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Collecting in Nebraska's Cretaceous Strata

Channel sandstones of the Dakota Group, Jefferson County, Nebraska. (See Field Trip #1.)

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There is an abundance of collectible materials in Nebraska's Cretaceous rocks. Included are gypsum crystals, marcasite, scenic jasper, flint, plant fossils, ammonite imprints, clams, oysters, and fish and shark remains.

Cretaceous rocks underlie most of Nebraska except in the southeast and an isolated area on the Chadron Arch in the northwest. More than 7,200 feet of Cretaceous rocks occur in the southwest corner of the panhandle.

The Nebraska Cretaceous consists of eight principal rock units which document the most recent marine transgressions across the western interior of the North American Continent and a long period of post-Cretaceous weathering and soil development. The Cretaceous is economically important as a source of water, oil, natural gas, agricultural lime, as well as limestone, clay, and shale for construction materials.

Cretaceous rocks are mostly overlain by Tertiary stream and wind deposits, but in eastern Nebraska they are mantled by younger stream and wind deposits and Pleistocene glacial deposits. Thus, outcrops are not extensive and most data has been derived from cores, cuttings, and geophysical logs of deep wells.

GENERAL STRATIGRAPHY

Dakota Group

The Dakota Group, named for Dakota County, Nebraska, consists mostly of sandstones, shales, and clays, and locally contains thin beds of chalk, limestone, coal, and pyrite. Dakota strata may be light to dark gray (dominant in the west), or oxidized reds, yellows, or browns (typical in southeastern Nebraska), with greens and grays common near the base. The diverse lithology and colors suggest environments of deposition that include streams, tidal flats, and shallow seas. Some coloration may indicate weathering due to later sub-aerial exposure.

The Dakota group ranges from about 400 to 600 feet in eastern Nebraska and exceeds 900 feet in the northwest. Much of this variation is due to the paleotopography of the depositional surface. Some Dakota strata has been removed by erosion.

EXPLANATION

Lance Formation	Pierre Shale	Dakota Group
Fox Hills Sandstone	Niobrara Chalk	Jurassic System, undifferentiated
"Transitional Pierre"	Graneros Shale, Greenhorn Limestone, Carlile Shale, undifferentiated	Pennsylvanian-Permian Systems, undifferentiated

Generalized distribution of Cretaceous and older rocks overlain by Tertiary and younger strata.

In eastern Nebraska, mappable formations of the Dakota Group are not recognized, but in the panhandle three units, the basal Cloverly Formation, the Skull Creek Shale, and the Omadi Formation, comprise the Dakota. The Cloverly is mostly sandstones and clays but varies in lithology and color; the Skull Creek is mostly a shale but contains siltstones and sandstones; and the Omadi, sandstones and shales. Sandstones in the Omadi are important oil and gas reservoirs in Nebraska's panhandle.

In Nebraska the Dakota rests unconformably on rocks which become progressively older to the northeast. They overlie the Jurassic Morrison Formation in the west; northwest trending Pennsylvanian-Permian rocks, and then Mississippian, Devonian, Ordovician, and Precambrian rocks to the northeast.

Some important Dakota outcrops are in Ponca State Park in Dixon County and in the Basswood State Recreational Area in Dakota County. There are numerous, good Dakota exposures in southern Jefferson County (See Trip 1) and along I-80 and nearby county roads near the Platte River in Cass and Sarpy counties. Shales in the Dakota Group may yield plant fossils, and the only dinosaur specimen collected in Nebraska, a bone of a duck-billed dinosaur (*Trachodon*) was collected

from the Dakota near the town of Tekamah in Burt County.

Graneros Shale

In eastern Nebraska the Graneros is a marine shale less than 60 feet thick consisting of a lower, medium to dark gray, clayey shale and an upper, light to medium gray, calcareous shale which some workers include in the overlying Greenhorn Limestone. The Graneros gradually thickens to the west and is about 80 to 120 feet thick in west central Nebraska and over 350 feet in parts of the panhandle. In the panhandle, the Graneros contains several bentonite beds, the lowest of which is easily recognized in well logs.

The contact of the Graneros Shale with the underlying Dakota Group is based on lithology and is somewhat subjective. On a regional perspective, shales in the lower part of the Graneros in the west interfinger with upper Dakota sandstones to the east.

Graneros shale crops out in Dixon County at Ponca State Park and in southern Jefferson County, as well as in Thayer County along the Little Blue River (Trip 2). The Graneros contains many clams of the genus *Inoceramus* (*Mytiloides*), some ammonites, shark and fish remains. A small Graneros outcrop in Saunders County yielded the remains of a plesiosaur that

were excavated and prepared by members of the Lincoln Gem and Mineral Club. This specimen is one of the most complete plesiosaurs ever found and is now an important display at the University of Nebraska Museum.

Greenhorn Limestone

The Greenhorn Limestone consists of medium-gray, interbedded limestones and chalks with a few bluish bentonite seams. These weather to yellow and off-white. Over much of Nebraska the Greenhorn is an easily recognized marker formation in both outcrops and on geophysical well logs. The Greenhorn commonly ranges from 25 to 45 feet thick, but in the northern panhandle it can be as thin as 10 feet and in the southern panhandle more than 55 feet. The Greenhorn becomes much less calcareous in the southwestern panhandle and grades into shales similar to those in the Graneros below and Carlile above. In this area, Greenhorn shales lie in contact with the Niobrara, the Carlile Shale having been eroded away before Niobrara deposition.

The Greenhorn was deposited on an eroded surface on the Graneros shale. Some of the variation in thicknesses of both the Graneros and Greenhorn may be due to relief on this surface.

The Greenhorn yields many collectible fossils. The clam *Inoceramus* (*Mytiloides*) *labiatus*, *ammonites*, fish and shark remains can be found on most exposures. See Trips 1 and 2.

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CRETACEOUS FIELD TRIPS

The following trips have been designed to familiarize the reader with the Cretaceous geology of Nebraska

Trip Number	Stratigraphic Units	Collectible Materials
1. 4.2 miles south from jct of Highways 8 and 15 south of Fairbury, and continuing south toward the Kansas-Nebraska border.	The first outcrop is a sandstone of the Dakota Group. 1 mile farther south is a shale of the Dakota Group in the abandoned clay pit (private property). The outcrop area continues south to the state line where shales and limestones of the Graneros-Greenhorn intervals are exposed.	The sandstone contains numerous concretions. Gypsum, marcasite, and plant fossils occur in the clay pit. The shale and limestone exposures contain numerous marine fossils including clams and some shark teeth.
2. 3.0 miles south of Alexandria on Highway 53.	Shales and limestones of Graneros and Greenhorn Formations.	Ammonite imprints, including <i>Prionocyclus</i> , <i>Bacculites</i> . Numerous clams and some fish and shark remains.
3. 1.6 miles south from jct of Highways 136 and 10 in Franklin and 1 mile west on county rd. on south side of Republican River.	Shales and limestones of Niobrara Formation.	Numerous clams, oysters, and some fish and shark remains.
4. 1.7 miles south of Bloomington on County road.	Shales and limestones of Niobrara Formation.	Numerous clams, oysters, some fish remains.
5. 2.0 miles west of jct of Highways 12 and 15 south of Niobrara.	Pierre shale Formation.	Abundant gypsum crystals. Some ammonites including <i>Bacculites</i> .
6. Roadcuts on county road on south side of Republican River 1.9 miles south of jct of Highways 136 and 281 in Red Cloud.	Shales and limestones of Niobrara Formation.	Numerous clams, few ammonites and some fish remains.
7. Roadcuts about 1.4 miles south of Gavins Point Dam, Knox County, on Highway 121.	Pierre shale Formation. Limestones and shales of Niobrara Formation.	Gypsum in Pierre shale. Clams and some fish and shark remains in Niobrara Formation.
8. Roadcut 3.5 miles south of Franklin on Highway 10 and 4.6 miles east on county road.	Cherty limestone at top of Niobrara Formation.	Cutting materials-scenic jaspers, flint.

Carlile Shale

The Carlile Shale is a medium to dark gray, marine shale with local sandy and limy zones. The Carlile may be up to 300 feet thick in central Nebraska but is absent in the southwestern panhandle. The thickness differences are mostly due to the eroded depositional surface on the Greenhorn below and an unconformable contact with the Niobrara above.

In eastern Nebraska, the Carlile includes the lower Fairport Shale, the middle Blue Hill Shale, and the upper Codell Sandstone. The Fairport, 60 to 80 feet thick, is bluish gray and calcareous, with thin, limy, fossiliferous layers. The Blue Hill is clayey and ranges from 80 to 100 feet in thickness. The Codell Sandstone is light to medium gray, usually less than 10 feet thick and is discontinuous over much of Nebraska except in the northeast where it may attain 50 feet and is an important aquifer.

Regionally, progressively younger Carlile beds onlap the older Greenhorn to the east. Thin, calcareous shale zones that become much more limy to the east are sometimes confused with the Greenhorn.

Some large septarians including calcite, barite, and celestine crystals have been collected from Carlile outcrops north of Hay Springs, in northeastern Dawes County. Locally, the Carlile may contain clams and ammonites. The Codell sandstone yields many shark teeth.

Niobrara Chalk

The Niobrara Chalk consists of the basal Fort Hayes Limestone (30 to 50 feet) and the Smoky Hill Chalk to the southeast. In northeastern Nebraska, the Niobrara is about 220 feet thick; it exceeds 500 feet in the southwest near the Kansas border. In the panhandle and north central Nebraska, it consists mostly of alternating chalk and shale and a discontinuous basal sandstone that grades laterally to a sandy siltstone, and an overlying, discontinuous clay shale. This lower shale has been mistaken for the Carlile and the basal sand mistaken for the Codell. In the subsurface the Niobrara is usually medium to dark gray with varying amounts of white speckles, but in some outcrops the grays have oxidized to yellow or orange. Where younger Cretaceous rocks are absent, a hard, cherty limestone sometimes occurs at the top of the Niobrara. Some of this material polishes very well and occurs in a variety of colors including greens, grays, browns, yellows, oranges, and reds. (See Trip no. 8). This horizon occurs in both outcrop and subsurface and is thought to be a paleosol (fossil soil), indicating a long period of exposure and weathering.

The Niobrara can be an important aquifer and gas source. Some irrigation wells have been developed in the eastern subcrop belt, the water possibly coming from a network of solution enlargements of faults and fractures. Where the Pierre overlies the Niobrara a number of shallow wells have proven gas reservoirs.

The Niobrara contains many marine vertebrate and invertebrate fossils including clams, oysters, fish, and shark remains (See Trips 3, 4 and 6). The Niobrara has yielded marine rep-

Gypsum crystal, Carlile Shale, Newcastle area.

tiles in Kansas and South Dakota. The lack of these fossils in Nebraska probably reflects the limited outcrops.

Pierre Shale

The Pierre is a marine shale sequence in Nebraska; its thickness varies greatly, being thinnest or absent on uplifts and thickest in basins. Some of the Pierre may have been eroded from uplifting areas and redeposited in nearby basins simultaneously. The Pierre is a clay shale to the east, becoming more calcareous to the north. In western Nebraska the Pierre becomes sandier and siltier. The Pierre is over 700 feet thick in north central Nebraska, where it contains a 150 to 250 foot thick chalky sequence called the Mobridge. In the southwestern corner of the panhandle, the Pierre exceeds 5,800 feet; the upper 1,200 feet is the transition zone consisting of sandy and silty shales with several sandstone beds. About 3,000 feet below the base of the transition zone is an interbedded sequence of sandstones and shales called the Hygiene.

The Pierre rests on an eroded Niobrara surface throughout Nebraska. In the panhandle, the basal shales and Ardmore Bentonite were deposited on an eroded Niobrara surface, and the thickness configuration of these beds reflect the paleotopography (DeGraw 1973).

The Pierre crops out in the northwestern corner of the panhandle. About 20 miles north of Crawford in Sioux and Dawes counties many outcrops yield large amounts of gypsum and some marine invertebrate fossils including clams and ammonites. A small plesiosaur and diving bird were collected near the South Dakota border.

Good outcrops of Pierre Shale also occur in northeastern Nebraska. An excellent example is found 2.5 miles west of the town of Niobrara and state Highway 12 (See Trip no. 5). This outcrop has yielded some ammonites and many very fine gypsum crystals.

Fox Hills Sandstone

The Fox Hills sandstone occurs in the western part of the

southern panhandle. It consists of a sequence of blue-gray, very fine- to fine-grained sandstones that may exceed 250 feet in thickness. The Fox Hills also contains interbedded silty and clayey shales. The sandstones thin eastward and grade into sandy silts; to the west some of these beds abruptly end near the Wyoming border. These sandstones appear to be shallow, nearshore, marine sand bars. Although not extensively utilized, the Fox Hills appears to be an excellent aquifer.

Lance Formation

The Lance Formation is restricted to the southwestern panhandle where it exceeds 375 feet. The Lance shows a variable lithology ranging from claystones to siltstones to lenticular sandstones, and local beds of lignite and limestone. It varies from black to brownish to bluish gray and can be deeply oxidized, exhibiting brilliant hues of reds, purples, and yellows; mild reduction colors of light blues and greens provide sharp contrasts. Some of this coloring may reflect the original environment but much of it may be attributed to the Interior Paleosol. Remains of the dinosaur *Triceratops* have been found in the Lance a few miles into Wyoming, but none have been found in Nebraska.

Interior Paleosol (Fossil Soil)

Throughout much of western Nebraska and adjacent areas the top of the Cretaceous rocks has been deeply weathered prior to and during early Oligocene of Tertiary time. This resulted in highly oxidized coloration on paleouplands and mildly reduced coloration in paleolowlands in the areas where the Oligocene Chadron Formation was deposited on the Cretaceous. This coloration may be as thick as 75 feet on impervious shales, such as the Pierre, and 300 feet on more permeable beds, such as the Lance and Fox Hills.

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