Paleontologists tour North Dakota's internationally significant fossil sites in association with the 2003 annual meeting of the Society of Vertebrate Paleontology

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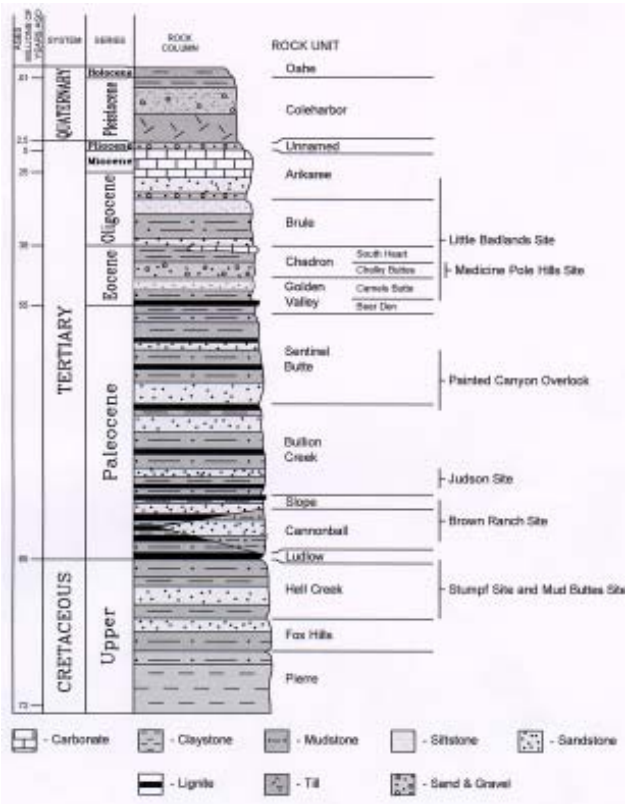
Introduction

The Society of Vertebrate Paleontology (SVP) consists of scientists and avocationists interested in paleontology, particularly those interested in fossils of vertebrate animals and invertebrate animals and plants associated with them. Each year, members of this international society meet to present the results of current research about recent fossil finds, discuss the significance of the finds, share information about latest techniques in preparation and preservation of fossils, discuss fossil resource management issues, and enjoin on many other topics. Annual meetings of the SVP are typically held in different cities in the United States. Last year's annual meeting was held in Norman, Oklahoma, but meetings have also taken place in Toronto and Mexico City. The 2003 conference was in St. Paul, Minnesota, and was attended by about 1000 paleontologists.

A premeeting field trip to an area of paleontological interest usually occurs prior to the four-day-long conference. This year, internationally significant fossil sites in North Dakota were the subject of the field trip. Joseph Hartman, paleontologist with the University of North Dakota Department of Geology and Geological Engineering, was the primary field trip organizer. Coleaders of the trip included John Hoganson, North Dakota Geological Survey; Allen Kihm, Minot State University; Dean Pearson, Pioneer Trails Regional Museum, Bowman; and John Hunter, New York Institute of Technology, Old Westbury. Student facilitators and presenters were Karew Schumaker (of Minot), Minot State University, and Georgia Knauss (of Bowman), University of Iowa, Iowa City. The 27 field trip participants, listed below, represented five countries and ten states (Table 1).

Figure 1. *Location of sites visited by the SVP field trip: 1. Stumpf Site Natural Area; 2. Johnsrud Paleontology Laboratory, North Dakota Heritage Center; 3. Judson Site; 4. Little Badlands Natural Area; 5. Mud Buttes Site; 6. Medicine Pole Hills Site; 7. Pioneer Trails Regional Museum, Bowman; 8. Brown Ranch Site; and 9. Painted Canyon Overlook, Theodore Roosevelt National Park.*



Others that joined the group at various times on the trip were Brett Woodward, North Dakota Geological Survey; John Stumpf, owner of the Stumpf Site; and Terry Schaefer, Blaine Schaefer, and Merle Clark, Pioneer Trails Regional Museum.

The 1600-mile, three-day field excursion began at the SVP annual meeting headquarters in downtown St. Paul. A running commentary about the geology that the three-van caravan traveled through in Minnesota and North Dakota was accomplished by two-way radio communication between the vans. In the afternoon of the first day, we arrived at our first fossil site stop, the Stumpf Site Natural Area south of Huff.

Stumpf Site Natural Area

Extensive exposures of the Cretaceous Hell Creek Formation and overlying Paleocene Ludlow Formation occur along the Missouri River escarpment and in erosional outliers associated with the escarpment near Huff in Morton County.

Figure 2. *Stratigraphic column of North Dakota showing names and ages of rock units exposed at the fossil sites visited by the SVP field trip. The term Slope Formation is not used by all geologists and is referred to by some as the Ludlow, particularly at the Brown Ranch Site. The Bullion Creek Formation is also called the Tongue River.*

Table 1. Participants in the 2003 annual meeting of Society of Vertebrate Paleontology field trip to North Dakota fossil sites.

Arvid Aase	Fossil Butte National Monument, Kemmerer, Wyoming
John Alroy	University of California-Santa Barbara
Richard Baer	Lathrup Village, Michigan
David Chopp	Oconomowoc, Wisconsin
Christian Cicimurri	Clemson University, Clemson, South Carolina
David Cicimurri	Clemson University, Clemson, South Carolina
William Clemens	Museum of Paleontology, University of California, Berkeley
Stephen Cumbaa	Canadian Museum of Nature, Ottawa, Ontario
Philip Currie	Royal Tyrrell Museum of Palaeontology, Drumheller, Alberta
Kevin Dermody	State Museum of Pennsylvania, Carlisle
Eric Dewar	University of Massachusetts, Amherst
Dougal Dixon	Boyds Mills Press, Dorset, United Kingdom
Bryan England	College of Charleston, Department of Biology, South Carolina
Masato Fujita	Board of Education of Ohyama Town, Toyama, Japan
Bill Gallagher	New Jersey State Museum, Trenton
Phil Gensler	Hagerman Fossil Beds National Monument, Hagerman, Idaho
Jon Graff	San Jose, California
Naoki Ikegami	Mifune Dinosaur Museum, Kumamoto Pref., Japan
Eva Koppelhus	Royal Tyrrell Museum of Palaeontology, Drumheller, Alberta
Mona Marsovsky	Alberta Palaeontological Society, Calgary, Alberta
Vaclav Marsovsky	Alberta Palaeontological Society, Calgary, Alberta
Bevin O=Grady	Rutgers University, Camden, New Jersey
John Pappas	Rutgers University, Camden, New Jersey
Kenneth Stadtman	Brigham Young University, Provo, Utah
John Strong	Anza-Borrego Desert State Park, Corona Del Mar, California
Yukimitsu Tomida	National Science Museum Department of Geology, Tokyo, Japan
Wighart von Koenigswarld	Institut fur Palaeontologie, Bonn, Germany

One of the most complete Hell Creek Formation sections in south-central North Dakota is seen at the Stumpf Site, where the lower contact of the Hell Creek Formation with the underlying Cretaceous Fox Hills Formation and the upper contact of the Hell Creek Formation with the Ludlow Formation are exposed. Also at this site, the marine Breien Member of the Hell Creek Formation and marine Cantapeta Tongue of the Hell Creek Formation have been identified. The Cretaceous/Tertiary (K/T) boundary has also been roughly approximated in this section.

At the Stumpf Site, the Hell Creek Formation consists of poorly cemented fine-grained sandstone, siltstone, carbonaceous-rich shale, mudstone, and rare lignite beds. These rocks have yielded the fossil remains of dinosaurs, mammals, fish, amphibians, turtles, crocodiles, alligators, champsosaurs, freshwater mollusks (snails and clams), and leaves. Fossils of marine animals, including sharks, ratfish, and oysters and other marine mollusks, have been found in the marine sandstone of the Breien Member of the Hell Creek Formation at this site.

Figure 3. *Somber gray beds of the Hell Creek Formation exposed at the Stumpf Site Natural Area. (Photo by Joseph Hartman).*

Figure 4*. Field trip members standing on a Hell Creek Formation sandstone surface at the Stumpf Site Natural Area. (l.to r.) Dean Pearson, Bill Clemens, Joseph Hartman, Georgia Knauss, and John Hunter. (Photo by John Hoganson).*

Figure 5. *John Hoganson (with backpack and pick) is explaining the significance of the Breien Member of the Hell Creek Formation at the Stumpf Site Natural Area. John is standing on Breien Member sandstone. (Photo by Joseph Hartman).*

Figure 6. *Georgia Knauss showing a* Tyrannosaurus rex *tooth to field trip participants recovered from a microsite at the Stumpf Site Natural Area. (l. to r.) Masato Fujita, Bill Gallagher, Dougal Dixon, Georgia Knauss, Steve Cumbaa, John Alroy, and John Strong. (Photo by John Hoganson).*

Figure 7. *Phil Currie and Yukimitsu Tomida examining a Hell Creek outcrop at the Stumpf Site Natural Area. (Photo by John Hoganson).*

After a visit to the Stumpf Site, the group toured the North Dakota Geological Survey's Johnsrud Paleontology Laboratory at the North Dakota Heritage Center and fossil exhibits in the museum.

Figure 8. *SVP field trip participants examining fossils in the Johnsrud Paleontology Laboratory at the North Dakota Heritage Center, Bismarck. (Photo by Joseph Hartman).*

Judson Site

Day two began with a stop at the Judson Site, near the town of Judson, Morton County. The Judson Site consists of a series of roadcuts on the uplands at the western margin of the Heart River Valley. At this site, the Paleocene Bullion Creek Formation (Tongue River Formation) is exposed and has yielded an important late Paleocene mammalian fauna called the Judson Local Fauna. Fossils of 28 different kinds of mammals, including multituberculates, insectivorans, primates, and condylarths, have been recovered from this site. This is one of the most diverse late Paleocene mammal sites in the country.

Figure 9. *Allen Kihm discussing the paleontological significance of the Judson Local Fauna at the Judson Site. (Photo by John Hoganson).*

Little Badlands Site

The Little Badlands is an area in southwestern Stark County where the Golden Valley Formation, White River Group (Chadron and Brule Formations), and Arikaree Formation are exposed. Three localities within the Little Badlands, the Little Badlands Proper, Obritsch Ranch, and Fitterer Ranch, contain the largest outcrop area of the White River Group in North Dakota. The Little Badlands Proper is sometimes referred to as the South Heart Badlands. In 1988, the Little Badlands Proper and the Fitterer Ranch sites were added to the registry of North Dakota Natural Areas because of their importance as paleontological sites.

Throughout the badlands area, the Eocene Chadron Formation is underlain unconformably by golden micaceous sandstone of the Camels Butte Member of the Golden Valley Formation. The Chadron Formation is divided into the lower Chalky Buttes Member consisting of white, gravel-bearing sandstone and mudstone and the upper gray claystone of the South Heart Member. Fossil remains of elephant-size brontotheres and primitive horses have been found in the Chadron Formation in this area. The Chadron Formation is overlain by the Oligocene Brule Formation in the Little Badlands. The Brule consists of pinkish-brown to gray-green complexly interbedded claystone, calcareous mudstone, siltstone, freshwater limestone, tuffaceous beds, and crossbedded sandstone beds. This formation is very fossiliferous and has yielded the remains of at least 90 kinds of mammals (including rhinoceros, camels, horses, rodents, rabbits, and saber-tooth cats), fish, amphibians, reptiles, birds, and snails. The Brule Formation is overlain in some areas of the Little Badlands by sandstones of the Arikaree Formation.

Figure 10. *White River Group (Chadron and Brule Formations) outcrops at the Little Badlands Natural Area. (Photo by John Hoganson).*

Mud Buttes Site

One of the most significant Hell Creek Formation sites in North Dakota is in an area called Mud Buttes on Bureau of Land Management-administered land, Bowman County. At this site, in badland terrain, the Cretaceous Hell Creek Formation is exposed and is overlain by the Paleocene Ludlow Formation. At the Mud Buttes Site, the Hell Creek Formation consists of somber gray-colored mudstone, interpreted to be floodplain paleosols, and lenticular sandstone and mudstone beds, deposited in lakes and river channels. The Ludlow Formation consists of sandstone, variegated mudstone, carbonaceous shale, and lignite beds. The contact between these formations is placed at the bottom of the lowest laterally continuous lignite, although when the lignite is absent, the contact is not as easy to define.

One reason that the Mud Buttes Site is significant is because the K/T boundary has been identified there. The boundary is coincident with the formational contact and is recognized by fossil pollen and the presence of shocked quartz and iridium. Remains of dinosaurs (at least eight kinds), lizards, mammals, turtles, crocodiles, fish, and mollusks have been recovered during numerous paleontological studies at Mud Buttes. A locality at Mud Buttes has produced one of the most diverse fossil leaf assemblages known from the Hell Creek Formation.

Figure 11. *Kevin Demody and Bill Gallagher searching for mammalian fossils in the Brule Formation at the Little Badlands Natural Area. (Photo by John Hoganson).*

Figure 12. *Phil Gensler holding the jaw of an oreodont (sheep-like mammal) that he found weathering out of the Brule Formation at the Little Badlands Natural Area. (Photo by Joseph Hartman).*

Figure 13. *SVP field trip participants at the Mud Buttes Site standing on a Hell Creek outcrop. Front row (l. to r.) David Cicimurri, Christian Cicimurri, Richard Baer, Arvid Aase, Kevin Demody, John Alroy, Georgian Knauss, John Hunter; Second row (l. to r.) Karew Schumaker, Yukimitsu Tomida, Mona Marsovsky, Steve Cumbaa, Dougal Dixon, Bill Gallagher, Wighart von Koenigswald, Jon Graff, Eva Koppelhus; Third row (l. to r.) Brett Woodward, Phil Gensler, Masato Fujita, Naoki Ikegami, John Pappas, Ken Stadtman, Phil Currie; Fourth row (l. to r.) Bevin O'Grady, Vaclav Marsovsky, John Hoganson, John Strong, David Chopp, Bill Clemens, Eric Dewar; Back row (l. to r.) Allen Kihm, Terry Schaefer, Blaine Schaefer. Dean Pearson was not present for the photograph. (Photo by Joseph Hartman).*

Figure 14. *Georgian Knauss (holding diagram) provided an interpretation of the K/T boundary at the Mud Buttes Site. She and others are standing on The K/T boundary. The Ludlow Formation is above and the Hell Creek Formation is below the K/T boundary. (Photo by John Hoganson).*

Figure 15*. The K/T boundary clay at the Mud Buttes Site is being pointed out by John Hunter. (Photo by John Hoganson).*

Medicine Pole Hills Site

The Medicine Pole Hills Site is a series of small vegetated (pastureland) buttes located south of Rhame, Bowman County. Blowouts and fluvial erosion have exposed isolated outcrops of sandstone and conglomeratic sandstone at the summit of some of the small buttes. These sandstones have been interpreted to be the Chalky Buttes Member of the Eocene Chadron Formation. A sandstone outcrop contains the most significant Chadron Formation fossil site in North Dakota. The fossil fauna recovered from the site is called the Medicine Pole Hills Local Fauna. An extremely diverse vertebrate fauna has been recovered from a quarry at this site. The fauna includes fish, amphibians, turtles, crocodylians, lizards, snakes, birds, and mammals. Fossils from this site are currently being studied by several paleontologists.

At the end of the day, the group visited the paleontology laboratory and fossil exhibits at the Pioneer Trails Regional Museum in Bowman.

Figure 16. *Karew Schumaker (with the knit hat) and Allen Kihm, paleontologists at Minot State University working on the Medicine Pole Hills fauna are discussing the significance of the Medicine Pole Hills Local Fauna at the Medicine Pole Hills Site. (Photo by John Hoganson).*

Figure 17*. Phil Currie examining fossils at the Pioneer Trails Regional Museum paleontology laboratory. (Photo by Joseph Hartman).*

Brown Ranch Site

Day three began with a journey up the West River road from Marmarth with a brief stop at Pretty Butte and then on to the Brown Ranch Site. The Brown Ranch Site is an extensive area of badland terrain consisting of land owned by the John Brown family intermixed with United States Forest Service-administered property southeast of Golva, Slope County. At this site, the fossiliferous lower Paleocene Ludlow Formation is exposed and consists of gray channel sandstone, yellow siltstone, and numerous thin lignite and clinker beds. The Brown Ranch geologic section includes tongues of the marine Cannonball Formation interbedded within the Ludlow

Formation. This co-correlation of marine and nonmarine strata assists in interpreting the history of the last sea that covered North Dakota (or the interior of North America, for that matter). Fossil sites in the Ludlow consisting of mammalian remains and mollusks provide information about the animals that lived the first 2 to 3 million years after the K/T boundary extinction event.

Figure 18. *The middle Paleocene Ludlow Formation exposed in the Little Missouri River badlands. (Photo taken from the Brown Ranch Site overlook by Joseph Hartman).*

Figure 19. *Joseph Hartman discussing the geology and paleontology at the Brown Ranch Site. (Photo by John Hoganson).*

Painted Canyon Overlook

The last site that the tour visited before returning to St. Paul was the Painted Canyon Overlook in the South Unit of Theodore Roosevelt National Park. The gorgeous and breathtaking view of the expansive Little Missouri Badlands represents several hundred feet of the upper Paleocene Sentinel Butte Formation. Alternating beds of sandstone, siltstone, mudstone, lignite, and clinker produce the brightly colored, layered exposures in the buttes. These rocks have yielded the fossils of crocodiles, turtles, champsosaurs, fish, mammals, and mollusks. Petrified wood is, however, the most common fossil found in the Park.

Figure 20. *Expansive exposures of the Paleocene Sentinel Butte Formation in the Little Missouri River badlands at the South Unit of Theodore Roosevelt National Park. View is to the north from Painted Canyon Overlook. (Photo by John Hoganson).*

It is not often that we have the opportunity to show off the State of North Dakota's fossil resources to such an eminent group of scientists. There were many discussions about the field trip during the SVP meeting in St. Paul, where several of the field trip members provided very positive comments about the trip to their colleagues. After seeing North Dakota for the first time, many of the participants indicated that they will return to explore other areas of the state. A field trip guidebook will be published by the University of North Dakota in the near future. ***We thank John Stumpf, Ken Miller, Albert Privratsky, Jeff Oakland, John and Nikki Brown, the Bureau of Land Management, and the U.S. Forest Service for allowing access to their properties.***

Geologists inhabit scenes that no one ever saw, scenes of global sweep, gone and gone again, including sea, mountains, rivers, forests, and archipelagoes of aching beauty rising in volcanic violence to settle down quietly and then forever disappear.
John McPhee