

DISCOVERING

DINOSAURS



Edmontosaurus

TEACHERS PARTICIPATE IN DINODIG

BY CHLOE NORTHROP AND ARTHUR V. CHADWICK

Dinosaurs are hot! They fascinate children throughout their educational experience, often into high school and beyond. However, nearly all of the sources of interesting and exciting information about dinosaurs include statements about their evolutionary development and extinction within a context of millions of years. Not knowing how to counter this, some Christian educators have avoided the topic of dinosaurs altogether. This forces inquiring students to consult secular sources for information on the topic and guarantees that they will be exposed to fanciful stories that lack a biblical framework. What can you, as a Christian educator, tell your students about dinosaurs? Where can you turn for information that is accurate, current, and consistent with the biblical account of Creation and a global flood?

Now there is a source you can access that is not only exciting and fun, but that will also equip you to speak authoritatively about dinosaurs and to place them within biblical context.



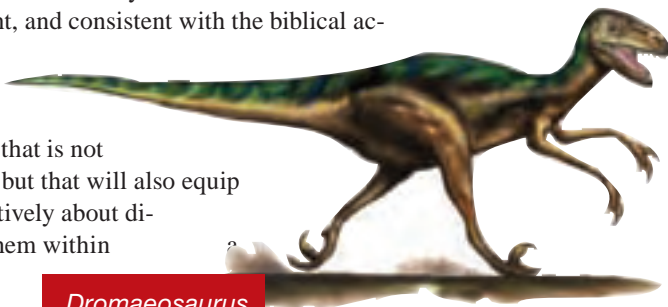
Archaeologist Celeste Voigt excavates an *Edmontosaurus* femur.

Dinosaur Research in Wyoming

Scientists from Southwestern Adventist University (SWAU) in Keene, Texas, have been excavating dinosaur fossils and conducting research on dinosaurs for more than 10 years in the Upper Cretaceous Lance Formation on a remote cattle ranch in eastern Wyoming, seeking to understand more about these fascinating creatures. The Dinosaur Research Project is part of a larger study of taphonomy, the science of reconstructing the causes of death and subsequent

history of fossil remains.

The site contains an extensive accumulation of fossil remains totaling more than 10,000 creatures, including 12 genera of dinosaurs, 10 genera of non-dinosaurian reptiles, seven genera of fish, five genera of mammals, as well as mollusks and even dinosaur eggshells in a deposit called a “bonebed.” The most numerous fossils at the site are bones of *Edmontosaurus*, the duckbilled dinosaur, a 30- to 40-foot-long herbivore that may have lived in water or a swamp-like environment. The remains of *Triceratops*, the three-horned plant-eating dinosaur, are also fairly



Dromaeosaurus

S AU I R S



The Hanson Research Station in eastern Wyoming, fully occupied by the Dinodig crew.

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common, along with *Tyrannosaurus*, *Pachycephalosaurus*, and *Dromaeosaurus*. The past several summers, we have been excavating the remains of a very rare carnivorous dinosaur, *Nanotyrannus*.

How Did They Get There?

When scientists find an accumulation of fossil bones, they often explain it in the following way: “A herd of dinosaurs (or other creatures) was crossing a river during flood stage. Some of the animals were swept away and drowned. Their bodies were carried down to a bend in the river where their carcasses lodged. As this continued over a period of hundreds or thousands of years, a bone deposit formed that subsequently was buried and fossilized.”

Our research has provided data that we can use to test the “bend in the river” scenario of the standard model. In the process, we have developed and employed innovative tools that enable us to extract data not generally available to other re-



Researchers in one of the quarries work to uncover the remains of *Nanotyrannus*, a rare carnivorous species of dinosaur.

searchers. The results to date indicate that our bonebed, one of the largest in the world, did not accumulate over time. Instead, a huge number of *Edmontosaurus* and a few other ornithomimid and theropod dinosaurs were killed in a single event or series of events. The carcasses subsequently rotted for a time, leaving a massive accumulation of bones, flesh, and theropod teeth, perhaps in a swampy freshwater area. Subsequently, a catastrophically triggered event re-suspended the bones and their entombing sediments and transported them rapidly to deeper water where they formed a graded bed, typical of a catastrophic debris flow. Over time, they were buried, uplifted, and finally, exposed again by modern erosion.

While this explanation does not require the catastrophe to have been the global flood of Noah, the interpretation is consistent with such an event.

Because this site represents a transported assemblage, we do not expect to learn much about the environment in which the animals lived. We do hope to better understand how this huge group of animals perished and how they came to reside in this Western continental interior site, how far they were transported, and in what direction. We may also be able to help reconstruct a picture of how they looked. On a nearby ranch, a *Triceratops* was recently discovered with a fairly complete impression of its skin. We are currently studying the remains of two *Triceratops* on our site. Only time will tell what additional mysteries lie beneath the eastern Wyoming hills.

Project Goals

The Dinosaur Research Project, begun in 1996 by Drs. Art



Digital reproduction of one of the major quarries, available online at the Dinosaur Research Project Website. The maps reconstruct the positions of all of the bones discovered with centimeter accuracy.



Dinosaur bones discovered at the dig site are stored in drawers back at the museum in Keene, Texas.

Chadwick and Lee Spencer (who is presently at Southern Adventist University) and now sponsored each June by Southwestern Adventist University and the Earth History Research Center, headquartered on the SWAU campus, is known informally as the “Dinodig.” From its inception, the project’s goals have included the following: conducting research; teaching college students; providing training, background, and information for elementary, secondary, and college teachers; and offering dinosaur enthusiasts the opportunity to travel to a remote section of the United States to participate in a truly remarkable project.

It is exciting and awe-invoking to realize the bone you have just recovered was once inside a magnificent living creature that is no longer on the earth.

For four weeks each year, volunteers work side by side with the scientists and experienced leaders in the quarries to expose the dinosaur bones buried there. All of the quarry leaders are themselves teachers who initially came for the experience or credit, but were so fascinated that they have become long-term participants in the project. It is not unusual for people to have spent nine or more seasons at the dig. Each year, more than 90 participants, scientists, teachers, students and volunteers make significant contributions to the research project.

Every participant unearths dinosaur bones that no human has ever touched. It is exciting and awe-invoking to realize the bone you have just recovered was once inside a magnificent living creature that is no longer on the earth. Because nearly 1,000 bones are found each summer, every participant is able to find something unique. But that is not all: Teachers return to the classroom energized and with authoritative information about these remarkable dinosaurs, which they can share from firsthand experience. By participating in the dig, teachers can receive Continuing Education Units or Professional Development Credits in laboratory science and gain real science exposure in the field.



Heather Roberts, a geologist now attending pharmacy school at Loma Linda University in California, conducting research at the Dinodig.



Nodosaurus



Dinosaur Research Project co-director Dr. Art Chadwick removes overburden from the bone layer in preparation for excavation of a dinosaur bone.



A radius (lower arm bone) from a duckbilled dinosaur found at the Dinodig.



Dinosaur Research Project co-director Dr. Larry Turner explains the layout of the quarries to new workers.



Difficult excavations require a group effort.

Research Incorporates Innovative Methods

The research being carried out at this Wyoming site includes advanced and innovative techniques that Drs. Art Chadwick and Larry Turner have developed and introduced to the scientific community. When a bone is discovered, the worker carefully exposes its surface using fine dental tools. Before it is removed, the bone is photographed using a digital camera. The surface contours of the bone are recorded using a high resolution Global Positioning System (GPS) that is accurate to millimeters. These data are stored in a computer and backed up in computers at the Southwestern Adventist University (SWAU) campus in Texas via satellite uplink Internet in camp. At the end of the season, each photograph is associated in the computer with the GPS data taken from the bone in the field, and the quarry is reconstructed in virtual 3-D. This allows researchers to examine the arrangement and orientation of the bones as they lay in the quarry, but with the dirt removed.

When the bones reach the SWAU campus, they are either encased in plaster jackets, foamed onto rigid supports, or wrapped in foil, surrounded by bubble wrap, and packed in boxes. In many research projects, ordinary specimens are shuttled off to a warehouse, never to be seen again. Not so for this project. The scientists at SWAU have as their goal to incorporate every specimen into the larger collections before they return to the field the following season. For this to happen, the bones must be unpacked, cleaned, repaired, labeled, and integrated into the museum collection. Much of this off-season work is done by student workers and teacher volunteers.

The online museum contains information about and photographs of the more than 10,000 bones that have been collected thus far. Once added to the collection, all new specimens are available as digital photographs and as 3-D Virtual Reality (3DVR) images, which can be rotated with the click of a computer mouse to view them from different perspectives. Check out the featured specimen at <http://fossil.swau.edu/>.

Each bone is coded so the investigator can use “map view” to see where it was located in the quarry. No other museum

site offers these features. The SWAU museum Website at <http://fossil.swau.edu> has been the subject of two papers at sci-

entific meetings and one professional publication. Over the past decade, various aspects of the research and the techniques used at the dig have been presented by Drs. Chadwick, Spencer, and Turner to their colleagues at annual professional meetings. The dig coordinators have also developed an educational site about the dinosaurs for public and private classroom use. You can find it at <http://dinosaur.swau.edu/>.

Experiencing the Dinodig

In addition to the interesting scientific discoveries, the experience of participating in the Dinosaur Research Project (Dinodig) is rich and deep. The camp is set among the bluffs and rolling countryside of the Wyoming “badlands.” Camp life begins stirring shortly after 5:00 a.m., when the meadowlarks begin trilling their melodious wake-up calls. The cooking crew is up at 6:00, breakfast is served at 7:00, followed by morning devotions; and participants are off to the quarries by 8:00. Although many choose to walk the mile through the grasslands in the cool of the morning, transportation is available most days. Quarry life centers on one of about five sites that are active each season. Each quarry has an experienced teacher as its leader.

The search for new discoveries continues until noon, when participants take a break for lunch. This is a time for visiting the other quarries to check on discoveries there, and to share experiences with friends. After lunch, work continues until 4:30 p.m., when the kitchen crew returns to camp to shower and prepare the evening meal. The rest of the workers return to camp at 5:30, supper is served at 6:00, and the evening lec-



The red dot on this map of the state of Wyoming is the Dinodig excavation site.



A well-preserved pubic bone from an *Edmontosaurus* dinosaur, being wrapped for shipment to the museum.



Educators Dr. Karen Jensen (left) and quarry supervisor Kathleen Wilson discuss a new find.



Quarry supervisor and academy science teacher Tyke Connell probes a newly discovered bone.

ture, usually on dinosaurs or a topic of interest on origins, begins at 7:30. After the lecture, there is time for study, personal development, or leisure activity. Then it's lights out, and quiet prevails in camp after 10:00.

Each participant has a basic tent, but the camp itself is a high-tech marvel. In addition to the satellite uplink, there is wireless Internet access, and plenty of computers are available for those who wish to send e-mails. There are also kitchen and eating areas with all the necessary components. The bathrooms feature hot and cold running water, showers, and privacy stalls. The lecture area has a video projector and screen to facilitate the evening lectures by the professors.

Daily responsibilities are divided and shared by the groups, so that each person participates in keeping the camp running efficiently. Every morning, participants attend morning worship before work begins in the quarries. There is usually music and a short devotional thought to start the day off right. On Friday afternoon, the weekly schedule changes, and the group goes to Newcastle (about an hour away) to do laundry, purchase needed supplies, and make Sabbath preparations.

Sabbath is a day of rest and fellowship for the people at the camp. Everyone has a chance to reflect on the week and enjoy time together. After worship, there are nature walks and plenty of outdoor activities. Without the distraction of television and with only limited cell phone reception, it is a great time to re-



Geologist Ryan Thompson examines the outcrop for clues to its origin.

Teachers return to the classroom energized and with authoritative information about these remarkable dinosaurs, which they can share from firsthand experience.

charge one's batteries and relax in a way that is impossible at home.

Many participants come for the entire month of the Dinodig, while some choose to stay for as little as a day. There are many exciting tourist destinations nearby, including Mount Rushmore, Crazy Horse, Devils Tower, Custer State Park, Jewell Cave, and many museums. The dig schedule includes day trips that enhance the participants' knowledge of the surrounding area.

Every participant in the Dinosaur Research Project is important to its overall success. It takes many dedicated people to ensure the continuation of this significant research. The teachers who attend for continuing education credit play a large part in setting the direction for the group.



Professor Tetsuya Yamamoto from Japan contributes his paleontological expertise to the project.



Patcy Dorn, dig participant, takes a break to enjoy the scenery from the top of one of the quarries.



Justin Woods, technical director for the Hanson Research Station, makes adjustments to the GPS mapping system.



Quarry workers hoist a giant femur (thigh bone) from an unidentified dinosaur.

and current Director of the Earth History Research Center, a global consortium of research scientists focused on issues of

origins; and Director of the Dinosaur Research Project. Dr. Chadwick earned his doctorate from the University of Miami, followed by additional work in geology at the University of California, and university teaching at several institutions before coming to SWAU. He has participated in taphonomic research on a Miocene project in Peru involving fossil whales and has carried out and published sedimentological research on the Tapeats Sandstone in the Grand Canyon and on the fossil forests in Yellowstone National Park. He is continuing a lifelong study of the global circulation patterns from the geologic record.

Getting There

If you are interested in participating in this project, you can find details about the cost and other information at the Dinodig site: <http://dinodig.swau.edu>. Participants who cannot make the early June start date because of school commitments are still welcome to participate. The nearest airport is in Rapid City, South Dakota. Transportation from the airport is available on a set schedule. Participants staying for the entire season can ride with the directors from Keene, or can be picked up along the way if they live on the route between Texas and Wyoming. People wishing to drive will be provided with directions after they register for the dig.

We invite you to join us! You cannot imagine what is in store for you if you have never participated. It will change your life. ✉



Chloe Northrop



Arthur Chadwick

Chloe Northrop is a graduate student at the University of North Texas in Denton, working on a Master of Arts in History. She graduated from Southwestern Adventist University, and

has participated in the Dinodig six times. **Arthur V. Chadwick, Ph.D.**, is Research Professor of Geology and Biology at Southwestern Adventist University in Keene, Texas. He is a co-founder

This article has been peer reviewed.

SOURCES CITED, in Chronological Order

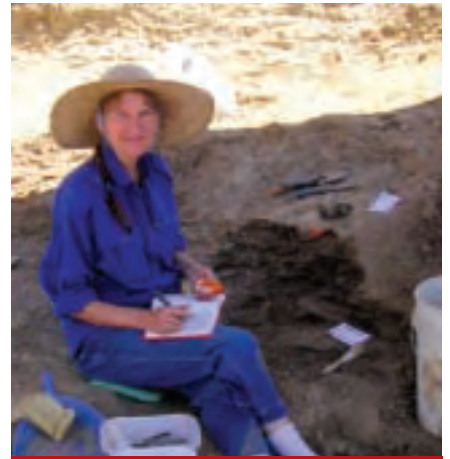
- L. E. Turner, A. V. Chadwick, and L. Spencer, "High Resolution GPS Mapping in a Vertebrate Taphonomic Quarry." Geological Society of America. Abstracts with Program (2000); 32:A499.
- L. Spencer, L. Turner, and A. V. Chadwick, "A Remarkable Vertebrate Assemblage From the Lance Formation, Niobrara County, Wyoming." Geological Society of America. Abstracts with Program (2001) 33:A499.
- A. Chadwick, L. Turner, and L. Spencer, "Digital Modeling of a Vertebrate Taphonomic Quarry Using GIS Software," *Journal of Vertebrate Paleontology* 22 (2002), p. 43A.
- A. Chadwick, L. Turner, and L. Spencer, "Recreating an Upper Cretaceous Dinosaur Assemblage with GIS Software," *Journal of Vertebrate Paleontology* 23 (2003), p. 40A.
- A. V. Chadwick, L. E. Turner, and Lee Spencer, "Five Years' Experience Using GIS for Data Collection and Analysis in an Upper Cretaceous Dinosaur Quarry in the Lance Formation," *Journal of Vertebrate Paleontology* 24 (2004), p. 45A.



Scouting for new finds at a paleontologist's dream site.



Tyke Connell excavates a huge dinosaur femur.



Paleobotanist Dr. Karen Jensen records another exciting find.



Sixty-five of the 90 participants in the 2008 dig gather for a group photo.



Tyrannosaurus Rex

- L. E. Turner, A. V. Chadwick, and Lee Spencer, "Using Rocket Science to Study Rock Science," *Journal of Vertebrate Paleontology* 24 (2004), p. 123A.
- J. Woods and A. V. Chadwick, "Development of an On-Line Database With GIS Connections for Vertebrate and Other Fossils," Geological Society of America. Abstracts with Programs 37:7 (2005), p. 44.
- A. V. Chadwick, Lee Spencer, and L. E. Turner, "Taphonomic Windows Into an Upper Cretaceous *Edmontosaurus* Bonebed," Geological Society of America. Abstracts with Programs 37:7 (2005), p. 159.
- A. Chadwick, L. Spencer, and L. Turner, "Preliminary Depositional Model for an Upper Cretaceous *Edmontosaurus* Bonebed," *Journal of Vertebrate Paleontology* 26 (2006), p. 49A.
- J. Woods and A. Chadwick, "Development of an On-Line Database With GIS Connections for Vertebrate and Other Fossils, in Collaboration for the Dissemination of Geologic Information Among Colleagues," A. Fleming, ed., Proceedings, Geoscience Information Society, Alexandria, Virginia 36 (2007), pp. 53-69.
- J. Woods and A. Chadwick, "Development and Use of 3-D Virtual Reality Movies in an Online Fossil Museum," Geological Society of America. Abstracts with Programs 39:6 (2007), p. 64.
- D. Eberth, M. Shannon, and B. Noland, "A Bonebeds Database: Classification, Biases, and Patterns of Occurrence." In R. Rogers, D. Eberth, and A. Fiorello, eds., *Bonebeds, Genesis, Analysis, and Paleobiological Significance* (Chi-

- cago: University of Chicago Press, 2007).
- P. Larsen, M. Larsen, C. Ort, and R. Baaker, "Skinning a Triceratops," *Journal of Vertebrate Paleontology* 27 (2007), p. 104A.

For Additional Reading

Dinosaurs, Where Did They Come From? And Where Did They Go? (Pacific Press, 2006). This authoritative and substantive children's book by Adventist geologist Dr. Elaine Kennedy provides good talking points for science classrooms.

Dinosaurs: An Adventist View (Clarion Call Books, 2009). This scholarly book by Adventist lawyer David C. Read covers many of the questions that Adventist educators at all levels must face in the classroom.

Both of these books should be available at Adventist Book Centers and online.

An article by James Haywood in an earlier edition of the JOURNAL provided information on dinosaurs' reproductive habits and eggs, as well as helpful classroom activities: <http://circle.adventist.org/files/jae/en/jae200567032909.pdf>.