Mammuthus exilis*): their origin, age, size, and extinction. Geological Society of America Annual Meeting; Philadelphia, PA. October, 2006. (Professional audience of ca. 100 individuals)
- b) Shoshani, J., N. Suzuki, A. Tikhonov, L. Agenbroad, B. Buigues, and P. Lazarev. Anatomical structures of the head and leg of the Yukagir mammoth (*Mammuthus primigenius*), and evolutionary inferences. 4<sup>th</sup> International Mammoth Conference. Yakutsk, Sakha Republic, Russia. June 2007. (Professional audience, ca. 75 individuals)
- c) Agenbroad, L., S. Lukowski, O. Potapova, and K. Thompson. Osteological atlas of Columbian mammoth (*Mammuthus columbi*) from the Mammoth Site of Hot Springs, South Dakota, USA. 4<sup>th</sup> International Mammoth Conference. Yakutsk, Sakha Republic, Russia. June, 2007. (professional audience of ca. 75 individuals)
- d) Potpova, O., R. Guzman, and L. Agenbroad. Remains of mammoth (*Mammuthus*) from Sedazo Local Fauna, Auguascalientes, Mexico. 4<sup>th</sup> International Mammoth Conference. Yakutsk, Sakha Republic, Russia. June, 2007. (Professional audience of ca 75 individuals)
- e) Thompson, K., L. Agenbroad, O. Potapova, and S. Holte. From salvage Operation to in situ preservation, techniques used in conservation at the Mammoth Site of Hot Springs, South Dakota. 57<sup>th</sup> annual meeting of the Society for Vertebrate Paleontology. Austin, TX. October, 2007. Professional audience of ca. 100 individuals)
- f) Falkingham, P., L. Agenbroad, K. Thompson, and P. Manning. Vertebrate tracks and their significance at the Mammoth Site (late Pleistocene) of Hot Springs, South Dakota. Geological Society of America annual meeting. Denver, CO. October, 2007. (professional audience of ca. 80 individuals)

**Films:**

- a) Prehistoric Predators: the giant short-faced bear. National Geographic Society.

**Volunteer tasks and Accomplishments:**

- a) Expertise, skills, ideas, etc. of the volunteers: the enthusiasm of the volunteers was outstanding. Their group spirit and compatibility was very high.
- b) The volunteers helped meet the objective of the project by excavation of tons of surrounding materials; discovering more than 70 specimens in the 2007 season; screen washing 129 bags of matrix; and training of 1 in-service teacher scholarship recipient. All team members were exposed to placing field casts on bones to be removed; mapping techniques; identifying bones; and determining the age of individuals by tooth analyses.

**Educational Opportunities:**

- 1) This project directly involves the following groups:
  - 1) Local community: the project has the support of the Chamber of Commerce; local motels; restaurants; businesses, and state and regional tourism markets.

- 2) Students: local students are hired as guides during the heavy tourist season.
- 3) We have an intern program for graduate students (8 in '07) getting practical experience on-site, interacting with the public, gaining molding and casting techniques, laboratory skills, and field excavation experience.
- 4) Early Career Scientists (2 in '07) are encouraged by direct participation in an active excavation. We have generated scholarships for students and in-service teachers (1 in '07).
- 5) Other groups include Elderhostel, national and international colleges and universities, Davidson Gifted Scholars program, and Project Exploration for inner city youth.
- 6) 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.
- 7) The Mammoth Site has provided graduate students the completion of 3 Master's Degree theses, 7 published papers and at least 16 professional presentations.

#### **Partnerships:**

- a) 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.
- b) These institutions have provided discussions, preservation advice, publications, forums for research questions and goals, and formats for presentations.
- c) 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 2007 Field Excavations at the Mammoth Site of Hot Springs, SD, Inc.**

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 56 mammoths (by tusk count), and associated fauna.

#### **III. HIGHLIGHTS: 2007:**

A total of 78 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 5 tons of sediment were screen washed 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.

#### **IV. 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 56 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, a camel, a llama, wolves and a variety of smaller animals. It is a natural laboratory for taphonomic studies.

With the 2007 field season, we celebrate the 33rd year since discovery of this unique repository.

The 2007 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, Trimble 5600 transit and ARC-GPS and ARC-Map mapping of the bones;
- d) Water screen 10% of sterile fill and 100% near bone.
- e) Discover new faunal remains.

#### **V. 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 and Trimble transits. The data are 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.

#### **VI: VOLUNTEER TASKS and ACCOMPLISHMENTS:**

- a) A Family Team of 10 members; two Earthwatch teams of 11 and 12 participants, respectively, were involved in 2007. One team member was provided an in-service teacher scholarship by the Frank Family Foundation. All participants excavated; screen washed; helped construct, or observe, plaster field jackets; did tooth metric analyses; and participated in bone identification and mapping (where applicable).
- b) A total of 78 new specimens were discovered; bags of screenwash were processed (equating to approximately 5 tons); and nearly fifteen tons of sediments were excavated from the site. Detailed excavation near bone was slow, but productive. Bulk sediment removal in the testing for the north-central sinkhole limit will be pursued further, in the future. New bone was discovered in this relatively 'sterile' area by Team II.
- c) There was the discovery of a trace fossil (bird track) in the clay horizons of the middle of the deposit.
- d) Some bones from prior seasons were removed to the laboratory. New areas of fill were explored. Bones to be removed for further excavation and detailing were selected and initially prepared for exhibit, or removal in 2007.

#### **VII. 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 screen washed for microfaunal remains. New material was identified, mapped and either left *in situ*, or transferred to the preparation

laboratory. One new individual (by tusk count) was recovered in the 2007 season, new bone localities were found and await further detailed excavation.

#### **VIII. DISCUSSION:**

- a) The objectives for the 2007 season were well met. Not every team member found new bone, but they increased the chances for future teams, by removal of overburden. Overburden removal has begun in untested portions of the site.
- b) Future excavation will continue with the 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 - 2007 promises 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. Representatives from the Waco, TX site, sought advice in creating a visitor facility there, similar to ours. They also wish to form a 'sister' facility for the Mammoth Site, or gain National Park status.

#### **IX. PUBLICATIONS:**

- a) Please see the attached listing.

#### **X. 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 at present.
  - 3) Educators in colleges and universities have used Mammoth Site materials for in-service workshops, field trips, and on-site educational activities.
  - 4) Merit badges for Boy Scouts and Girl Scouts have utilized Mammoth Site activities.
  - 5) Regional elementary schools regularly field trip to the Mammoth Site.
  - 6) College and University field schools regularly visit the Mammoth Site.
  - 7) Presentations on the educational opportunities developed at the Mammoth Site were presented at the Society for Vertebrate Paleontology in Austin, TX; a paper on the trace fossils from the Mammoth Site was given at the Geological Society of America annual meeting (Denver, CO) in October.
  - 8) Training of 8 graduate-post graduate interns.
  - 9) Conducting a Jr. Paleontology Excavation for 3-13 year olds using replica bones.

#### **XI. ACKNOWLEDGEMENTS:**

- a) Staff:
  - Dr. Larry Agenbroad, Principal Investigator
  - Wanda Agenbroad, Logistics coordinator
  - Don Morris, Crew Chief
  - Kris Thompson, and Stephanie Lukowski, DonEsker: Bone bed curator-preparator/secondary education
  - Rosalie Symington, EDM mapper ARCHINFO programmer
  - Don Esker Trimble 5600 mapper, ARC-GPS, ARC-Map facilitator.
  - Brian Agenbroad, Screen wash

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 Muniz, St. Cloud University, MN  
Dr. George Frison, University of Wyoming  
Sue Ware, Denver Museum of Nature and Science, CO  
Dr. Eric Grim Illinois State Museum  
Dr. Russell Graham, Pennsylvania State University, PA w/ 6 students  
Dr. H. Parkman, University of Washington  
Dr. Kelly Withers, University of South Queensland, Australia  
Dr. Leanna Timperley, Santa Fe, NM