

THE HISTORY OF THE NORTH DAKOTA GEOLOGICAL SURVEY PUBLIC FOSSIL DIG PROGRAM

By John W. Hoganson

Introduction:

In 2000, I met with representatives of the North Dakota Department of Tourism (now the North Dakota Department of Commerce Tourism Division) to discuss the possibility of providing fossil dig experiences to the general public. A trend was noted at that time that more and more people were looking for outdoor adventures, or as we now refer to them, ecotourism experiences. This, coupled with the popularity of dinosaurs, prompted museums, universities, and others in the western states where fossils are found to offer these kinds of ecotourism adventures. We had been relying on our staff and volunteers to carry out our fossil excavations and paleontological field inventories. Public fossil digs would not only help in our efforts to develop the North Dakota State Fossil Collection but would also attract tourists to North Dakota. A unique kind of economic diversity would be provided to some areas of the state where paleontological resources occur. This kind of educational experience would also be available to North Dakota residents.

Since 2000, the program has expanded dramatically. In that year, we offered one fossil dig experience. In 2008, and again next year, we will be offering four separate dig experiences (fig. 1). Each of the digs is about one week in duration. At the onset, it was realized that the NDGS would have to rely on non-profit partners to handle the logistics of participant registration, food, lodging etc. The partners receive the fees charged to the participants. The NDGS fossil dig program is part of the North Dakota Tourism Learning Based Vacations Program, now referred to as Education Vacations. Thousands of fossil specimens, some of great scientific interest and significance, have been recovered during these excavations. These fossils have

provided information about life in North Dakota during prehistoric times. The following are highlights of some of the past digs.

Pembina Gorge Excavations

An extensive rock exposure along a scenic hillside road in the Pembina Gorge area of northeastern North Dakota near Walhalla was the setting for our first public fossil dig in 2000. The site is state-owned land and a North Dakota Wildlife Management Area. The Cretaceous Niobrara and Pierre Formations are exposed along the road. A fossiliferous shale occurs at the base of the Pierre and our excavation efforts were concentrated on that shale (fig. 2). The 2000 - 2002 digs were co-sponsored by the North Dakota Parks and Recreation Department, managers of the land where the site is located.



Figure 2. Fossil dig participants at Pembina Gorge site, 2001.

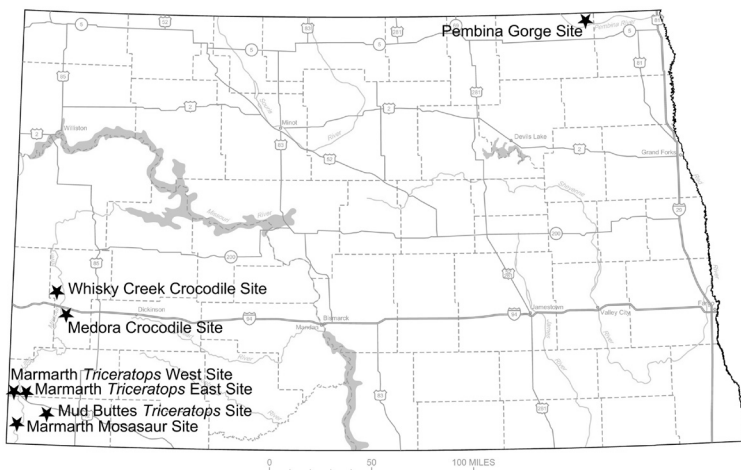


Figure 1. Public fossil dig localities in North Dakota.

About 80 million years ago North Dakota was covered by a warm, shallow-water ocean. The fossils found in the Pierre Formation at the Pembina Gorge site are the remains of animals that lived in that ocean including marine reptiles (mosasaurs, plesiosaurs, turtles); sharks and other fish; sea birds; and invertebrates including squids, gastropods (snails), bivalves (clams), and cephalopods. The most spectacular fossil found at this site is the 6-foot-long gladius (pen) of a giant squid (fig. 3). Squids have a hard support structure composed of shelly material in the posterior part of their bodies called a gladius. The 6-foot-long fossil indicates that the squid was at least 15 feet long! These initial public fossil digs were a resounding success because we recovered some scientifically important fossils and because of the public interest



Figure 3. The giant, 15-foot-long, squid, *Tusoteuthis*, in combat with a mosasaur. Painting courtesy of the Canadian Fossil Discovery Center.

Marmarth Mosasaur Site

Another important Pierre Formation site was discovered in the southwestern corner of North Dakota on Bureau of Land Management-administered property by members of the Marmarth Research Foundation, a foundation established by Tyler Lyson and Doug Hanks to collect and preserve fossils from the Marmarth area. At



Figure 4. Participants excavating a mosasaur skeleton at the Marmarth mosasaur site, 2006.



Figure 5. Mosasaur, a large marine lizard.

this site, a partial skeleton of a mosasaur was found (figs. 4 and 5). The NDGS collaborated with the Marmarth Research Foundation, with support from the Bureau of Land Management, to excavate the fossil in 2006. This is a beautiful, articulated specimen except for the skull and front part of the skeleton, which had eroded away before the fossil was discovered.

Marmarth *Triceratops* Excavations

Our first public fossil dig to collect the remains of a dinosaur was conducted in 2002 (fig. 6). At this site near Marmarth, the skull and partial skeleton of a *Triceratops* was weathering out of a sandstone (ancient river channel) in the 65-million-year-old Hell Creek Formation (fig. 7). At that time, western North Dakota was a warm, humid, deltaic

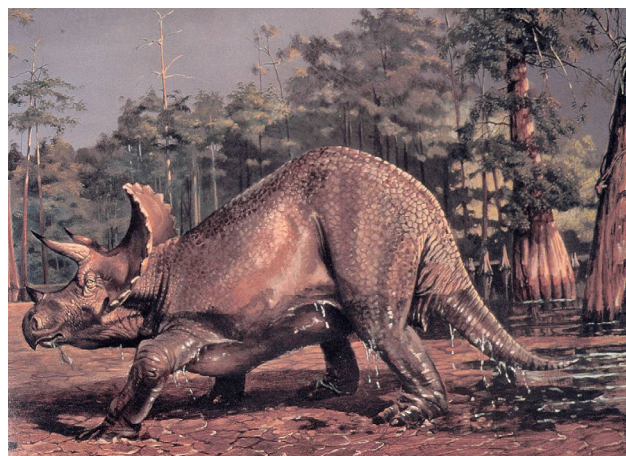


Figure 6. The 3-horned dinosaur, *Triceratops*. Painting by Eleanor Kish.



Figure 7. Participants excavating a *Triceratops* skeleton at the Marmarth *Triceratops* west site, 2002.

coastal plain that provided habitats for several species of dinosaurs and other exotic plants and animals. This site is located on United States Forest Service/Dakota Prairie Grasslands-administered land. The NDGS co-sponsored this public dig with the Forest Service. The partial skeleton of a *Triceratops* was recovered during this 10-day-long dig.

We excavated a second partial skull of a *Triceratops* from the Marmarth area during a 2007 public fossil dig. The fossil was again found on USFS/Dakota Prairie Grasslands-administered land who provided an excavation permit and enthusiastically supported the dig. The NDGS formed a partnership with the Marmarth Research Foundation to work this site. During a break from the *Triceratops* excavation a major discovery was made while exploring for other fossils. A nearly complete skull of the marsupial mammal, *Didelphadon*, was found weathering out of the Hell Creek Formation. Mammals lived with the dinosaurs at the end of the Cretaceous about 65 million years ago but they were diminutive, only mouse and rat size. Their remains are not commonly found and mostly only isolated teeth have been recovered. This is the first nearly complete *Didelphadon* skull ever found.

We returned to this site in 2008 to finish excavation of the *Triceratops* skull but spent most of the week prospecting for fossils and inventorying fossil sites on this USFS/Dakota Prairie Grasslands-administered section. This project was again co-sponsored by the Marmarth Research Foundation. Two significant discoveries were made, a beautifully preserved *Triceratops* brow horn and a complete carapace (upper shell) of a soft-shelled turtle. These fossils were again collected from the Hell Creek Formation.

Mud Buttes *Triceratops* Excavations

The Mud Buttes site south of Rhame has been recognized as an important Hell Creek Formation fossil site for many years because of the abundant vertebrate and plant fossils found there and because it is one of the few places in the world where the Cretaceous-Tertiary (K-T) boundary is recognized. (The K-T boundary marks the extinction event that killed off the dinosaurs and about 75% of all plants and animals living at this time, about 65 million years ago.) The Pioneer Trails Regional Museum, under direction of Dean Pearson, has been studying fossils from this site for many years. In 2007, the NDGS teamed up with that museum to collect the remains of two *Triceratops* dinosaurs. The site is administered by the Bureau of Land Management, they have been partners in the public fossil digs at this site. A very important Hell Creek Formation fossil leaf site also occurs here. Collecting leaf fossils from this site was a priority of the 2008 public dig.

Medora Crocodile Site

There are some fossil sites that are extensive, prolific, and take several years to excavate. The Medora crocodile site is one of these. Between about 60 million and 50 million years ago, during the Paleocene, rivers and streams deposited sediments eroded from the Rocky Mountains and other western sources over much of western North Dakota. Swamps also covered vast areas of the western part of the state. The climate was hot and humid, similar to south Florida today. Exotic plants, such as dawn redwood, *Ginkgo*, bald cypress, *Magnolia*, and even palm

trees grew in these swampy lowlands and vast forests that covered parts of western North Dakota. The ponds and swamps were inhabited by crocodiles, alligators, crocodile-like champsosaurs, turtles, salamanders, mammals, bivalves (clams), gastropods (snails), and insects. One of these fossiliferous swamp deposits in the Sentinel Butte Formation is found at the Medora crocodile site.

The site is on Theodore Roosevelt Medora Foundation property and the NDGS is co-sponsoring public fossil digs at this site with that foundation (fig. 8). We have learned a great deal about what life was like 60 million years ago in North Dakota from fossils found there. So far, fossils recovered include: two partial skeletons of the fish-eating, crocodile-like *Champsosaurus gigas*; a partial skeleton and teeth from many individuals of the crocodile *Borealosuchus* (fig. 9); remains of at least five kinds of fish including the gar, *Lepisosteus*, and dogfish, *Amia*; shell parts from three kinds of turtles including the soft-shelled turtle, *Plastomenus*; vertebrae of the large salamander, *Piceoerpeton*; trace fossils including worm burrows and crocodile coprolites (fossil feces); freshwater snails (*Campeloma*) and clams (mussels); and plant remains. We will continue to conduct public fossil digs at this site for at least two more years.



Figure 8. Participants at the Medora crocodile dig site, 2007.



Figure 9. Participant holding a crocodile tooth at the Medora crocodile dig site, 2007.



Figure 10. Participants at the Whiskey Creek crocodile site, 2008.

Whiskey Creek Crocodile Site

We are excited about the scientific potential of a new fossil crocodile site in the remote badlands west of Medora (fig. 10). This site was discovered several years ago by Doug Hanks, at that time with the Science Museum of Minnesota and currently with the Marmarth Research Foundation. The site remained uninvestigated until our public fossil dig there in August, 2008. This site is on USFS/Dakota Prairie Grasslands-administered lands and they are providing full support for excavations at the site. Again, we are collaborating with the Marmarth Research Foundation on this excavation. Abundant crocodile bones are found in the Paleocene (~60-million-year-old) Bullion Creek Formation. Even though work is just starting at this site we

are hopeful that a crocodile skeleton will emerge. There is also a crocodile trackway in a hard, resistant siltstone at this site and an adjacent site is yielding mammal remains. The Whiskey Creek site will be a focus of our 2009 public fossil dig program and probably for years to come.

Future Direction of the NDGS Public Fossil Dig Program

The success of the NDGS public fossil dig program can be measured by the number of people that have participated, the number of people that have returned to North Dakota to participate again, and the number of people we have had to place on waiting lists because we can only accommodate a few people on these fossil sites each day. Hundreds of people from 24 states and 4 foreign countries have come to North Dakota to take advantage of this opportunity (fig. 11). This program has brought a number of people to North Dakota who might otherwise not have come to the state. One example is a well traveled retired couple from Ohio who had been to every state except North Dakota. One of our fossil digs prompted them to come here and they spent two weeks after the dig exploring many areas of the state.

In addition to the sites described above there is no doubt that additional fossil sites will be discovered that will provide opportunities for future public fossil digs. If you are interested in participating with us on professionally administered, scientific fossil excavations contact the North Dakota Geological Survey.

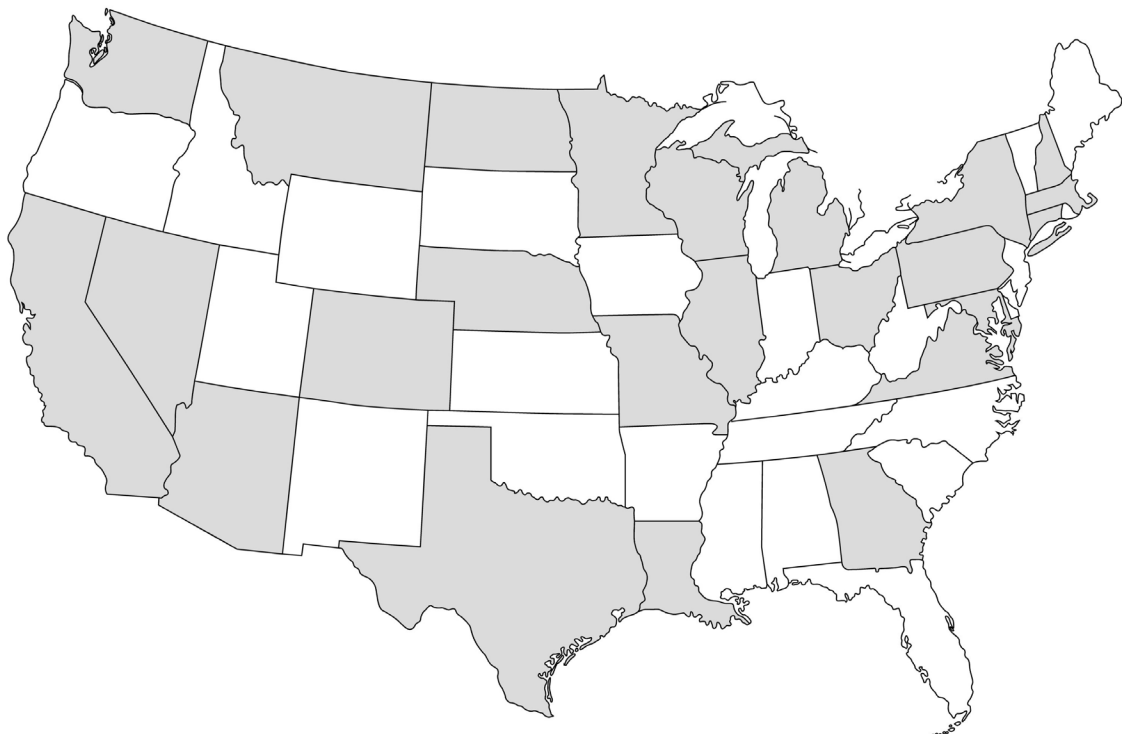


Figure 11. Participants in the NDGS public fossil dig program have come from 24 states (in gray).