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National Park Service
Natural Resource Stewardship and Science Directorate
Geologic Resources Division



Scotts Bluff National Monument

GRI Ancillary Map Information Document

Produced to accompany the Geologic Resources Inventory (GRI) Digital Geologic
Data for Scotts Bluff National Monument

scbl_geology.pdf

Version: 10/17/2014

Geologic Resources Inventory Ancillary Map Information Document for Scotts Bluff National Monument

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Geologic Resources Inventory Map Document



Scotts Bluff National Monument,
Nebraska

Document to Accompany
Digital Geologic-GIS Data

scbl_geology.pdf

Version: 10/17/2014

This document has been developed to accompany the digital geologic-GIS data developed by the Geologic Resources Inventory (GRI) program for Scotts Bluff National Monument, Nebraska (SCBL).

Attempts have been made to reproduce all aspects of the original source products, including the geologic units and their descriptions, geologic cross sections, the geologic report, references and all other pertinent images and information contained in the original publication.

National Park Service (NPS) Geologic Resources Inventory (GRI) Program staff have assembled the digital geologic-GIS data that accompanies this document.

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About the NPS Geologic Resources Inventory Program

Background

Recognizing the interrelationships between the physical (geology, air, and water) and biological (plants and animals) components of the Earth is vital to understanding, managing, and protecting natural resources. The Geologic Resources Inventory (GRI) helps make this connection by providing information on the role of geology and geologic resource management in parks.

Geologic resources for management consideration include both the processes that act upon the Earth and the features formed as a result of these processes. Geologic processes include: erosion and sedimentation; seismic, volcanic, and geothermal activity; glaciation, rockfalls, landslides, and shoreline change. Geologic features include mountains, canyons, natural arches and bridges, minerals, rocks, fossils, cave and karst systems, beaches, dunes, glaciers, volcanoes, and faults.

The Geologic Resources Inventory aims to raise awareness of geology and the role it plays in the environment, and to provide natural resource managers and staff, park planners, interpreters, researchers, and other NPS personnel with information that can help them make informed management decisions.

The GRI team, working closely with the Colorado State University (CSU) Department of Geosciences and a variety of other partners, provides more than 270 parks with a geologic scoping meeting, digital geologic-GIS map data, and a park-specific geologic report.

Products

Scoping Meetings: These park-specific meetings bring together local geologic experts and park staff to inventory and review available geologic data and discuss geologic resource management issues. A summary document is prepared for each meeting that identifies a plan to provide digital map data for the park.

Digital Geologic Maps: Digital geologic maps reproduce all aspects of traditional paper maps, including notes, legend, and cross sections. Bedrock, surficial, and special purpose maps such as coastal or geologic hazard maps may be used by the GRI to create digital Geographic Information Systems (GIS) data and meet park needs. These digital GIS data allow geologic information to be easily viewed and analyzed in conjunction with a wide range of other resource management information data.

For detailed information regarding GIS parameters such as data attribute field definitions, attribute field codes, value definitions, and rules that govern relationships found in the data, refer to the NPS Geology-GIS Data Model document available at: <http://science.nature.nps.gov/im/inventory/geology/GeologyGISDataModel.cfm>

Geologic Reports: Park-specific geologic reports identify geologic resource management issues as well as features and processes that are important to park ecosystems. In addition, these reports present a brief geologic history of the park and address specific properties of geologic units present in the park.

For a complete listing of Geologic Resource Inventory products and direct links to the download site visit the GRI publications webpage http://www.nature.nps.gov/geology/inventory/gre_publications.cfm

GRI geologic-GIS data is also available online at the NPS Data Store Search Application: <http://irma.nps.gov/App/Reference/Search>. To find GRI data for a specific park or parks select the appropriate park

(s), enter "GRI" as a Search Text term, and then select the Search Button.

For more information about the Geologic Resources Inventory Program visit the GRI webpage: <http://www.nature.nps.gov/geology/inventory>, or contact:

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The Geologic Resources Inventory (GRI) program is funded by the National Park Service (NPS) Inventory and Monitoring (I&M) Division.

GRI Digital Maps and Source Map Citations

The GRI produced two digital geologic-GIS maps for Scotts Bluff National Monument (SCBL). A larger-scale (1:24,000) map that focuses on the monument and includes greater geologic detail and mapping accuracy, and a smaller (1:250,000) scale map that focuses on the area around the monument including Chimney Rock National Historic Site.

The GRI digital geologic-GIS maps for Scotts Bluff National Monument, Nebraska (SCBL):

GRI Digital Geologic Map of Scotts Bluff National Monument, Nebraska (*GRI MapCode SCBL*)

The digital map was produced using the following unpublished draft source map,

Evanoff, E., 2014, Draft Geologic Map of Scotts Bluff National Monument, Nebraska: University of Northern Colorado, unpublished map, scale 1:24,000. (*GRI Source Map ID 75952*).

This map was produced by E. Evanoff by mapping geologic contacts and features in the field on an older USGS 7.5' quadrangle 1:24,000 scale base map that was printed at a scale of 1:10,000. In the case of many marker beds and contacts mapped on higher-angle slopes the exact location of these features was somewhat difficult to accurately map. As per communication with the E. Evanoff some markers beds and contacts, determined to be nearly regionally horizontal in the area, were moved by the GRI to a particular elevation level on the base map.

In checking the draft map against spatially accurate imagery it was noted by the GRI that the position and depiction of some features, including several features that are not necessarily on steeper slopes, remain positionally inaccurate. Users should thus assume that contact and marker bed positional accuracies and depictions may be off from their actual position. This is in addition to the maximum inaccuracy of up to 12.2 meters or 40 feet inherent with the USGS 7.5' quadrangle base map to which the geology was mapped on.

GRI Digital Geologic Map of the Scotts Bluff National Monument Area, Nebraska (*GRI MapCode SCBA*)

The digital map was produced using the following U.S. Geological Survey source publication. The GRI digital geologic-GIS map used only a portion of the full map, an area defined by the following coordinates: -104.000 and -103.250 longitude, 42.000 and 41.500 latitude.

Swinehart, J.B. and Diffendal, R.F. Jr., 1997, Geologic Map of the Scottsbluff 1 Degree x 2 Degree Quadrangle, Nebraska and Colorado: U.S. Geological Survey, Geologic Investigations Series Map, I-2545, scale 1:250,000. (*GRI Source Map ID 2940*).

Additional information pertaining to each source map is also presented in the GRI Source Map Information (SCBLMAP) table included with the GRI geologic-GIS data.

GRI Digital Geologic Map of Scotts Bluff National Monument, Nebraska

Map Unit List

The geologic units present in the digital geologic-GIS monument (SCBL) map produced for Scotts Bluff National Monument, Nebraska (SCBL) are listed below. Units are listed with their assigned unit symbol and unit name (e.g., Qa1 - Younger alluvium). Units are generally listed from youngest to oldest. Information about each geologic unit is also presented in the monument map's GRI Geologic Unit Information (SCBLUNIT) table included with the GRI geologic-GIS data.

Cenozoic Era

Quaternary Period

Anthropogenic Materials

[Qcrs](#) - Concrete retaining surface

[Qaf](#) - Artificial fill

Younger Holocene Deposits

[Qa](#) - Modern alluvium, post-1900

[Qrf](#) - Recent rock falls

[Qnpa](#) - North Platte alluvium

[Qs](#) - Sand dune deposits

[Qc](#) - Colluvium deposits

Older Quaternary Deposits

[Qlo](#) - Loess deposits

[Qal](#) - Alluvium and valley fill deposits

Tertiary Period

[Arikaree Group](#)

[Tmh](#) - Monroe Creek and Harrison Formations, undivided

[Tg](#) - Gering Formation

[White River Group](#)

[Tbr](#) - Brule Formation

[Tbrw](#) - Brule Formation, Whitney Member

[Tbrwu](#) - Brule Formation, upper Whitney tuff

[Tbrwl](#) - Brule Formation, lower Whitney tuff

[Tbrw and Tbro contact](#)

[Tbro](#) - Brule Formation, Orella Member

[Tbros](#) - Brule Formation, Orella Member, sandstone ribbon deposits

[Tbror](#) - Brule Formation, Orella Member, base of the red mudstone beds

[Tbrog](#) - Brule Formation, Orella Member, green mudstone marker bed

[Tbrow](#) - Brule Formation, Orella Member, lower white carbonate nodule bed

Map Unit Descriptions

Descriptions of geologic map units, generally listed from youngest to oldest, are presented below.

Anthropogenic Materials

Qcrs - Concrete retaining surface (Holocene)

Light brown concrete surface covering the west face of Scotts Bluff between the second and third tunnel above the Scotts Bluff summit road and covering the Brule/Arikaree contact. (*GRI Source Map ID 75952*) ([Evanoff, 2014 draft map](#)).

Qaf - Artificial fill (Holocene)

Compacted but unconsolidated gravel, sand, and mud under roads, buildings, and railroads in the monument. (*GRI Source Map ID 75952*) ([Evanoff, 2014 draft map](#)).

Younger Holocene Deposits

Qa - Modern alluvium, post-1900 (Holocene)

Unconsolidated light gray to brown, gravelly to muddy sand in modern gullies. Unconsolidated alluvium accumulated in the northern gullies after the 1899 to 1903 construction of the Gering Ditch and later construction of the Union Pacific Railroad. More than 10 m thick on the south side of the Gering Ditch below the north point of Scotts Bluff. (*GRI Source Map ID 75952*) ([Evanoff, 2014 draft map](#)).

Qrf - Recent rock falls (Holocene)

Blocks of tan to gray Arikaree Group sandstone on the surface of the colluvium deposits. Form from the recent fall of sandstone blocks from the cliffs on top of Scotts Bluff and South Bluffs. (*GRI Source Map ID 75952*) ([Evanoff, 2014 draft map](#)).

Qnpa - North Platte alluvium (Holocene)

Unconsolidated gravel and sand adjacent to the channel of the North Platte. Includes cobbles and pebbles derived from the Rocky Mountains. (*GRI Source Map ID 75952*) ([Evanoff, 2014 draft map](#)).

Qs - Sand dune deposits (Holocene)

Unconsolidated, brown, well-sorted, fine to very-fine grained sand capping ridges on the west side of Scotts Bluff. Typically has abundant yucca plants (*Yucca glauca*) growing on these sands. (*GRI Source Map ID 75952*) ([Evanoff, 2014 draft map](#)).

Qc - Colluvium deposits (Holocene)

Unconsolidated block to sand deposits on the flanks of the bluffs. Blocks and rubble are angular fragments of Arikaree Group sandstones, surrounded by brown to tan muddy sand. Merge downslope to the head of the alluvium/valley fill deposits. These slopes are typically covered by vegetation on the flanks of the bluffs. (*GRI Source Map ID 75952*) ([Evanoff, 2014 draft map](#)).

Older Quaternary Deposits**Qlo - Loess deposits (lower Holocene and Pleistocene?)**

Unconsolidated thick structureless beds of tan to light gray, silty muds. Are thickest in the western margin of the Monument where they reach thicknesses of more than 8 m. Also cap the smooth surfaces on top of the older alluvium/valley-fill deposits, and occur at the top center of the South Bluff. (*GRI Source Map ID 75952*) ([Evanoff, 2014 draft map](#)).

Qal - Alluvium and valley fill deposits (lower Holocene and Pleistocene?)

Well-bedded but unconsolidated, light gray to tan, muddy sands with scattered granules and pebbles derived from the Arikaree Group sandstone beds. Bedding includes thin to medium horizontal beds separated at intervals by dark gray organic rich layers representing buried soils. Are valley-fills more than 15 m thick on an ancient badland topography. (*GRI Source Map ID 75952*) ([Evanoff, 2014 draft map](#)).

Arikaree Group

In this area the Arikaree Group is represented by the Monroe Creek Formation ([Tmc](#)) and underlying Gering Formation ([Tg](#)).

Tmh - Monroe Creek and Harrison Formations, undivided (Miocene and early Miocene)

Typically thick to very thick-bedded massive and structureless beds of fine to very fine grained, tan to light gray sandstone. The sandstone beds are locally cemented from groundwater into elongate cylindrical calcareous nodules, called "pipe concretions." Can also have abundant globular nodules scattered throughout the sandstone massive sandstone beds. Includes two intervals along the Saddle Rock hiking trail of very well-bedded sandstones, composed of thin to thick horizontal beds and medium- to very-large-scale crossbed sets (Swinehart and Loope, 1987). Also contains two very light pink gray volcanic tuffs, at 16.6 and 23.1 m above the base of the formation. Thickness measured along the Saddle Rock hiking trail to the top of Scotts Bluff is 62.6 m (205 ft). (*GRI Source Map ID 75952*) ([Evanoff, 2014 draft map](#)).

Tg - Gering Formation (late Oligocene)

Well-bedded, fine to very fine grained, light brown to light gray sandstone beds with two white volcanic ashes, 14.0 m and 18.6 m above the base of the formation. Unit has abundant thin to medium horizontal beds, locally deformed by tracks of large mammals and containing calcite crystal pseudomorphs after gypsum (Swinehart and Loope, 1987). Top contact sharp. Unit fills a paleovalley with the thickest fill on the north side of Scotts Bluff. Thickness measured along the Saddle Rock hiking trail, 28.0 m (92 ft). (*GRI Source Map ID 75952*) ([Evanoff, 2014 draft map](#)).

White River Group

In this area the White River group is represented by the Brule Formation ([Tbr](#)).

Tbr - Brule Formation (Oligocene)

Divided into the Whitney Member ([Tbrw](#)) and Orella Member ([Tbro](#)).

Tbrw - Brule Formation, Whitney Member (Oligocene)

Tan to light brown gray siltstone and sandy siltstone beds; massive structureless thick to very thick beds as much as over 10 m thick. Rare widespread sheets of well-bedded, light brown gray, silty sandstone typically 4 m thick. Includes two very light gray very thick volcanic tuffs, the lower Whitney tuff and the upper Whitney tuff. Top contact sharp, broadly erosional. Total thickness 123.1 m (404 ft). (*GRI Source Map ID 75952*) ([Evanoff, 2014 draft map](#)).

Tbrwu - Brule Formation, upper Whitney tuff (Oligocene)

Very light gray, tuffaceous sandy siltstone with scattered fine- to medium-sand sized euhedral biotite crystals in lower meter; base diffuse, top very indistinct. 2.8 m (9 ft) thick. Referred to as marker 6 on the source geologic map. (*GRI Source Map ID 75952*) ([Evanoff, 2014 draft map](#)).

Tbrwl - Brule Formation, lower Whitney tuff (Oligocene)

Very light gray tuffaceous sandy siltstone with scattered fine-sand size euhedral biotite crystals in lower meter; base sharp, top very indistinct. 4.6 m (15 ft) thick. Referred to as marker 5 on the source geologic map. (*GRI Source Map ID 75952*) ([Evanoff, 2014 draft map](#)).

Tbrw and Tbro Contact

Contact between brown structureless siltstone and nodular mudstone beds, and light reddish brown, thin to medium bedded, clayey mudstone beds. Overlies a light bluish gray volcanic ash. Both the red beds and the bluish tuff fill large-diameter burrows extending down into the underlying units. (*GRI Source Map ID 75952*) ([Evanoff, 2014 draft map](#)).

Tbro - Brule Formation, Orella Member (Oligocene)

Brown-gray to tan mudstone beds that are thin to thick horizontal bedded; with intervals of red and light green gray mudstone beds, rare thick brown siltstone beds and well-bedded muddy sandstone sheets. Includes two arkosic pebbly sandstone ribbons and two volcanic tuff beds. Lower tuff is a thin medium gray bed that is 0.1 m thick in the lower outcrops, 2.8 m below a persistent light green gray mudstone marker (marker 2; [Tbro1](#)). Upper tuff is a bluish gray bed just below the red, well bedded mudstones mapped as marker 3 or [Tbro2](#). White local carbonate nodular bed near the base to the exposures. Top

contact is at the top of the last widespread nodule bed developed on mudstone interval; bottom contact not exposed in the monument. Total thickness 33.3 m (109 ft). (*GRI Source Map ID 75952*) ([Evanoff, 2014 draft map](#)).

Tbros - Brule Formation, Orella Member, sandstone ribbon deposits (Oligocene)

Coarse grained, grayish brown to gray arkosic sandstones with pebbles and cobbles in long, lenticular ribbon deposits. Are channel-belt deposits of two streams that stratigraphically occur 2.3 and 4.7 m above the base of the reddish brown mudstones (marker 3; [Tbror](#)). (*GRI Source Map ID 75952*) ([Evanoff, 2014 draft map](#)).

Tbror - Brule Formation, Orella Member, base of the red mudstone beds (Oligocene)

Contact between brown structureless siltstone and nodular mudstone beds, and light reddish brown, thin to medium bedded, clayey mudstone beds. Overlies a light bluish gray volcanic ash. Both the red beds and the bluish tuff fill large-diameter burrows extending down into the underlying units. (*GRI Source Map ID 75952*) ([Evanoff, 2014 draft map](#)).

Tbrog - Brule Formation, Orella Member, green mudstone marker bed (Oligocene)

Persistent green gray, thick mudstone bed that produces a green band across the lower Orella Member outcrops. (*GRI Source Map ID 75952*) ([Evanoff, 2014 draft map](#)).

Tbrow - Brule Formation, Orella Member, lower white carbonate nodule bed (Oligocene)Schultz &

Very light gray nodular mudstone bed, 0.2 m thick. Referred to as the "upper purplish white layer" by Schultz and Stout in 1955, but is not a volcanic tuff as is the original upper purplish white layer in the Toadstool Park area of northwest Nebraska. (*GRI Source Map ID 75952*) ([Evanoff, 2014 draft map](#)).

GRI Digital Geologic Map of the Scotts Bluff National Monument Area, Nebraska

Map Unit List

The geologic units present in the digital geologic-GIS monument area (SCBA) map for Scotts Bluff National Monument, Nebraska (SCBL) are listed below. Units are listed with their assigned unit symbol and unit name (e.g., Qa1 - Younger alluvium). Units are listed from youngest to oldest. No description for water is provided. Information about each geologic unit is also presented in the area map's GRI Geologic Unit Information (SCBAUNIT) table included with the GRI geologic-GIS data.

Cenozoic Era

Quaternary Period

[Qa1](#) - Younger alluvium

[Qes](#) - Eolian sand

[Ql](#) - Loess

[Qca](#) - Colluvium and alluvium

[Qa2](#) - Intermediate alluvium

[Qa3](#) - Older alluvium

Tertiary Period

[Tb](#) - Broadwater Formation

[To](#) - Ogallala Group

[Ta](#) - Arikaree Group

[White River Group](#)

[Tbr](#) - Brule Formation

[Tc](#) - Chadron Formation

*** Of note, as only a portion of the source map was used for the GRI digital geologic-GIS monument area map not all units present on the source publication are listed or presented in this document.*

Map Unit Descriptions

Descriptions of geologic map units, generally listed from youngest to oldest, are presented below.

Qa1- Younger alluvium (Holocene-latest Pleistocene)

Commonly pebbly gravel and sand, minor thin sandy silt beds, yellowish-gray to yellowish-orange; unit underlies the modern floodplain and low terraces generally less than 20 ft above stream level in North and South Platte River valleys and along Pumpkin Creek, Lodgepole Creek, and other tributaries. North Platte River gravel consists principally of granite, anorthosite, rhyolite, mafic igneous rocks, quartzite, gneiss, schist, sandstone, and chert that were eroded mostly from the Hartville uplift, Laramie Range, and Medicine Bow Mountains in Wyoming (Stout and others, 1971; Diffendal, 1990). Also includes locally derived clasts of Ogallala Group sandstone and calcrete and calcareous concretions and siltstone from the Arikaree and White River Groups. Anorthosite clasts derived from the southern Laramie Range are most abundant in alluvium along Pumpkin Creek. Gravel along Lodgepole Creek consists mostly of clasts reworked from Ogallala Group rocks, Sherman Granite, Laramie Anorthosite, and quartzite from the Medicine Bow Range in Wyoming. Gravel in South Platte River alluvium was reworked from older Cenozoic deposits in the drainage basin and from the Rocky Mountains in Colorado. The composition of clasts in alluvium in tributaries reflects the formations exposed in the drainage basins (Diffendal and Corner, 1983; Stout and others, 1971). Unit includes channel, floodplain, terrace, and

alluvial-fan deposits. Deposits fill valleys eroded into Tertiary bedrock. Locally, the bedrock floor beneath the valley of the North Platte River is cut by deep and narrow anastomosing channels (Wenzel and others, 1946; Souders, 1986); such channels have been called inner channels by Schumm (1977). The unit locally includes areas of colluvium, eolian sand ([Qes](#)), and bedrock too small to map separately. Includes deposits equivalent to the alluvium of the TO, T1, and T2 terraces of Schultz and Stout (1945, 1948) and the Qal and Qb units of Scott (1978). Commonly 20-150 ft thick. (*GRI Source Map ID 2940*) ([Geologic Investigations Series Map. I-2545](#)).

Qes - Eolian sand (Holocene-late? Pleistocene)

Well-sorted fine sand, pale-brown, pale-yellowish-brown, and dark-yellowish-brown; laminated cross-stratification and horizontal bedding (Ahlbrandt and Fryberger, 1980); burrows and vertebrate tracks (mostly *Bison*; Loope, 1986) are common. Locally contains several paleosols characterized by A/AC profiles. Primarily forms stabilized compound parabolic dunes and large crescentic dunes as much as 340 ft high north of North Platte River in the Nebraska Sand Hills (Swinehart, 1990). Includes interdune deposits of eolian and lacustrine fine sand, organic-rich sandy silt, mud, muck, and peat. Small dunes and sand sheets locally cover intermediate alluvium ([Qa2](#)) and, to lesser extent, younger alluvium ([Qa1](#)) along North Platte River, south of Pumpkin Creek, and on east side of Lodgepole Creek near its mouth. Locally includes unmapped loess ([Ql](#)) north of North Platte River valley and small unmapped outcrops of the Ogallala and Arikaree Groups and Brule Formation. Also includes minor colluvium and alluvium. Radiocarbon ages of paleosols within dune sand and on peat beneath dunes in the Sand Hills indicate several episodes of dune activity during the Holocene (Ahlbrandt and others, 1983; Swinehart and Diffendal, 1990). In the Crescent Lake area, as much as 54 ft of marsh, peat, and lacustrine-rich mud is present in paleovalleys that were blocked by eolian sand during at least two episodes of aridity over the last 12,000 yrs (Loope and others, 1995). (*GRI Source Map ID 2940*) ([Geologic Investigations Series Map. I-2545](#)).

Ql - Loess (Holocene-middle? Pleistocene)

Wind deposited silt and sandy silt, noncalcareous to slightly calcareous, moderate-yellowish-brown. Caps old alluvial deposits (QTal) and the Ash Hollow Formation of the Ogallala Group on Cheyenne Tableland and locally older alluvium ([Qa3](#)) and intermediate alluvium ([Qa2](#)), and a broad band of loess extends along the north side of the North Platte Valley. Numerous outcrops of Ash Hollow Formation too small to map separately are included in unit. Locally may correlate with both the Bignell Loess (Holocene) and the Peoria Loess (late Wisconsin) (Schultz and Stout, 1945; Stout and others, 1971; May and Holen, 1993). Includes eolian silt older than Peoria at the eastern end of Cheyenne Tableland (Stout and others, 1971; Diffendal, 1991). Generally less than 20 ft thick but is more than 200 ft thick in southwestern Keith, northeastern Deuel, and southeastern Garden Counties. Thin loess covers Ogallala Group rocks ([To](#)) in most of Cheyenne Tableland, but unit is mapped only where thickness exceeds about 10 ft. Stipple pattern indicates loess deposits more than 20 ft thick. (*GRI Source Map ID 2940*) ([Geologic Investigations Series Map. I-2545](#)).

Qca - Colluvium and alluvium (Holocene-late? Pleistocene)

Sand, silt, and minor gravel, moderate-brown to yellowish-gray; exists principally on valley slopes. Unit grades laterally into younger deposits which are correlative with younger alluvium ([Qa1](#)) and into older deposits correlative with intermediate alluvium ([Qa2](#)). Thickness commonly 10-40 ft, locally as much as 80 ft. (*GRI Source Map ID 2940*) ([Geologic Investigations Series Map. I-2545](#)).

Qa2 - Intermediate alluvium (late? Pleistocene)

Commonly pebbly gravel and sand and locally thin beds of pale-orange to yellowish-brown silt. Locally includes minor lacustrine silt. Clast composition similar to that of younger alluvium ([Qa1](#)). Deposit underlies a discontinuous terrace about 80-90 ft above river level along both sides of North Platte River west of Bridgeport and along south side of the river east of Bridgeport (Babcock and Visser, 1951). Also underlies terrace south and east of Pumpkin Creek in Morrill and Banner Counties (Diffendal, 1984). North Platte and Pumpkin Creek terraces merge southeast of Bridgeport. Includes alluvial deposits that locally cap elongate hills south of Pumpkin Creek (Babcock and Visser, 1952; Diffendal and Corner, 1983). Qa2 deposits underlie discontinuous terraces along tributaries of the North Platte River in southeastern Garden County (Diffendal and Leite, 1989). Small areas of unmapped loess, colluvium, and bedrock are locally included in the unit. Unit is commonly covered by thin deposit of unmapped eolian sand. (GRI Source Map ID 2940) ([Geologic Investigations Series Map. I-2545](#)).

Qa3 - Older alluvium (early Pleistocene)

Commonly pebbly gravel and sand, pale-orange. Forms terrace remnants about 200-300 ft above creek level south of Pumpkin Creek in Morrill and Banner Counties (Diffendal and Corner, 1983), a remnant between Pumpkin Creek and the North Platte River, and remnants 150-350 ft above river level north of the North Platte River in Morrill and Scotts Bluff Counties. South of Pumpkin Creek, clasts are dominantly Sherman Granite and Laramie Anorthosite derived from the southern Laramie Range. Locally derived clasts of Brule Formation siltstone and concretions, Arikaree Group concretions, and Ogallala Group calcrete and silcrete are also present. Trough cross-stratification exposed in gravel pits (Diffendal and Corner, 1983). Fossils of *Mammuthus meridionalis* (Nesti) and *Equus* sp. cf. *E. scotti* Gidley, exposed along Pumpkin Creek, indicate an Irvingtonian North American land mammal age (NALMA) (Corner and Diffendal, 1983). Probably includes two or more ages of alluvium on north side of North Platte River valley. Thickness ranges from 10 to 90 ft. (GRI Source Map ID 2940) ([Geologic Investigations Series Map. I-2545](#)).

Tb - Broadwater Formation (Pliocene)

Fluvial pebble to cobble gravel and sand; locally includes minor silt, clay, and diatomite beds; pale yellow to grayish orange. Divided into an upper unnamed unit and a lower unit informally named the Remsburg Ranch beds (Swinehart and Diffendal, 1987, 1995). Upper unnamed unit corresponds to Broadwater Formation as originally defined by Schultz and Stout (1945); however, members named by those authors not recognized in the map area. Formation is exposed on north side of North Platte River valley. Pliocene age of Broadwater based on vertebrate faunas (Repenning, 1987). Composite thickness of Broadwater Formation as much as 300 ft

Upper unnamed unit - Not shown on map. Pebbly gravel and sand. Crops out along the North Platte River valley north and east of Broadwater and southeastward to the valley of Blue Creek. Contains as many as three silt, silty sand, and diatomite subunits in outcrop and in test holes (Swinehart, 1979; Swinehart and Diffendal, 1987). Distinctive gravel clasts include quartzite from Medicine Bow Mountains of southeastern Wyoming (Swinehart and Diffendal, 1987) and anorthosite from Laramie Range of Wyoming (Stanley and Wayne, 1972; Swinehart and Diffendal, 1990). Other clasts are granite, granodiorite, quartz, mafic plutonic rocks, gneiss, chert, sandstone, siltstone, and acidic volcanic rocks. Southeastern and south-central Wyoming were principal source areas for these clasts. Maximum intermediate diameter (b axis) of clasts is 3 in. Vertebrate fossils typical of the upper unnamed unit include *Sorex* sp., *Megalonyx* sp., *Lepus* sp., *Stegomastodon mirificus primitivus*, *Equus*, spp.,

Camelops sp., and *Gigantocamelus fricki* (Barbour and Schultz, 1937; Schultz and Stout, 1945, 1948). Mammal fossils from Lisco quarries in Garden County are early Blancan in age whereas those from Broadwater quarries in Morrill County are medial Blancan (Voorhies and Comer, 1986). Fish (Bennett, 1979), amphibian, and reptile fossils (Holman and Schloeder, 1991), are in fine-grained deposits of the upper unnamed unit in Lisco quarries. Unit commonly 50-150 ft thick; maximum exposed thickness 200 ft

Rensburg Ranch beds of Swinehart and Diffendal (1987) - Not shown on map. Composed of pale-brown to grayish-orange cobble gravel and sand. Silt and diatomite beds present locally. Gravel clast composition is similar to that in the upper unnamed unit, but the informal Rensburg Ranch beds contain more clasts of mafic plutonic rocks and fewer clasts of sandstone and siltstone (Swinehart, 1979; Swinehart and Diffendal, 1987). Average intermediate diameter of the ten largest clasts (mostly quartzite) at several localities range from 4 to 5.5 in. These clasts are considerably larger than the largest clasts in the upper unnamed unit. Sedimentary structures include horizontal stratification, gravel imbrication, and crossbeds that are as much as 10 ft thick. Rensburg Ranch beds primarily represent fill deposits of anastomosing inner stream channels (Schumm, 1977, p. 188) incised into bedrock. Unit crops out discontinuously along north side of North Platte River valley from northeast of Torrington, Wyoming, to Garden County in eastern part of the map area. In map area unit caps bedrock hills from northeast of Bridgeport to west of Lake Alice. Identifiable vertebrate fossils are rare but include *Gigantocamelus*, *Canis*, and *Megatylopus*(?) (Voorhies and Comer, 1986). Maximum exposed thickness of Rensburg Ranch beds about 150 ft. (GRI Source Map ID 2940) ([Geologic Investigations Series Map. I-2545](#)).

To - Ogallala Group (upper and middle Miocene)

Principally fluvial deposits locally subdivided, in descending order, into the informal Angora sand and gravel beds of Swinehart and Diffendal (1995), Ash Hollow Formation, and informal Duer Ranch beds of Swinehart and Diffendal (1987) along north side of North Platte River valley in Morrill County (Swinehart and Diffendal, 1995). Only Ash Hollow Formation crops out widely south of the North Platte valley. Individual units not mapped separately because of their limited areas of outcrop at map scale. Deposits commonly fill paleovalleys ([fig. 2](#)), including some that cut deeply into older strata (Scott, 1982; Swinehart and others, 1985). Map unit locally includes areas of post-Ogallala deposits and older bedrock units too small to map separately

Angora sand and gravel beds of Swinehart and Diffendal (1995) (upper Miocene)—Not shown on map. Consists of grayish-pink sand and gravel and interbeds of silt and diatomite (Swinehart and Diffendal, 1995). Similar in lithology to the Broadwater Formation but contains about 10 percent acidic volcanic rock clasts and lacks anorthosite. Exposed continuously north of the North Platte River from north of Broadwater northwestward to U.S. Highway 385. Vertebrate fossils include horses and camels provisionally assigned to the Hemphillian NALMA (M.R. Voorhies, oral commun., 1987). Commonly 80-150 ft thick; maximum thickness about 300 ft in drill holes and 200 ft in outcrop.

Ash Hollow Formation (upper Miocene)—Not shown on map. Sandstone, pebbly sandstone, and siltstone, gray, olive, olive-brown, brown, and reddish-brown; gravel, sand, and conglomerate, very pale orange to moderate-orange-pink; also contains diatomite, volcanic ash, calcrete, and silcrete (Diffendal, 1987). North of North Platte River, gray, greenish-yellow and olive colors are more common; south of the North Platte, brown and orange colors are more common. Gravel and sand bodies more common south of the North Platte River and Pumpkin Creek valleys. Stratification in sandstone, pebbly sandstone, and siltstone usually obliterated by bioturbation and soil development. Gravel, sand, and conglomerate typically trough cross-stratified; individual troughs as much as 6 ft thick; some horizontal planar bedding (Goodwin and Diffendal, 1987). Some bodies of conglomerate, sand, and gravel are tabular, others are braid-like in plan view and fill valleys incised into bedrock. Gravel clast composition is variable; in Banner and Morrill Counties, some clasts are similar to the Broadwater Formation (Tb). For example, the Ash

Hollow Formation contains as much as 21 percent anorthosite (Diffendal, 1982b). Typically, 4-10 percent acidic volcanic rock clasts are present. Valley fill includes many locally derived clasts, some as large as 30 ft in length (Diffendal, 1983, 1990). At least two volcanic ash beds are north of the North Platte River, at least eight ash beds are exposed south of Broadwater along an unnamed tributary of the river, and seven ash beds are south of Bridgeport along eastern tributaries of Greenwood Creek. Multiple ash beds are also present along Ash Hollow and Lodgepole Creeks. These beds are horizontally stratified, trough crossbedded, or massive; some minor contorted bedding is present. Individual ash beds rarely form outcrops of more than 2 mi²; some fill former gullies and ponds. Calcrete and silcrete beds exist in the Ash Hollow Formation (Gardner and others, 1992) but rarely form outcrops of more than 1 mi². Common plant fossils are diatoms, charophytes, grass husks, nutlets, endocarps, and wood (Diffendal and others, 1996; Thomasson, 1990). Invertebrate fossils of ostracode carapaces and gastropod molds and shells are also present. Ash Hollow vertebrate fossils include a large number of distinctive taxa, such as large land tortoises, rhinoceroses, camels, horses, and carnivores (Breyer, 1981; Diffendal, 1982b; Swinehart and Diffendal, 1987; Voorhies and others, 1987; Voorhies, 1990) of Clarendonian and Hemphillian NALMA. Vertebrate fossils exist most commonly in olive sand, diatomite, and gravel. Fission-track ages of volcanic glass from ash beds in southern Morrill and Garden Counties range from about 7 to 9 Ma (Boellstorff, 1978). Formation unconformably overlies the Duer Ranch beds. The Ash Hollow Formation on the north side of the North Platte Valley exceeds 300 ft in thickness near the Morrill-Garden County line but is thinner to the west-northwest. Exposed thickness in the southern part of the map area exceeds 400 ft; in the subsurface the thickness is as much as 500 ft (Swinehart and others, 1985; Souders, 1986).

Duer Ranch beds of Swinehart and Diffendal (1987) (middle Miocene)—Not shown on map. Dominantly fluvial, brown silty sandstone, lesser amounts of siltstone and conglomerate, and some colluvium. Crops out discontinuously over 4 mi² about 7 mi southeast of Broadwater (Swinehart and Diffendal, 1987). Sandstone shows indistinct stratification, but coarse-grained sandstone and conglomerate locally are trough crossbedded. The informal Duer Ranch beds fill steep-gradient paleogullies and show primary dips of as much as 7° along gully axes and as much as 20° near gully sides. Similar paleovalley fills in the basal part of Ogallala reported from test holes in southern Morrill County and also in Banner, Kimball, and Cheyenne Counties (Diffendal, 1982b; Swinehart and others, 1985). Vertebrate fossils include *Cosoryx* sp., which led Voorhies (1990) to assign this unit to an early Clarendonian NALMA. Maximum thickness about 100 ft. (*GRI Source Map ID 2940*) ([Geologic Investigations Series Map, I-2545](#)).

Ta - Arikaree Group (lower Miocene and upper Oligocene)

Divided into three major units (Swinehart and Diffendal, 1995): informal Camp Clarke unit, Harrison and Monroe Creek Formations, undivided, and Gering Formation. Camp Clarke unit and Harrison and Monroe Creek Formations are predominantly volcaniclastic sediment of eolian origin. Gering is predominantly fluvial volcaniclastic sediment. Individual units not mapped separately because of their limited areas of outcrop at map scale

Camp Clarke unit of Swinehart and Diffendal (1995) (lower Miocene)—Not shown on map. Sandy siltstone and silty sandstone, volcaniclastic; yellowish gray to pale yellowish brown. Crops out along southward-flowing tributaries of North Platte River from north of Broadwater northwestward into the northeastern part of Scotts Bluff County. In the eastern 13 mi of outcrop belt the unit is massive, resembles loess, and contains potato-shaped calcareous concretions as much as 3 in. in diameter. The Camp Clarke unit contains abundant calcrete layers (paleosols) with siliceous rhizoliths. Unit is coarser grained in the western half of its outcrop belt. Swinehart and Diffendal (1995) recognized two well-exposed subunits in the lower part of the Camp Clarke unit on Indian Creek about 9 mi north-northwest of Bridgeport: the informal Indian Creek beds and an unnamed unit composed of conglomerate, gravel,

and sand. Vertebrate fossils, locally abundant in Camp Clarke unit, are late Arikareean NALMA (Swinehart and others, 1984). Camp Clarke unit commonly 60-100 ft thick; maximum thickness 120 ft.

Indian Creek beds of Swinehart and Diffendal (1995)—Not shown on map. Sandstone, siltstone, and claystone, pale-greenish-yellow to light-gray; as much as 110 ft thick.

Conglomerate, gravel, and sand—Not shown on map. Light gray; clasts as much as 2 ft in diameter of locally derived calcareous siltstone concretions from older Arikaree and White River strata; subunit is time transgressive because it is in the basal part of both the Camp Clarke unit and the Indian Creek beds. Subunit is as much as 60 ft thick.

Harrison (lower Miocene) and Monroe Creek (upper Oligocene) Formations, undivided—Not shown on map. Silty sand and silty, very fine to fine-grained sandstone, gray, brownish-gray, grayish-brown, and yellowish-gray, volcanoclastic, massive to poorly defined planar bedding; locally crossbedded; primarily of eolian origin; zones of siliceous rhizoliths common; evidence of bioturbation extensive. Unit contains conspicuous calcium carbonate-cemented concretions as much as tens of feet long called pipy concretions (Darton, 1903c; Schultz, 1941; Aadland, 1959). Schultz (1941) reported the concretions to be a hundred yards or more long. Locally derived conglomerate fills anastomosing channels eroded into older parts of Harrison and Monroe Creek strata (Goodwin, 1987). Unit extensively exposed along Wildcat Ridge and north of North Platte River; minor exposures along south side of Pumpkin Creek valley west from Redington. Volcanic ash beds uncommon and are best exposed along south-flowing tributaries of North Platte River and on Wildcat Ridge (Vondra and others, 1969; Swinehart and Loope, 1987). A basal ash bed (informally named Olsen's third ash; Swinehart and Diffendal, 1995; Tedford and others, 1996) yielded an $^{40}\text{Ar}/^{39}\text{Ar}$ age of 27.76 ± 0.30 Ma (ash-bed locality 1, sec. 13, T. 19 N., R. 53 W.). Typically, contact with underlying Gering Formation appears conformable but locally is erosional. Unit commonly 80-120 ft thick on north side of North Platte River valley and 200-300 ft thick on Wildcat Ridge; maximum thickness as much as 400 ft.

Gering Formation (upper Oligocene)—Not shown on map. Fine- to medium-grained sandstone, silty sandstone, and sandy siltstone; gray, brownish gray, and brown, volcanoclastic. Locally includes conglomerate, marl, and volcanic ash beds. Two major lithofacies represented in outcrops along flanks of Wildcat Ridge (Tedford and others, 1996). The upper lithofacies, primarily of fluvial origin, is very thin to thin-bedded, horizontally stratified, fine-grained sandstone and sandy siltstone, but locally includes some strata of eolian and shallow lacustrine (playa?) origin. Fossil animal tracks (Loope, 1986) and calcite pseudomorphs after gypsum crystals are locally common. Contains as many as five superposed ash beds; best exposures immediately south of Chimney Rock (4 mi south of Bayard) and at Scotts Bluff National Monument (Swinehart and Loope, 1987). Typically 25-70 ft thick; maximum thickness 90 ft. The lower lithofacies is a fluvial sequence of horizontal, thin- to medium-bedded sandstone, locally crossbedded and characterized by sand- to pebble-size pumice clasts, possibly derived from north-central Colorado (Izett, 1975). Pumice most easily recognized where it forms pebbles in conglomerate lenses in medium-grained sandstone, but it also exists as scattered medium-size grains in sandy siltstone. Pumice-bearing lithofacies also crops out north of Broadwater and is recognized in drill holes in east-central Morrill County. Commonly 60-80 ft thick; maximum thickness 115 ft. Along Lawrence Fork multiple fluvial cut-and-fill deposits that grade vertically into finer grained, massive, bedded strata of possible eolian origin appear also to fill some paleogullies (Diffendal, 1982a). We do not use the member designations of the Gering proposed by Vondra and others (1969). They included parts of what we have mapped as Brule Formation (brown siltstone unit and Whitney Member) in their lowest unit, the Helvas Canyon Member. They placed their Twin Sisters Pumice Conglomerate Bed at the base of their highest unit, the Mitchell Pass Member, but did not recognize the presence of sand-size pumice as much as 35 ft below the base of the Twin Sisters Bed. Mammalian fossils common, especially in fluvial deposits (Martin, 1973; Swisher, 1982). Species are typical of the early Arikareean NALMA (Tedford and others, 1996). Swisher (in Swinehart and Diffendal, 1995) obtained three $^{40}\text{Ar}/^{39}\text{Ar}$ ages on Gering ash beds: 28.28 ± 0.15 Ma from pumice clasts 38 ft above the base of the Gering in the NE 1/4 NW 1/4 sec. 6, T. 20

N., R. 55 W. (ash-bed locality 2), Scotts Bluff County; 28.11 ± 0.18 Ma from an ash bed near the top of the pumice-bearing lithofacies in the NE 1/4 SW 1/4 sec. 21, T. 19 N., R. 51 W. (ash-bed locality 3), Morrill County; and 28.28 ± 0.10 Ma on ash bed 1 ft above base of the upper lithofacies in the SW corner, sec. 17, T. 20 N., R. 52 W. (ash-bed locality 4), Morrill County. Formation commonly 50-100 ft thick; maximum thickness about 130 ft. (GRI Source Map ID 2940) ([Geologic Investigations Series Map I-2545](#)).

Twr - White River Group (lower Oligocene and upper Eocene)

Predominantly volcanoclastic eolian and fluvial sedimentary rocks that are mostly finer grained than those of Arikaree Group. Group divided into Brule Formation ([Tbr](#)) and underlying Chadron Formation ([Tc](#)) which crops out at only one locality.

Tbr - Brule Formation (lower Oligocene)

Sandy siltstone and silty sandstone, grayish-brown to yellowish-orange. Principally eolian volcanoclastic sediments and some minor fluvial deposits. Contains several volcanic ash beds that can be correlated regionally (Swinehart and others, 1985). Brule subdivided into three units (from youngest to oldest): a brown siltstone unit, the Whitney Member, and the Orella Member. Units were not mapped separately because of scale of map. Brule Formation underlies almost all of the quadrangle and crops out along the valleys of Lodgepole Creek, Ash Hollow, Blue Creek, Lawrence Fork, Pumpkin Creek, and South Platte and North Platte Rivers.

Brown siltstone unit - Not shown on map. Sandy siltstone and silty, very fine grained sandstone, brown to yellowish-brown; volcanoclastic (contains as much as 60 percent glass shards). Mudstone and fine- to coarse-grained sandstone exist locally. Eolian part of unit commonly contains beds 2-5 ft thick or is massive; fluvial channel-fill deposits are medium to thin bedded (1 in. to 2 ft thick) and cross-stratified. Invertebrate bioturbation features are common. Calcareous concretion zones common in massive sandy siltstone. Exposed along north side of North Platte River valley northwestward from Broadwater, and along south side from Ash Hollow westward to just east of Rush Creek. Also exposed along flanks of Wildcat Ridge and along south side of Pumpkin Creek valley. At least two ash beds present in lower part of unit (Nonpareil ash zone of Swinehart and others, 1985). Swisher and Prothero (1990) reported a $40\text{Ar}/39\text{Ar}$ age of 30.05 ± 0.19 Ma for the basal Nonpareil ash bed at Round Top in northwestern Nebraska. Two or more additional ash beds are in fluvial deposits (Tedford and others, 1996). One, the Roundhouse Rock ash (NE 1/4 SW 1/4 sec. 21, T. 19 N. R. 51 W., Morrill County; ash-bed locality 5) has a $40\text{Ar}/39\text{Ar}$ age of 28.6 ± 0.96 Ma (Swisher and Prothero, 1990). Those authors, however, assigned this ash to the Gering Formation. Unit commonly 50-150 ft thick; maximum thickness about 320 ft.

Whitney Member - Not shown on map. Siltstone, grayish-orange to yellowish-brown; composed of eolian volcanoclastic sediment. Mudstone and fine- to medium-grained fluvial sandstone present locally. Siltstone generally massive to very thick bedded (2-5 ft thick). Siltstone cemented with authigenic clay and calcite (Swinehart, 1979). Lacustrine silt and diatomaceous silt are present locally. Whitney Member underlies the brown siltstone unit and crops out in essentially the same areas. Whitney Member conformable on Orella Member. Whitney has two regionally correlative ash beds (upper ash and lower ash; Schultz and Stout, 1955; Swinehart and others, 1985). Evidence for bioturbation by invertebrates common in volcanic ash beds (Schwartman, 1989). Invertebrate fossils are present in lacustrine sediments and in paleosols. Fossil turtles and mammals generally represented by isolated fragments; oredonts are most common taxa. Swisher and Prothero (1990) reported $40\text{Ar}/39\text{Ar}$ age of 30.58 ± 0.61 Ma on the upper ash and 31.85 ± 0.02 Ma on the lower ash from Scotts Bluff National Monument (ash-bed locality 6, NE 1/4 NE 1/4 sec. 33, T. 22 N., R. 55 W.). Member commonly 200-250

ft thick; maximum thickness about 300 ft.

Orella Member - Not shown on map. Mudstone and siltstone, brown, greenish-gray to pink, volcaniclastic. Fine- to medium-grained, fluvial, crossbedded sandstone and thin-bedded mudstone are present locally (Blodgett, 1974), especially in upper half of the member. Crops out on north side of Scotts Bluff National Monument and locally in Lodgepole Creek valley. A regionally correlative ash bed (M ash) in the lower part of Orella Member that is known only in the subsurface is present in this quadrangle (Swinehart and others, 1985). Member commonly 300-350 ft thick; maximum thickness about 400 ft. (*GRI Source Map ID 2940*) ([Geologic Investigations Series Map. I-2545](#)).

Tc - Chadron Formation (upper Eocene)

Claystone and mudstone, gray, greenish-gray, and pink; bentonitic. Lower part of Chadron not exposed. Drill-hole data (Swinehart and others, 1985) reveal fine- to coarse-grained sandstone, claystone, and mudstone occupying paleovalleys in the unexposed part of the formation ([fig. 1](#)). Chadron Formation underlies almost all of quadrangle but crops out only in small area just south of North Platte Valley at west boundary of quadrangle. New radiometric dates from the Eocene-Oligocene boundary stratotype in Italy and other areas indicate that the boundary is at about 34.0 Ma (Berggren and others, 1992). New ages for ash beds from White River equivalent strata in Wyoming suggest that the Chadron Formation is older than 34.0 Ma (Prothero and Swisher, 1992). Therefore, we consider the Chadron in the quadrangle to be late Eocene in age. Exposed thickness is 25 ft; maximum thickness in subsurface is about 270 ft (Souders, 1986). (*GRI Source Map ID 2940*) ([Geologic Investigations Series Map. I-2545](#)).

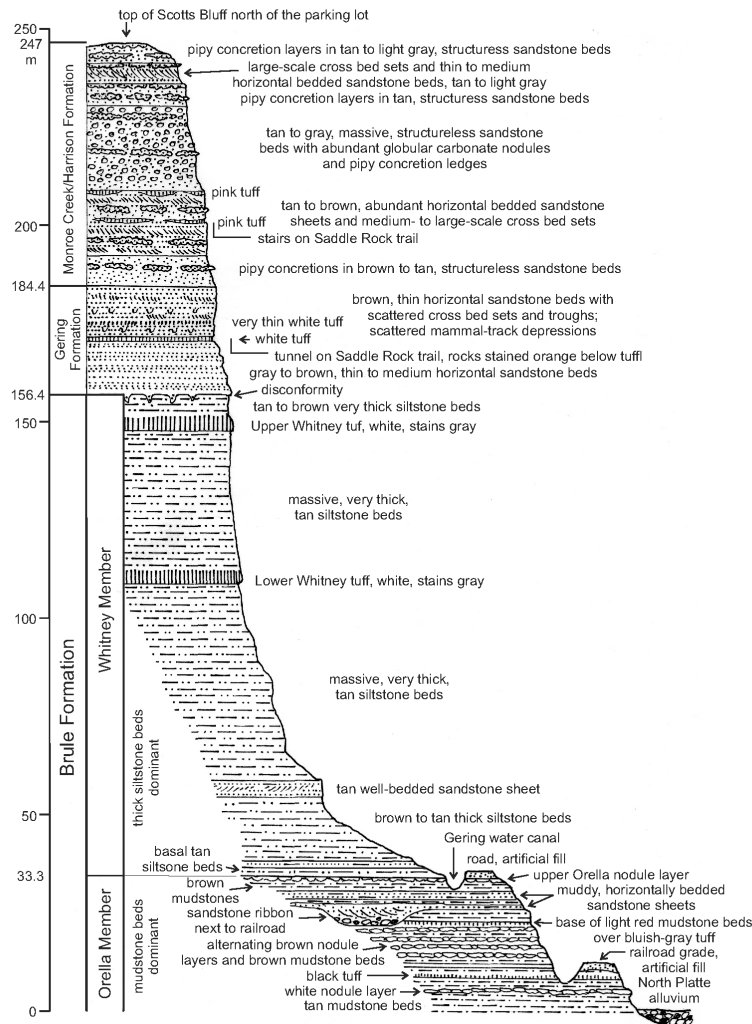
Additional GRI Source Map Information

Evanoff, 2014 Draft Map

Evanoff, E., 2014, Draft Geologic Map of Scotts Bluff National Monument, Nebraska: University of Northern Colorado, unpublished map, scale 1:24,000. (*GRI Source Map ID 75952*).

Composite Stratigraphic Section

Composite section measured from next to the modern North Platte alluvium (Qnpa) to the top of Scotts Bluff north of the monument's visitor center parking lot.



Of note, if viewing this graphic digitally (i.e., viewing the pdf and not a printed hard copy) the graphic is of high-resolution, and thus zooming-in to see more detail is possible. ([Evanoff, 2014 draft map](#)).

References

Schultz, C. B., and Stout, T. M., 1955, Classification of Oligocene sediments in Nebraska: The University of Nebraska State Museum Bulletin, v. 4, p. 17-52.

Swinehart, J. B., and Loope, D. B., 1987, Late Cenozoic geology along the summit to museum hiking trail, Scotts Bluff National Monument, western Nebraska: Centennial Field Guide Volume 3, North-Central Section of the Geological Society of America, p. 13-18.

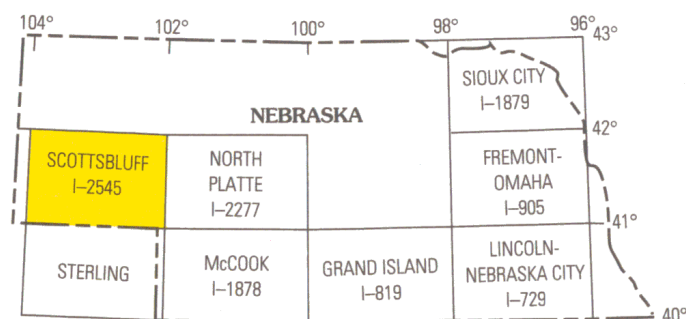
([Evanoff, 2014 draft map](#)).

U.S. Geological Survey I-2545

Swinehart, J.B. and Diffendal, R.F. Jr., 1997, Geologic Map of the Scottsbluff 1 Degree x 2 Degree Quadrangle, Nebraska and Colorado: U.S. Geological Survey, Geologic Investigations Series Map, I-2545, scale 1:250,000. (GRI Source Map ID 2940).

***The GRI digital geologic-GIS map produced from this source publication used only a portion of the full map. The area extent used is defined by the following coordinates: -104.000 and -103.250 longitude, 42.000 and 41.500 latitude.*

Location/Index Map

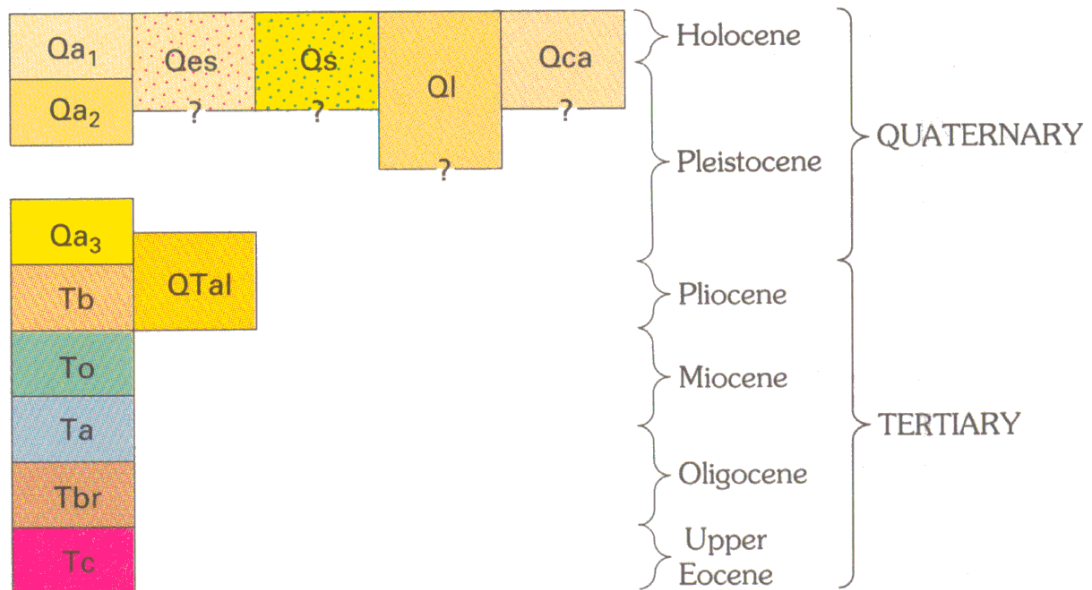


INDEX SHOWING LOCATION OF SCOTTSBLUFF QUADRANGLE AND OTHER 1° x 2° GEOLOGIC QUADRANGLES PUBLISHED BY THE U.S. GEOLOGICAL SURVEY

Extracted from: [Geologic Investigations Series Map, I-2545](#)

Correlation of Map Units

CORRELATION OF MAP UNITS



*** Of note, as only a portion of the source map was used for the GRI digital geologic-GIS monument area (SCBA) map not all units present on the source publication correlation of units figure are present in this document. Units Qs and QTal, although present in the above figure, are not present on the GRI digital geologic-GIS monument area map.*

Extracted from: [Geologic Investigations Series Map, I-2545](#)

Introduction

The Scottsbluff 1° x 2° quadrangle, in western Nebraska, is in the northern part of the High Plains section of the Great Plains Physiographic Province (Fenneman, 1931). The map area is mostly a constructional plain that has been dissected principally since the Pliocene by the rivers and streams that drain the area. Most of the southern half of the map area contains the partly eroded remnant of the High Plains known as the Cheyenne Tableland, a region occupying about 3,600 mi². Lodgepole Creek, and to a lesser extent Lawrence Fork, Ash Hollow, and tributaries of Pumpkin Creek, and the North Platte and South Platte Rivers have modified the topography of the tableland (Condra, 1946). The part of the High Plains north of the valley of the North Platte River is mostly in the Sand Hills but includes a small part of the Box Butte Tableland. Between the Cheyenne Tableland and the Box Butte Tableland and Sand Hills are the Pumpkin Creek valley and Wildcat Ridge, a remnant of the High Plains capping the deeply dissected divide separating Pumpkin Creek from the North Platte Valley. These parts of western Nebraska are historically important, because they were crossed by the Mormon Trail, Oregon Trail, Sidney-Deadwood Trail, the Pony Express (remnants of all of these can be seen today), and the Union Pacific Railroad along Lodgepole Creek. Famous landmarks include Ash Hollow, Chimney Rock, Jail and Courthouse Rocks, and Scotts Bluff.

The geologic history of the rocks exposed in the map area began some 30 million years after the Cretaceous seas withdrew from the Western Interior Seaway, and the land was subjected to subaerial processes. In the map area, the oldest Cenozoic rocks of the upper Eocene Chadron Formation were deposited in a paleovalley system ([fig. 1](#)) eroded into Cretaceous rocks. Upland areas during late Eocene time were mainly in the southwestern and western parts of the quadrangle. A north-trending branch of a paleovalley system along the east side of the quadrangle may have been controlled by the Rush Creek structure (Diffendal, 1980; Swinehart and others, 1985). After fluvial deposition of the Chadron ceased, dominantly eolian volcanoclastic sediments (upper part of the Chadron Formation and the Brule Formation of the White River Group) were deposited during the late Eocene and early Oligocene. The middle part of the Brule Formation does, however, locally contain thick alluvial deposits (Blodgett, 1974; Swinehart and others, 1985).

A narrow paleovalley was formed across the quadrangle before deposition in the late Oligocene of the Gering Formation (Arikaree Group). The long axis of Wildcat Ridge generally coincides with the paleovalley, which contains most of the Gering Formation in the quadrangle (Swinehart and others, 1985; Tedford and others, 1966). Although the Gering is mostly composed of fluvial sediments, most of the overlying upper Oligocene and lower Miocene Arikaree Group (Harrison and Monroe Creek Formations, undivided, and beds of the informal Camp Clarke unit) are composed of eolian volcanoclastic deposits.

In contrast to the White River and Arikaree Groups, the Ogallala Group (middle and upper Miocene) is dominantly fluvial, paleovalley-fill deposits. Most of the alluvial material was derived from erosion of rocks in the Southern Rocky Mountains (Stanley, 1976). The principal Ogallala paleovalley system extends across the southern part of the quadrangle ([fig. 2](#)). Toward the end of Ogallala Group deposition, a southeast-trending paleovalley was eroded north of the present North Platte Valley and later filled with the informal Angora sand and gravel beds.

The Broadwater Formation (Pliocene) consists principally of fluvial sand and gravel and fills a major paleovalley north of the present North Platte River (Swinehart and others, 1985; Swinehart and Diffendal, 1987).

The North Platte River system probably began to form during erosion of the valley that was filled by the Angora sand and gravel beds (upper Miocene), but principal tributaries like Pumpkin Creek apparently developed later, during or after the early Pleistocene (Diffendal and Corner, 1983). From western Garden County westward across the quadrangle, the North Platte River has migrated generally southward and has entrenched several times, whereas Pumpkin Creek has migrated northward and has also entrenched several times.

The map area is mostly covered by surficial deposits composed chiefly of eolian sand, loess, colluvium, and alluvium (Mortlock and others, 1920; Hayes, 1921; Wolfanger and others, 1924; Clocker and others, 1962; Sautter and others, 1965; Yost and others, 1968; Helzer and others, 1985; and unpublished preliminary soil surveys of Banner, Cheyenne, Garden, and Keith Counties being prepared by the Soil Conservation Service).

Deformation has affected parts of the quadrangle (DeGraw, 1969; Diffendal, 1980; Sonnenberg and Weimer, 1981; Swinehart and others, 1985; Ahlbrandt and Groen, 1987). Surface rocks from Sidney Draw in southwestern Cheyenne County northeastward to southwestern Garden County are folded. Contour maps of the base of the Ogallala Group ([fig. 2](#)) and on the base of the Cenozoic rocks ([fig. 1](#)) show highs and lows that correspond with fold axes shown by Sonnenberg and Weimer (1981).

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Note

This map is necessarily generalized. For more detailed information, consult the geologic data stored in files of the Conservation and Survey Division, University of Nebraska-Lincoln. Other geologic maps at different scales that include all or parts of the map area are by Darton (1903a,b,c), Lugn (1939), Weeks and Gutentag (1981), and Weeks and others (1988). Detailed groundwater investigations of parts of the map area were done by Wenzel and others (1946), Babcock and Visser (1951, 1952), Bjorklund (1957), Bjorklund and Brown (1957), Smith (1966, 1969), Smith and Souders (1971, 1975), Souders (1986), Gottula (1993), and Verstraeten and others (1995).

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Structure Contour Map Figures

Figure1: Structure Contour Map Drawn on the Base of Cenozoic Rocks.

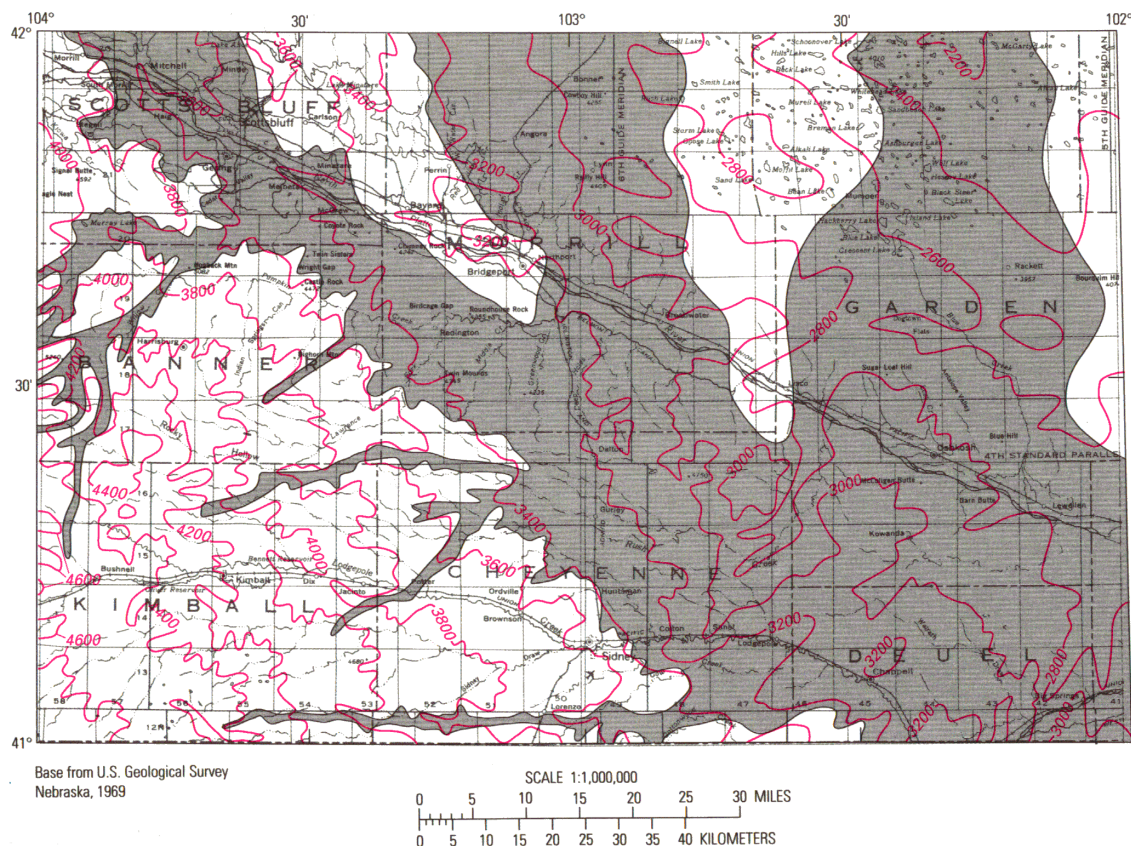


Figure 1. Contour map drawn on the base of Cenozoic rocks, Scottsbluff 1° x 2° quadrangle. This surface represents a pre-late Eocene unconformity, and the unconformity is overlain by the Chadron Formation (upper Eocene). Shading indicates areas where paleovalleys commonly contain 10-100 ft of fluvial sandstone in lower part of Chadron. Maximum local thickness of sandstone is 160 ft in southeastern Morrill County (Souders, 1986). The locations of the paleovalleys are not always well defined by contours because of post-Chadron deformation. Map compiled by H. M. DeGraw and V.L. Souders of the Conservation and Survey Division (CSD) based on data from electric logs from about 10,000 oil and gas test wells and from sample logs and electric logs from 30 test holes drilled by the CDS and cooperators. Contour interval 200 ft. Datum is mean sea level.

***The GRI digital geologic-GIS map produced from this source publication used only a portion of the full map. The area extent used by the GRI is defined by the following coordinates: -104.000 and -103.250 longitude, 42.000 and 41.500 latitude.*

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Figure2: Structure Contour Map Drawn on the Base of the Ogallala Group.

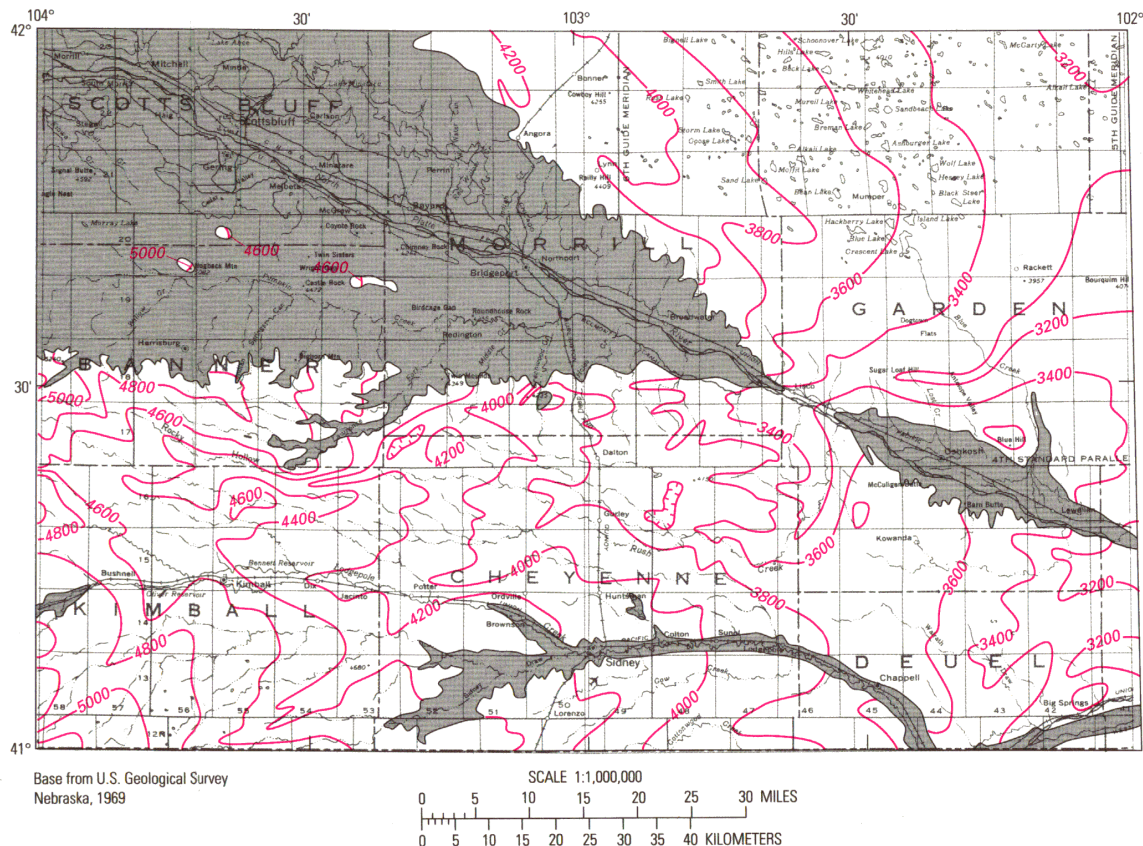


Figure 2. Contour map drawn on the base of the Ogallala Group, Scottsbluff 1° × 2° quadrangle. This surface represents multiple episodes of erosion between 18 and 5 million years ago. Shading indicates areas where the Ogallala has been removed by erosion or was not deposited. Map compiled by V.L. Souders, J.B. Swinehart, and R.F. Diffendal, Jr., based on data from electric logs from about 1,000 oil and gas test wells, sample logs and electric logs from about 280 test holes drilled by the Conservation and Survey Division and cooperators, and geologic mapping. Contour interval 200 ft. Hachures on contour lines indicate enclosed depression. Datum is mean sea level.

****The GRI digital geologic-GIS map produced from this source publication used only a portion of the full map. The area extent used by the GRI is defined by the following coordinates: -104.000 and -103.250 longitude, 42.000 and 41.500 latitude.**

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