South Dakota Department of Environment & Natural Resources
Geological Survey

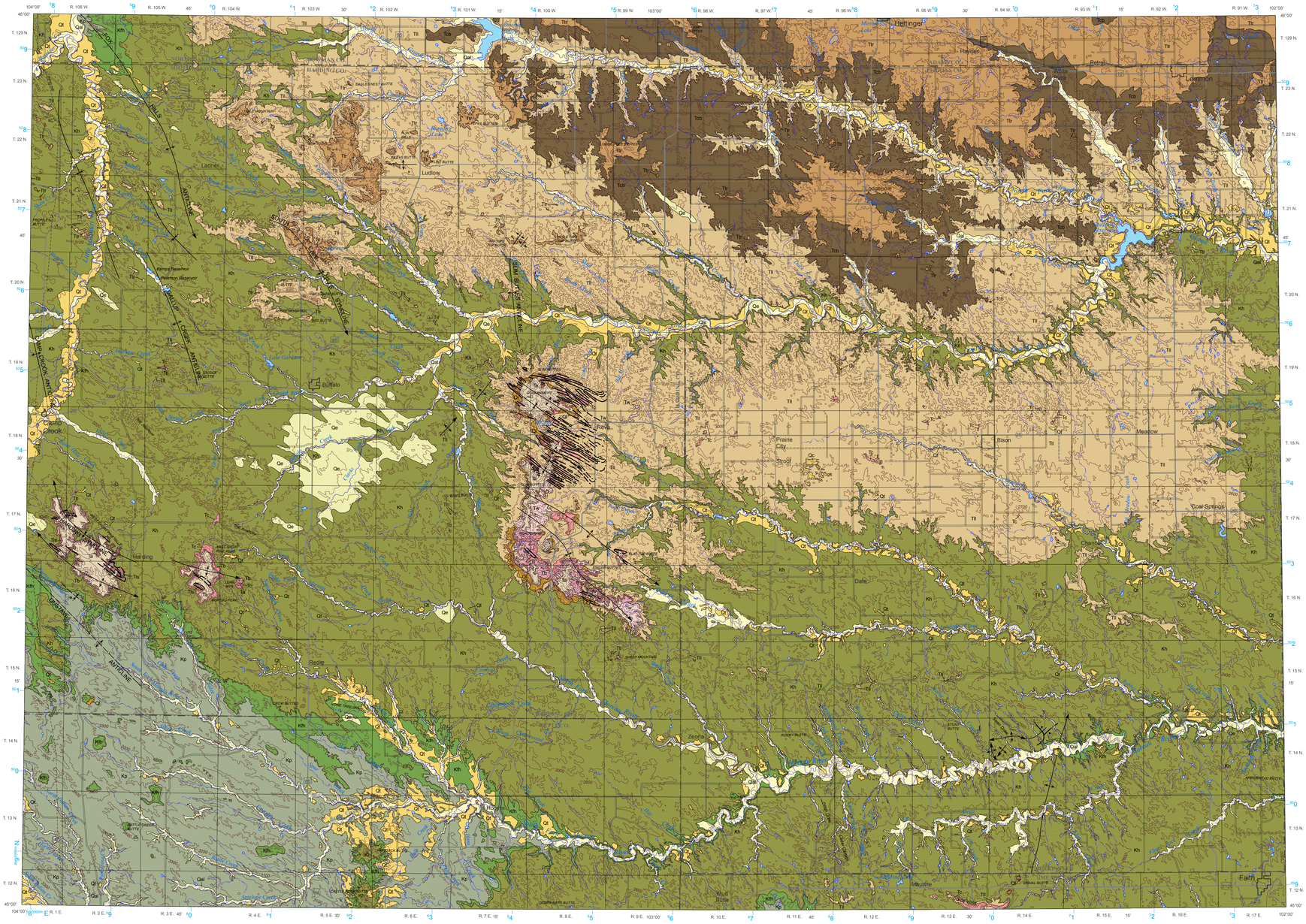
Department of Environment and Natural Resources
Division of Financial and Technical Assistance
Geological Survey Program
1° x 2° Series Geologic Quadrangle Map 1

Geologic Map of the Lemmon 1° x 2° Quadrangle, South Dakota and North Dakota

Mark D. Fahrenbach and J. Foster Sawyer
2011

State of South Dakota
Dennis Daugaard, Governor

South Dakota Geological Survey
Derric L. Iles, State Geologist



EXPLANATION

Qal **Alluvium** (Holocene) – Loosely consolidated to unconsolidated, typically stratified, rounded to angular, poorly- to well-sorted, clay- to boulder-sized clasts. Deposited as alluvial fans, in stream valleys, and on present flood plains. Multiple alluvial levels and ages may occur within a single mapped deposit. Thickness up to 40 ft (12 m)

Ql **Landslide deposit** (Holocene-Pleistocene) – Landslide, slump, and collapsed material along the flanks of higher buttes. Composed of chaotically mixed boulders and finer grained rock debris locally derived from Mesozoic and Cenozoic deposits, to large coherent blocks up to 0.5 mi (0.8 km) that have moved as a single unit

Qc **Colluvium** (Holocene-Pleistocene) – Residual, let down deposits of dominantly light-gray, tan to brown orthoquartzite boulders of Tongue River Formation up to 5 ft (1.5 m) thick and 10 ft (3 m) long. Most boulders have cavities from root and branch impressions. Surfaces weather brown and are often highly wind-polished

Qe **Eolian deposit** (Holocene-Pleistocene) – Unconsolidated to moderately consolidated, poorly- to well-stratified, angular to rounded, typically calcareous silt to medium-grained quartz sand with some dark mineral grains. Characterized by deflation topography with blowouts, and having both active and dormant dunes with up to 40 ft (12 m) of relief. Loess forms a thin mantle over older deposits in many areas. Thickness undetermined

Qt **Terrace deposit** (Holocene-Pleistocene) – Loosely consolidated to unconsolidated, typically stratified, poorly- to well-sorted, heterogeneous sand- to boulder-sized clasts deposited as pediments, paleochannels, and terrace fills of older floodplains. Most terraces contain clay and organic matter. Some terraces in Harding County are composed only of clasts of iron oxide concretions. Deposits may occur up to 140 ft (43 m) above present drainages. Multiple terrace levels and ages may occur within a single mapped deposit. Thickness up to 60 ft (18 m)

Unconformity

Ta **Arikaree Formation** (Miocene) – Massive, light-gray, greenish- to yellowish-gray, very fine-grained, chalky, tuffaceous quartz sandstone and siltstone containing abundant volcanic material. Some beds are cross-bedded or have fine black laminae. Concretions are abundant throughout. Local lenses consist of quartzite, dolomite and dolomitic limestone, light-gray volcanic ash, bentonite, arkose, silty shale, and claystone. Basal portion of the formation is thin-bedded and contains coarse-grained sand and conglomeratic lenses having reworked clasts and fossils from the underlying Brule and Chadron formations. Upper portion of the formation is thick-bedded to massive. Weathering typically forms vertical cliffs. Thickness 200-320 ft (61-98 m)

Unconformity

Tls **Pre-Arikaree landslide** – Landslide blocks contain rocks of the Hell Creek, Ludlow, Chadron, and Brule formations. The fault-bounded blocks of the Chadron and Brule formations that occur at the East and West Short Pine Hills and the blocks containing the Hell Creek through Brule formations are interpreted to be joint-controlled pre-Arikaree landslides which are overlain by nearly horizontal Arikaree Formation. Formations of the individual blocks were not differentiated at the East and West Short Pine Hills. The landslide blocks are up to 3,800 ft (1,158 m) long, 500 ft (152 m) wide, more than 300 ft (91 m) thick, and have up to 250 ft (76 m) of downward displacement. Blocks are generally parallel to each other and have similar strikes and dips, and follow a N.45°-65°W. system of major joints

White River Group

Tw **White River Group** (undifferentiated) – Includes the Chadron and Brule Formations. Combined thickness from 40-300 ft (12-91 m)

Tb **Brule Formation** (Oligocene) – Massive to thin-bedded, banded white, pink, light-green, and light-brown to brown bentonitic claystone, tuffaceous siltstone, and well-bedded, calcareous, tuffaceous quartz sandstone. Characterized by chalcedony dikes, clay nodules, and abundant mammalian fossils. Weathering forms sharp soires, ridges, and cliffs. Preserved only where not removed by pre-Arikaree erosion. Thickness up to 250 ft (76 m) in pre-Arikaree landslides, up to 150 ft (46 m) thick where undisturbed by landslides

Tc **Chadron Formation** (Eocene) – Basal portion consists of poorly cemented, greenish to white, coarse-grained sandstone, arkose, and local conglomerate. Upper portion consists of variegated dark-gray, light-brown to maroon bentonite, claystone, and fine-grained tuffaceous siltstone and quartz sandstone. Local flaggy freshwater limestone and silicified carbonate lenses with chert nodules occur, especially near the top of the formation. Weathering forms rounded "haystack buttes" having a popcorn-like surface. Thickest in pre-Oligocene topographic lows and in pre-Arikaree landslide blocks, thin or absent on topographic highs. Thickness up to 160 ft (49 m)

Disconformity

Fort Union Group

Ttr **Tongue River Formation** (Paleocene) – White, gray, yellowish-brown, and tan, massive, cross-bedded, lower and upper quartz sandstone and orthoquartzite with plant remains, and interbedded gray, brown, and green claystone and clayey siltstone. Conglomerate beds and petrified wood occur locally. The lower, massive, cross-bedded brown sandstone forms a resistant caprock and has carbonaceous material and numerous cavities produced by weathering. The "Lodgepole Lignite facies" occurs 70-140 ft (21-43 m) above the base of the formation, and includes 10-75 ft (3-23 m) of one or more seams of blocky lignite with associated brown clays and peat clays. Thickness up to 280 ft (85 m)

Tcb **Cannonball Formation** (Paleocene) – Gray, tan, and yellowish-brown siltstone, sandy and silty claystone, and clayey to silty, fine-grained quartz sandstone. Contains fine-grained, calcareous quartz sandstone lenses, wood fragments, and marine invertebrates. A resistant sandstone bed and abundant dark-gray limestone concretions occur at the top of the formation. Does not contain lignite. Intertongues with the upper portion of the Ludlow Formation in eastern Harding County. Thickness up to 180 ft (55 m)

Tll **Ludlow Formation** (Paleocene) – White, tan, yellow, and gray, cross-bedded, locally rippled, fine to medium-grained, silty quartz sandstone that forms ledges, especially near the middle of the formation, and interbedded, locally bentonitic, gray siltstone, claystone, and sandy or silty claystone and shale. Characterized by numerous coal and uranium-bearing lignite beds with associated peat-claystone, carbonaceous shale, clinker, and gypsum crystals. The "Shadehill Lignite facies" is 5-65 ft (1.5-20 m) thick and occurs at the base of the formation, with its lowest coal marking the Ludlow-Hell Creek contact. The "Hillen Lignite facies" is about 1-50 ft (0.3-15 m) thick and occurs near the middle of the formation. The "Giannonatti Lignite facies" is 15-60 ft (4.6-18 m) thick and occurs at the top of the formation. Where coal beds are absent, the lower contact is placed at the base of the lowest yellowish silt and sand or varicolored shale overlying gray bentonitic sediments. Intertongues with the lower Cannonball Formation in eastern Harding County. Thickness up to 420 ft (128 m)

Kh **Hell Creek Formation** (Upper Cretaceous) – Yellowish-brown to brown, light- to dark-gray "somber beds" of shale and bentonitic claystone, black, brown to red carbonaceous shale, gray and brown bentonitic silty shale, and gray, brown to yellow siltstone and ledge-forming, medium- to coarse-grained quartz sandstone. Conglomeratic channels and clastic sandstone dikes occur locally. May have rusty iron oxide or manganese oxide staining. Concretions of manganese oxide, iron carbonate, iron oxide, and sandstone occur throughout. Contains seams of coal, lignite, and carbonaceous shale, especially near the base and the top of the formation. Channels at the base have scoured 20-50 ft (6-15 m) into the Fox Hills Sandstone. Characterized by dinosaur and other vertebrate fossils, clinker beds, and gypsum veinlets and crystals. Thickness 260-600 ft (79-183 m)

Kfh **Fox Hills Sandstone** (Upper Cretaceous) – Bluish-green to green and light-gray to brownish-yellow, cross-bedded, very fine- to coarse-grained, micaceous or glauconitic, angular quartz sandstone and siltstone interbedded with dark-gray to gray and greenish to brown shale, silty shale, and carbonaceous shale. Upper and lower contacts are gradational through a 25-50 ft (8-15 m) thick interval. Fragments of Pierre Shale are locally included at the base and grade upward into argillaceous sandstone. A ledge-forming brownish sandstone containing *Halymedes major* burrow casts, and reddish-brown ironstone concretions occurs at the top of the formation. May have a "salt and pepper" appearance or yellow iron-oxide staining. Contains gypsum, plant fragments, and abundant marine invertebrates. Includes the Fairpoint, White Owl Creek, and Iron Lightening members. Thickness 25-300 ft (8-91 m)

Kp **Pierre Shale** (Upper Cretaceous) – Dark-gray to blue-gray and brownish-black to black, thin-bedded, bentonitic claystone, fissile to blocky shale that weathers with a popcorn-like appearance, and sandy shale and siltstone. Characterized by large carbonate concretions, cone-in-cone concretions, thin beds of yellow bentonite, gypsum crystals, and abundant marine fossils. The upper portion is locally carbonaceous and contains plant fragments. Forms prominent slump blocks where eroded along drainages. Exposed thickness up to 350 ft (107 m); total thickness 1,200-2,700 ft (366-823 m)

Contact

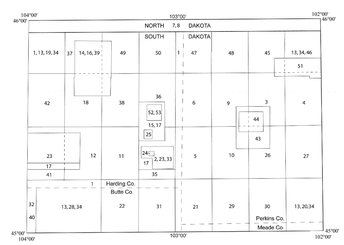
Fault
Long dashed where approximately located; short dashed where inferred; dotted where concealed; bar and ball on downthrown side

Anticline
Showing crestline and direction of plunge; long dashed where approximately located; dotted where concealed

Syncline
Showing troughline and direction of plunge; dotted where concealed

Correlation of Map Units

Qal Ql Qc Qe Qt		Quaternary
Unconformity		
Ta	Miocene	Tertiary
Unconformity		
Tls	Miocene	Tertiary
Tw	Oligocene	Tertiary
Tb	Oligocene	Tertiary
Tc	Eocene	Tertiary
Disconformity		
Ttr	Paleocene	Tertiary
Tcb	Paleocene	Tertiary
Tll	Paleocene	Tertiary
Kh	Late Cretaceous	Cretaceous
Kfh	Late Cretaceous	Cretaceous
Kp	Late Cretaceous	Cretaceous



Index to sources of geologic data
(numbers correspond to those listed in References)

Map base digitized from U.S. Geological Survey 1:250,000 Lemmon quadrangle 1979 Digital Raster Graphic.

Projection is Universal Transverse Mercator, Zone 13N.
Datum is 1983 North American.

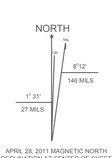
The Geological Survey Program, Department of Environment and Natural Resources, engages in an ongoing data collection and interpretation process. An outcome of that process is to reflect those interpretations on maps such as this one. Reasonable efforts have been made to ensure that this map accurately reflects the source data used in its preparation. This map is date specific. As additional data become available, geological interpretations may be revised and the map may be updated by the Geological Survey. This map should not be enlarged or otherwise used in an attempt to interpret more detail than can be seen at 1:250,000 scale.

Scale 1:250,000

.5 0 .5 10 15 20 Miles

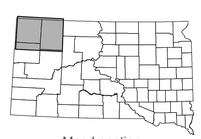
5 0 5 10 15 20 Kilometers

Contour Interval 100 feet



APRIL 28, 2011 MAGNETIC NORTH
DECLINATION AT CENTER OF SHEET

Digital Cartography by Wesley P. Christensen and Dan E. Costello



Map Location

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(Numbers indicate mapped areas shown on index map; unnumbered sources are general references)

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