U.S. Department of the Interior
National Park Service
Natural Resource Stewardship and Science Directorate
Geologic Resources Division

Theodore Roosevelt National Park

GRI Ancillary Map Information Document

Produced to accompany the Geologic Resources Inventory (GRI) Digital Geologic Data for Theodore Roosevelt National Park

thro_geology.pdf

Version: 3/31/2020

Geologic Resources Inventory Map Document for Theodore Roosevelt National Park

Table of Contents

Geologic Resources Inventory Map Document 1
About the NPS Geologic Resources Inventory Program 3
GRI Digital Maps and Source Map Citations 5
Index Map 7
Map Unit List 8
Map Unit Descriptions 9
Qef - Engineered fill (Holocene) 9
Qal - Modern alluvial deposits (Holocene) 9
Qf1 - Modern alluvial fan deposits (Holocene) 9
Qmp - Mantled Pediment deposits (Holocene) 9
Qf - Alluvial fan deposits, undivided (Holocene) 10
Qls - Landslide deposits (Holocene and Pleistocene) 10
Qoal - Older alluvial deposits (Holocene) 11
Qf2 - Holocene-age alluvial fan deposits (Holocene) 11
Qg - Glacial erratics (Pleistocene) 11
Qsg - Alluvium beneath Pleistocene terraces, undivided (Pleistocene) 11
Alluvium beneath Pleistocene terraces 12
Qt1 - Alluvium beneath Pleistocene terraces 1 (Pleistocene) 12
Qt2 - Alluvium beneath Pleistocene terraces 2 (Pleistocene) 12
Qt3 - Alluvium beneath Pleistocene terraces 3 (Pleistocene) 12
Qt4 - Alluvium beneath Pleistocene terraces 4 (Pleistocene) 12
QTa - Upland gravel (Pleistocene and Pliocene) 12
Tsbsl - Taylor bed silcrete lag on top of Sentinel Butte Formation (Paleocene) 13
Tsb - Sentinel Butte Formation (Paleocene) 13
Tsbck - Sentinel Butte Formation, unnamed clinker beds (Paleocene) 13
Tsby - Sentinel Butte Formation, lower yellow bed (Paleocene) 13
Tsbb - Sentinel Butte Formation, bentonite and ash (Paleocene) 13
Tsbc - Sentinel Butte Formation, HT Butte clinker (Paleocene) 14
Tbc - Bullion Creek Formation (Paleocene) 14
Geologic Cross Sections 15
Cross Section A-A' 15
Cross Section B-B' 15
Cross Section C-C' 15
GRI Ancillary Source Map Information 16
Miscellaneous Series No. 86 Report 16
Theodore Roosevelt National Park, North Unit 16
Correlation of Map Units 17
Map Legend 17
Quadrangle Location 18
Map Notes 18
Theodore Roosevelt National Park, South Unit 18
Correlation of Map Units 19
Map Legend 20
Quadrangle Location 20

Map Notes 20
Eagle Draw Quadrangle 21
Map Legend 21
Quadrangle Location 21
Hanks Gully Quadrangle 22
Map Legend 22
Quadrangle Location 22
Roosevelt Creek East Quadrangle 23
Map Legend 23
Quadrangle Location 23
Roosevelt Creek West Quadrangle 24
Map Legend 24
Quadrangle Location 24
GRI Digital Data Credits 25

Geologic Resources Inventory Map Document

Theodore Roosevelt National Park, North Dakota

Document to Accompany Digital Geologic-GIS Data

thro_geology.pdf

Version: 3/31/2020

This document has been developed to accompany the digital geologic-GIS data developed by the Geologic Resources Inventory (GRI) program for Theodore Roosevelt National Park, North Dakota (THRO).

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.

This document contains the following information:

1) **About the NPS Geologic Resources Inventory Program** – A brief summary of the Geologic Resources Inventory (GRI) Program and its products. Included are web links to the GRI GIS data model, and to the GRI products page where digital geologic-GIS datasets, scoping reports and geology reports are available for download. In addition, web links to the NPS Data Store and GRI program home page, as well as contact information for the GRI coordinator, are also present.

2) **GRI Digital Maps and Source Map Citations** – A listing of all GRI digital geologic-GIS maps produced for this project along with sources used in their completion. In addition, a brief explanation of how each source map was used is provided.

3) **Map Unit List** – A listing of all geologic map units present on maps for this project, generally listed from youngest to oldest.

4) **Map Unit Descriptions** – Descriptions for all geologic map units. If a unit is present on multiple source maps the unit is listed with its source geologic unit symbol, unit name and unit age followed by the unit's description for each source map.

5) **Geologic Cross Sections** – Geologic cross section graphics with source geologic cross section abbreviations.

6) **Ancillary Source Map Information** – Additional source map information presented by source map. For each source map this may include a stratigraphic column, index map, map legend and/or map notes.

7) **GRI Digital Data Credits** – GRI digital geologic-GIS data and ancillary map information document production credits.

For information about using GRI digital geologic-GIS data contact:

Stephanie O'Meara
Geologist/GIS Specialist/Data Manager
Colorado State University Research Associate, Cooperator to the National Park Service
Fort Collins, CO 80523
phone: (970) 491-6655
e-mail: stephanie.omeara@colostate.edu

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://go.nps.gov/gri_products

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: https://www.nps.gov/subjects/geology/gri.htm, or contact:

Jason Kenworthy
Inventory Coordinator
National Park Service Geologic Resources Division
P.O. Box 25287
Denver, CO 80225-0287
phone: (303) 987-6923
fax: (303) 987-6792
email: Jason_Kenworthy@nps.gov

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 digital geologic-GIS maps for Theodore Roosevelt National Park, North Dakota (THRO):

Digital Geologic-GIS Map of Theodore Roosevelt National Park and Vicinity, North Dakota (*GRI MapCode THRO*)

In addition to the above map the GRI also produced several component maps that collectively comprise the above park and vicinity map. The full extent of each source map (listed below) was used and all geologic features present on each map including all mine point features (e.g., gravel pits, quarries, wells) were captured. In addition, prominent map components present on each source map (e.g., unit colors, unit descriptions, geologic cross sections and other ancillary map graphics and text) were also incorporated into this GRI digital geologic-GIS dataset and product.

Component maps that comprise the park and vicinity map and their source map citations are listed below.

Digital Geologic-GIS Map of the North Unit of Theodore Roosevelt National Park, North Dakota (*GRI MapCode THRN*)

Biek, Robert F., and Gonzalez, Mark A., 2001, Geology of the Theodore Roosevelt National Park, North Unit, McKenzie County: North Dakota Geological Survey, Miscellaneous Series No. 86, Plate 2, scale 1:24,000 (Theodore Roosevelt National Park, North Unit). (*GRI Source Map ID 2157*).

Digital Geologic-GIS Map of the South Unit of Theodore Roosevelt National Park, North Dakota (*GRI MapCode THRS*)

Biek, Robert F., and Gonzalez, Mark A., 2001, Geology of the Theodore Roosevelt National Park, South Unit, Billings County: North Dakota Geological Survey, Miscellaneous Series No. 86, Plate 1, scale 1:24,000 (Theodore Roosevelt National Park, South Unit). (*GRI Source Map ID 2156*).

Digital Geologic-GIS Map of the Middle Unit of Theodore Roosevelt National Park, North Dakota (*GRI MapCode THRM*)

The above (middle unit) map is a compilation of four 7.5' quadrangle component maps. These component maps and their source map citations that comprise the middle unit map are listed below.

Digital Geologic-GIS Map of the Eagle Draw Quadrangle, North Dakota (*GRI MapCode EADR*)

Gonzalez, M.A., 2004, Surface Geology - Eagle Draw Quadrangle, North Dakota: North Dakota Geological Survey, 24K Series, EglD-sg, scale 1:24,000 (Eagle Draw Quadrangle). (*GRI Source Map ID 75953*).

Digital Geologic-GIS Map of the Hanks Gully Quadrangle, North Dakota (*GRI MapCode HAGU*)

Gonzalez, M.A., 2004, Surface Geology - Hanks Gully Quadrangle, North Dakota: North Dakota Geological Survey, 24K Series, HnkG-sg, scale 1:24,000 (Hanks Gully Quadrangle). (*GRI Source Map ID 75954*).

Digital Geologic-GIS Map of Roosevelt Creek East Quadrangle, North Dakota (*GRI MapCode RCEA*)

Gonzalez, M.A., 2004, Surface Geology - Roosevelt Creek East Quadrangle, North Dakota: North Dakota Geological Survey, 24K Series, RsvC E-sg, scale 1:24,000 (Roosevelt Creek East

Quadrangle). (*GRI Source Map ID 75955*).

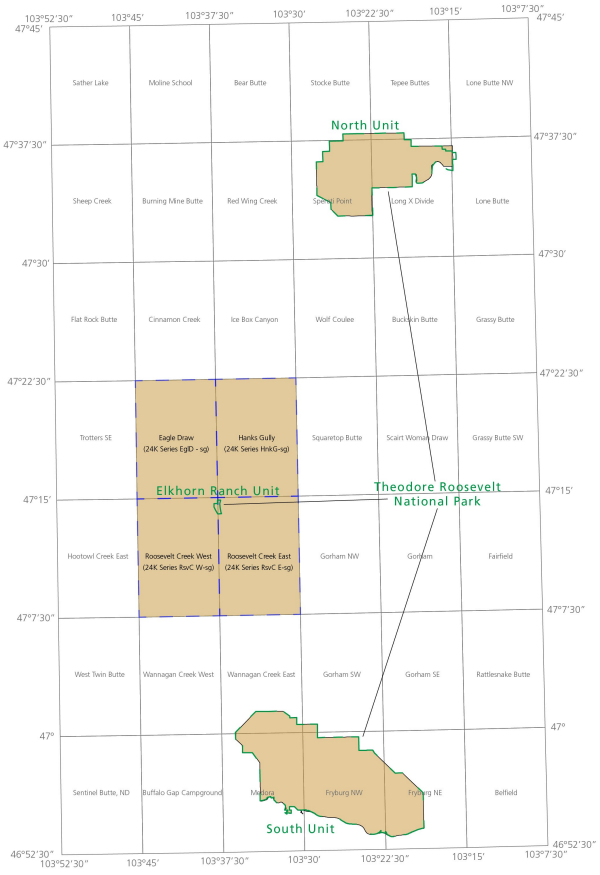
Digital Geologic-GIS Map of Roosevelt Creek West Quadrangle, North Dakota (*GRI MapCode RCWE*)

Gonzalez, M.A., 2004, Surface Geology - Roosevelt Creek West Quadrangle, North Dakota: North Dakota Geological Survey, 24K Series, RsvC W-sg, scale 1:24,000 (Roosevelt Creek West Quadrangle). (*GRI Source Map ID 75956*).

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

Index Map

The following index map displays the boundary for Theodore Roosevelt National Park (in dashed dark green, as of January, 2019). The extent of the GRI Digital Geologic-GIS Map of Theodore Roosevelt National Park is in shaded brown. The north unit of Theodore Roosevelt National Park is made up of parts of the Lone Butte, Long X Divide, Sperati Point, Stocke Butte, and Tepee Buttes 7.5' quadrangles. The middle unit of Theodore Roosevelt National Park is composed of the Eagle Draw, Hanks Gully, Roosevelt Creek East, and Roosevelt Creek West 7.5' quadrangles which are outlined in dashed blue. As mentioned each of the middle unit map 7.5' quadrangle maps is also available as a component map. The south unit of Theodore Roosevelt National Park is composed of parts of the Fryburg NE, Fryburg NW, Gorham SW, Medora, and Wannagan Creek East 7.5' quadrangles.



Index map produced by James Winter (Colorado State University).

Map Unit List

The geologic units present in the digital geologic-GIS data produced for Theodore Roosevelt National Park, North Dakota (THRO) are listed below. Units are listed with their assigned unit symbol and unit name (e.g., Qef - Engineered fill). Units are listed from youngest to oldest. No description for water is provided. Information about each geologic unit is also presented in the GRI Geologic Unit Information (THROUNIT) table included with the GRI geologic-GIS data. Some source unit symbols, names and/or ages may have been changed in this document and in the GRI digital geologic-GIS data. This was done if a unit was considered to be the same unit as one or more units on other source maps used for this project, and these unit symbols, names and/or ages differed. In this case a single unit symbol and name, and the unit's now recognized age, was adopted. Unit symbols, names and/or ages in a unit descriptions, or on a correlation of map units or other source map figure were not edited. If a unit symbol, name or age was changed by the GRI the unit's source map symbol, name and/or age appears with the unit's source map description.

Cenozoic Era

Quaternary Period

Qef - Engineered fill
Qal - Modern alluvial deposits
Qf1 - Modern alluvial fan deposits
Qmp - Mantled Pediment deposits
Qf - Alluvial fan deposits, undivided
Qls - Landslide deposits
Qoal - Older alluvial deposits
Qf2 - Holocene-age alluvial fan deposits
Qg - Glacial erratics
Qsg - Alluvium beneath Pleistocene terraces, undivided
Qt1 - Alluvium beneath Pleistocene terraces 1
Qt2 - Alluvium beneath Pleistocene terraces 2
Qt3 - Alluvium beneath Pleistocene terraces 3
Qt4 - Alluvium beneath Pleistocene terraces 4

Tertiary and Quaternary Periods

QTa - Upland gravel

Tertiary Period

Tsbsl - Taylor bed silcrete lag on top of Sentinel Butte Formation
Tsb - Sentinel Butte Formation
Tsbck - Sentinel Butte Formation, unnamed clinker beds
Tsby - Sentinel Butte Formation, lower yellow bed
Tsbb - Sentinel Butte Formation, bentonite and ash
Tsbc - Sentinel Butte Formation, HT Butte clinker
Tbc - Bullion Creek Formation

Map Unit Descriptions

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

Qef - Engineered fill (Holocene)

Fill used in the construction of roadways. Description from source maps: Theodore Roosevelt National Park, North Unit, Theodore Roosevelt National Park, South Unit, Eagle Draw Quadrangle, Hanks Gully Quadrangle, Roosevelt Creek East Quadrangle, and Roosevelt Creek West Quadrangle.

Qal - Modern alluvial deposits (Holocene)

Qal - Modern alluvium (Recent)
Sand, silt, clay, and gravel found in modern stream channels, flood plains, and beneath low stream terraces. Sediments typically comprise cross-stratified and coarse planar-stratified channel deposits of sand and gravel, grading upward to finely stratified overbank deposits of sand, silt, and clay. Sediments are moderately to moderately-well sorted. Sediments have been deposited within the past 500 years. Locally, includes small alluvial-fan deposits. Description from source maps: Theodore Roosevelt National Park, North Unit and Theodore Roosevelt National Park, South Unit.

Qal - Modern Alluvial Deposits (Recent)
Sand, silt, clay, and gravel deposited in modern stream channels, flood plains, and beneath low stream terraces. Sediments comprise cross-stratified and coarse planar-stratified channel deposits of sand and gravel, grading upward to ripple cross-stratified and finely planar-stratified overbank deposits of sand, silt, and clay. Sediments are moderately to moderately-well sorted. Locally includes small alluvial-fan and valley-margin colluvial deposits. Description from source maps: Eagle Draw Quadrangle, Hanks Gully Quadrangle, Roosevelt Creek East Quadrangle, and Roosevelt Creek West Quadrangle.

Qf1 - Modern alluvial fan deposits (Holocene)

Qf1 - Modern fans (Recent)
Complex assemblage of active and incised alluvial deposits of sand, silt, clay, and gravel deposited at the mouths of canyons and at confluences where low-order streams empty into higher-order streams. Sediments are poorly stratified and poorly to moderately sorted. Deposits contain thin layers of transported soil and weak profiles of soils formed in situ. Subdivided by age into Qf1 and Qf2. Modern fans (Qf1) are active and inset within older fans and most likely formed contemporaneously with modern alluvial (Qal) deposits in response to lower stream-grade elevations along trunks streams. Holocene-age fans (Qf2) are typically inactive and incised and formed contemporaneously with older alluvial (Qoal) deposits. Locally includes colluvium deposited by slopewash at the base of steep hillslopes. Description from source map: Theodore Roosevelt National Park, South Unit.

Qmp - Mantled Pediment deposits (Holocene)

Qmp - Mantled pediments (Recent)
Complex assemblage of active and incised alluvial deposits of sand, silt, and clay deposited over pediments. Sediments represent alluvium (weakly stratified, poorly sorted) washed from superjacent hillslopes and a combination of reworked (weakly stratified, well-sorted) and in situ (massive, well-sorted) eolian material. Deposits contain thin layers of transported soil and weak profiles of soils formed in situ. Some surface soils are well developed. Deposits are typically less than 3 feet thick, locally more than 6 feet thick. Theodore Roosevelt National Park, North Unit and Theodore Roosevelt

National Park, South Unit.

Qmp - Mantled Pediment Deposits (Recent)
Complex assemblage of active and incised alluvial deposits of sand, silt, and clay deposited over pediments. Sediments represent alluvium (weakly stratified, poorly sorted) washed from superjacent hillslopes and a combination of reworked (weakly stratified, well sorted) and in situ (massive, well sorted) eolian material. Deposits contain thin layers of transported soil and weak profiles of soils formed in situ. Some surface soils are well developed. Deposits are typically less than 3 feet (1 meter) thick, locally more than 6 feet (2 meters) thick. Description from source maps: Eagle Draw Quadrangle, Hanks Gully Quadrangle, Roosevelt Creek East Quadrangle, and Roosevelt Creek West Quadrangle.

Qf - Alluvial fan deposits, undivided (Holocene)

Qf - Alluvial fan deposits (Recent)
Complex assemblage of active and incised alluvial deposits of sand, silt, clay, and gravel deposited at the mouths of canyons and confluences where low-order streams empty into higher-order streams. Sediments are poorly stratified and poorly to moderately sorted. Deposits contain thin layers of transported soil and weak profiles of soils formed in situ. Holocene-age fans are typically inactive and incised and formed contemporaneously with Qoal deposits. Modern fans are active and inset within older fans and most likely formed contemporaneously with Qal deposits in response to lower stream-grade elevations along trunk streams. Locally includes colluvium deposited by slopewash at the base of steep hillslopes. Description from source map: Theodore Roosevelt National Park, North Unit.

Qf - Fan Deposits (Recent)
Active and incised alluvial deposits of sand, silt, clay, and gravel deposited at the mouths of canyons and at confluences where low-order streams empty into higher-order streams. Sediments are poorly stratified and poorly to moderately sorted. Deposits contain thin layers of transported soil and weak profiles of soils formed in situ. Gravel may be clast-or matrix-supported. Some beds have massive or reverse bedding. Locally includes colluvium deposited by slopewash at the base of steep hillsides. Description from source maps: Eagle Draw Quadrangle, Hanks Gully Quadrangle, Roosevelt Creek East Quadrangle, and Roosevelt Creek West Quadrangle.

Qls - Landslide deposits (Holocene and Pleistocene)

Qls - Landslide deposits (Recent/Pleistocene)
Locally derived sediment transported principally by gravity in rotational slumps. Slump blocks characterized by hummocky topography, numerous arcuate scarps, and chaotic bedding. Symbol demarcates smaller slope failures and hillslopes affected strongly by heave (creep). Locally includes hillslope materials transported by flows. Description from source maps: Theodore Roosevelt National Park, North Unit and Theodore Roosevelt National Park, South Unit.

Qls - Landslide Deposits (Recent/Pleistocene)
Variable mixture of strata and deposits that have slid or slumped to the base of steep slopes principally by gravity. Ground surface of many landslide deposits is characterized by hummocky topography, numerous arcuate scarps, and chaotic bedding. Locally includes hillslopes affected by creep and hillslope material transported by debris flows. Description from source maps: Eagle Draw Quadrangle, Hanks Gully Quadrangle, Roosevelt Creek East Quadrangle, and Roosevelt Creek West Quadrangle.

Qoal - Older alluvial deposits (Holocene)

Qoal - Older alluvium (Recent)
Sand, silt, clay, and gravel deposited beneath Holocene-age terraces. Sediments typically display an upward-fining sequence: crudely stratified gravel and sand predominant in the lower section and finely stratified sand, silt, and clay in the upper section. Buried soil profiles are common. Locally includes small alluvial-fan and valley-margin alluvial deposits. Description from source maps: Theodore Roosevelt National Park, North Unit and Theodore Roosevelt National Park, South Unit.

Qoal - Older Alluvial Deposists (Recent)
Sand, silt, clay, and gravel deposited beneath Holocene-age terraces. Sediments typically display an upward-fining sequence: crudely cross-stratified gravel and sand predominate in the lower section and finely planar-stratified and ripple cross-stratified sand, silt, and clay in the upper section. Buried soil profiles are common. Locally includes small alluvial-fan and valley-margin colluvial deposits. Description from source maps: Eagle Draw Quadrangle, Hanks Gully Quadrangle, Roosevelt Creek East Quadrangle, and Roosevelt Creek West Quadrangle.

Qf2 - Holocene-age alluvial fan deposits (Holocene)

Qf2 - Holocene-age fans (Holocene)
Complex assemblage of active and incised alluvial deposits of sand, silt, clay, and gravel deposited at the mouths of canyons and at confluences where low-order streams empty into higher-order streams. Sediments are poorly stratified and poorly to moderately sorted. Deposits contain thin layers of transported soil and weak profiles of soils formed in situ. Subdivided by age into Qf1 and Qf2. Modern fans (Qf1) are active and inset within older fans and most likely formed contemporaneously with modern alluvial (Qal) deposits in response to lower stream-grade elevations along trunks streams. Holocene-age fans (Qf2) are typically inactive and incised and formed contemporaneously with older alluvial (Qoal) deposits. Locally includes colluvium deposited by slopewash at the base of steep hillslopes. Description from source maps: Theodore Roosevelt National Park, South Unit.

Qg - Glacial erratics (Pleistocene)

Widely scattered, sub-angular to sub-rounded cobbles and boulders of granitic and carbonate composition that lie atop Sentinel Butte strata and poke through or are buried by a veneer of Holocene loess. Description from source map: Theodore Roosevelt National Park, North Unit.

* Unit is present in the Glacial Erratics data layer in the GRI digital geologic-GIS data.

Qsg - Alluvium beneath Pleistocene terraces, undivided (Pleistocene)

Qsg - Alluvium beneath Pleistocene Terraces (Pleistocene)
Poorly to moderately sorted sand and sub-rounded to sub-angular gravel of mixed lithologies (sandstone, mudstone, iron nodules, silicified wood, flint, clinker, chalcedony, quartize, granite, and volcanic porphyry) beneath broad, flat to gently sloping axial-stream terraces along the Little Missouri River. Sand and gravel deposits are typically 3 to 10 feet (1 to 3 meters) thick. Deposits of Qsg are subdivided locally on the basis of their height above the modern stream grade into Qsg1, 160 feet (50 meters) above grade, Qsg2, 220 feet (60 meters), Qsg3, 240 feet (70 meters), and Qsg4, 260-270 feet (80 meters). Description from source maps: Eagle Draw Quadrangle, Hanks Gully Quadrangle, Roosevelt Creek East Quadrangle, and Roosevelt Creek West Quadrangle.

Alluvium beneath Pleistocene terraces

Poorly to moderately sorted, sand and well-rounded gravel of local (sandstone, mudstone, concretions, silicified wood, flint, silcrete, clinker, chalcedony) and southwestern (quartzite and porphyry) affinity beneath broad, flat to gently sloping axial-stream terraces along the Little Missouri River. Sand and gravel layers are typically 5 to 10 feet thick, range from 2 to 20 feet in thickness, and are overlain by a mantle of eolian sand and silt, 0 to 10 feet thick. In the South Unit, deposits of Qt are subdivided on the basis of their height above the modern channel of the Little Missouri River into Qt1, 160 feet above grade, Qt2, 220 feet above grade, Qt3, 240 feet above grade, and Qt4, 260-270 feet above grade. Description from source map: Theodore Roosevelt National Park, South Unit.

The unit description above pertains to the following units: Qt1, Qt2, Qt3, and Qt4.

Qt1 - Alluvium beneath Pleistocene terraces 1 (Pleistocene)

No additional unit description provided. Unit present on source map: Theodore Roosevelt National Park, South Unit.

Qt2 - Alluvium beneath Pleistocene terraces 2 (Pleistocene)

No additional unit description provided. Unit present on source map: Theodore Roosevelt National Park, South Unit.

Qt3 - Alluvium beneath Pleistocene terraces 3 (Pleistocene)

No additional unit description provided. Unit present on source map: Theodore Roosevelt National Park, South Unit.

Qt4 - Alluvium beneath Pleistocene terraces 4 (Pleistocene)

No additional unit description provided. Unit present on source map: Theodore Roosevelt National Park, South Unit.

QTa - Upland gravel (Pleistocene and Pliocene)

QTa - Upland gravel (Late Tertiary/Quaternary System (?)
Sand and well-rounded gravel deposits atop Sentinel Butte strata. Sediments are moderately sorted, iron-stained, locally iron-cemented sand and polished pebble to cobble gravel of local (mudstone, sandstone, concretions, silicified wood, flint, silcrete, clinker, chalcedony) and southwestern (quartzite and porphyry) affinity. Basal contact is generally more than 400 feet above modern stream grade. Deposits are generally less than 10 feet thick, but may be up to 40 feet thick at Sperati Point; capped by a veneer of loess. Description from source map: Theodore Roosevelt National Park, North Unit

QTa - Upland gravel (Late Tertiary/Quaternary System (?)
Sand and well-rounded gravel deposits atop Sentinel Butte strata. Sediments are moderately sorted, iron-stained, locally iron-cemented sand and polished pebble to cobble gravel of local (sandstone, mudstone, concretions, silicified wood, flint, silcrete, clinker, chalcedony) and southwestern (quartzite and porphyry) affinity. Basal contact is generally more than 400 feet above modern stream grade. Deposits are generally less than 10 feet thick and are capped by a veneer of loess. Description from source maps: Theodore Roosevelt National Park, South Unit.

Tsbsl - Taylor bed silcrete lag on top of Sentinel Butte Formation (Paleocene)

No additional unit description provided. Unit present on source map: Theodore Roosevelt National Park, North Unit

* Unit is present in the Silcrete Lag Deposits data layer in the GRI digital geologic-GIS data.

Tsb - Sentinel Butte Formation (Paleocene)

Tsb - Sentinel Butte Formation (Paleocene)
Gray to brown, variably lithified sandstone, siltstone, mudstone, claystone, clinker, and lignite. A bed of tuff/bentonite up to 20 feet thick is found in parts of the North Unit. Calcite-cemented sandstone concretions, siderite nodules, and petrified wood are common. Sediments deposited in river, lake, and swamp environments. Typically forms sparsely vegetated, steep, rilled slopes and badlands topography. About 750 feet thick in the North Unit; only the lower 300 feet are exposed in the South Unit. Description from source map: Theodore Roosevelt National Park, North Unit.

Tsb - Sentinel Butte Formation (Paleocene)
Gray to brown, variably lithified sandstone, siltstone, mudstone, claystone, clinker, and lignite. Calcite-cemented sandstone concretions, siderite nodules, and petrified wood are common. Sediments deposited in river, lake, and swamp environments. Typically forms sparsely vegetated, steep, rilled slopes and badlands topography. About 750 feet thick in the North Unit; only the lower 300 feet are exposed in the South Unit. The HT Butte clinker, found immediately above the contact with Tbc, is designated by "c". Unnamed clinker beds are designated by "ck". Description from source maps: Theodore Roosevelt National Park, South Unit.

Tsb - Sentinel Butte Formation (Paleocene)
Alternating beds of gray to grayish brown, variably lithified sandstone, siltstone, mudstone, claystone, clinker, and lignite. Calcite-cemented sandstone concretions, siderite nodules, and petrified wood are common. Sediments deposited in river, lake, and swamp environments. Typically forms sparsely vegetated, steep, rilled slopes and badlands topography. About 750 feet (230 meters) thick. Description from source maps: Eagle Draw Quadrangle, Hanks Gully Quadrangle, Roosevelt Creek East Quadrangle, and Roosevelt Creek West Quadrangle.

Tsbck - Sentinel Butte Formation, unnamed clinker beds (Paleocene)

No additional unit description provided. Unit present on source maps: Theodore Roosevelt National Park, North Unit and Theodore Roosevelt National Park, South Unit.

Tsby - Sentinel Butte Formation, lower yellow bed (Paleocene)

No additional unit description provided. Unit present on source map: Theodore Roosevelt National Park, North Unit.

*****Unit is mapped as both an area and a linear feature in the GRI digital geologic-GIS data.

Tsbb - Sentinel Butte Formation, bentonite and ash (Paleocene)

No additional unit description provided. Unit present on source map: Theodore Roosevelt National Park, North Unit.

*****Unit is mapped as both an area and a linear feature in the GRI digital geologic-GIS data.

Tsbc - Sentinel Butte Formation, HT Butte clinker (Paleocene)

No additional unit description provided. Unit present on source map: Theodore Roosevelt National Park, North Unit.

c - HT Butte clinker (Paleocene)
The HT Butte clinker, found immediately above the contact with Tbc, is designated by "c". Unnamed clinker beds are designated by "ck". Description from source maps: Theodore Roosevelt National Park, South Unit.

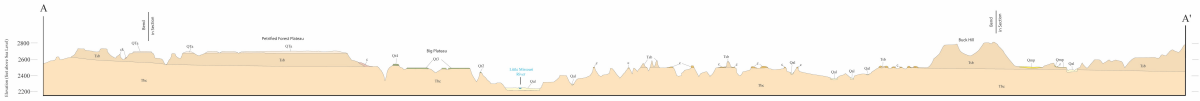
Tbc - Bullion Creek Formation (Paleocene)

Yellowish-brown, variably lithified sandstone, siltstone, mudstone, claystone, clinker, and lignite. Sediments deposited in river, lake, and swamp environments. Only upper 300 feet are exposed in the South Unit; does not crop out in North Unit. Unnamed clinker beds are designated by "ck". Description from source map: Theodore Roosevelt National Park, South Unit.

Geologic Cross Sections

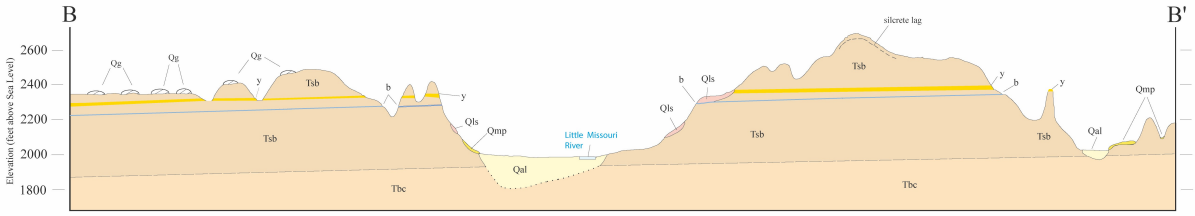
The geologic cross sections present in the GRI digital geologic-GIS data produced for Theodore Roosevelt National Park, North Dakota (THRO) are presented below. Cross section graphics were scanned at a high resolution and can be viewed in more detail by zooming in (if viewing the digital format of this document).

Cross Section A-A'



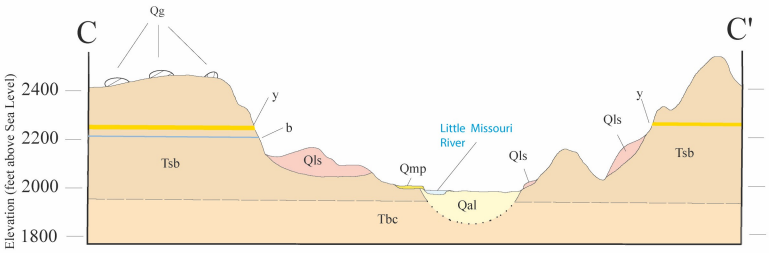
Extracted from: Theodore Roosevelt National Park, South Unit.

Cross Section B-B'



Extracted from: Theodore Roosevelt National Park, North Unit.

Cross Section C-C'



Extracted from: Theodore Roosevelt National Park, North Unit.

GRI Ancillary Source Map Information

The following sections present ancillary source map information associated with sources used for this project.

Miscellaneous Series No. 86 Report

The formal citations (plates 1 and 2 of 2) for this source.

Biek, Robert F., and Gonzalez, Mark A., 2001, Geology of the Theodore Roosevelt National Park, South Unit, Billings County: North Dakota Geological Survey, Miscellaneous Series No. 86, Plate 1, scale 1:24,000 (Theodore Roosevelt National Park, South Unit). (*GRI Source Map ID 2156*).

Biek, Robert F., and Gonzalez, Mark A., 2001, Geology of the Theodore Roosevelt National Park, North Unit, McKenzie County: North Dakota Geological Survey, Miscellaneous Series No. 86, Plate 2, scale 1:24,000 (Theodore Roosevelt National Park, North Unit). (*GRI Source Map ID 2157*).

The report for the Geologic Map of Theodore Roosevelt National Park, North and South Units, McKenzie County: North Dakota is presented below.

Miscellaneous Serious No. 86 (the embedded report document can be accessed by double-clicking on the report link)

The report contains the following sections:

Acknowledgments
Abstract
Introduction
Stratigraphy
Structure
Mineral Resources
Geologic Hazards
References
Glossary
Index

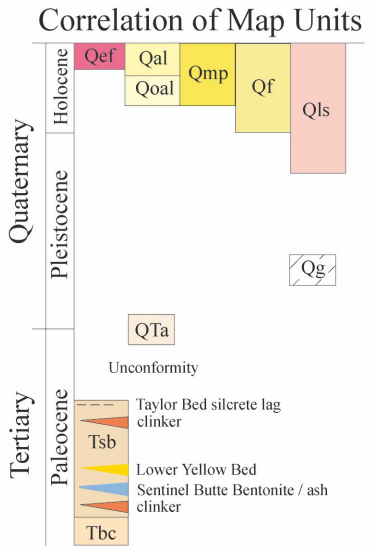
Theodore Roosevelt National Park, North Unit

The formal citation for this source.

Biek, Robert F., and Gonzalez, Mark A., 2001, Geology of the Theodore Roosevelt National Park, North Unit, McKenzie County: North Dakota Geological Survey, Miscellaneous Series No. 86, Plate 2, scale 1:24,000 (*GRI Source Map ID 2157*).

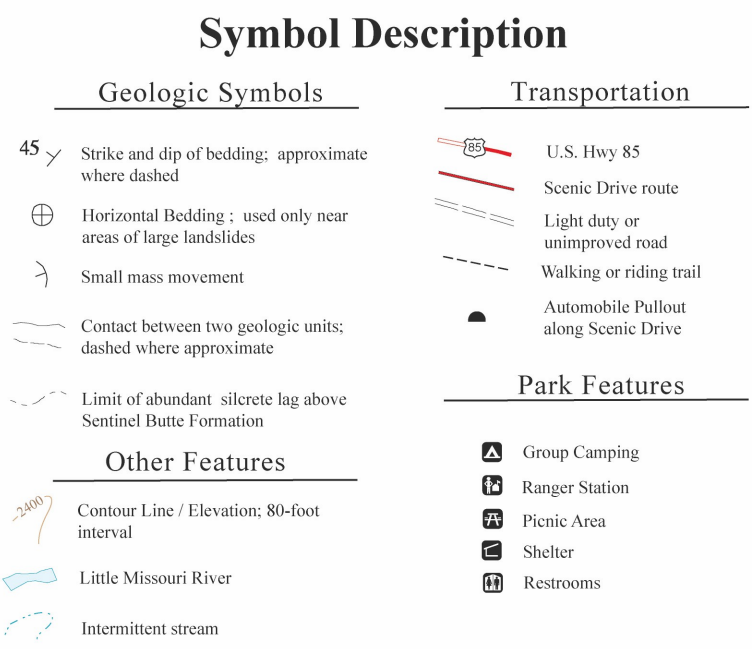
Prominent graphics and text associated with this source.

Correlation of Map Units



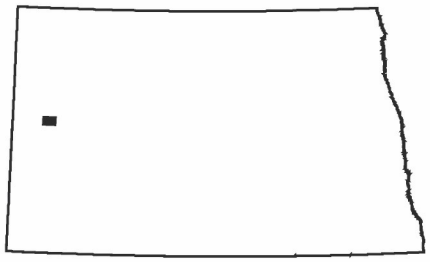
Graphic from source map: Theodore Roosevelt National Park, North Unit.

Map Legend



Graphic from source map: Theodore Roosevelt National Park, North Unit. Note that non-geologic features such as Transportation and Park Features were not captured in the GRI digital geologic-GIS data. See the source map publication for this information.

Quadrangle Location



Theodore Roosevelt National Park
North Unit, North Dakota

Graphic from source map: Theodore Roosevelt National Park, North Unit.

Map Notes

The North Dakota Geologic Survey compiled this map according to conventional cartographic standards, using what is thought to be the most reliable information available. The North Dakota Geological Survey does not guarantee freedom from errors or inaccuracies and disclaims any legal responsibility or liability for interpretations made from the map, or decisions based thereon.

This map is Plate II from North Dakota Geological Survey Miscellaneous Serious 86 (MS-86). The field work required to produce this map was conducted by Robert F. Biek and Mark A. Gonzalez, with additional work done by Edward C. Murphy. This project was carried out under Assistance Award 1434-95-A-1374, from the USGS, Department of the Interior.

Text from source map: Theodore Roosevelt National Park, North Unit.

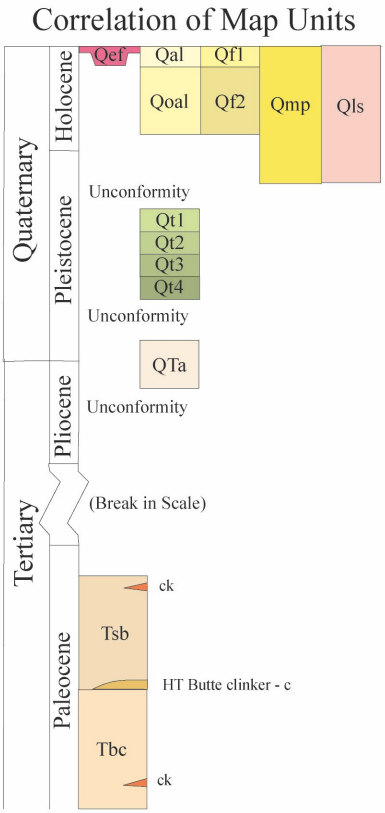
Theodore Roosevelt National Park, South Unit

The formal citation for this source.

Biek, Robert F., and Gonzalez, Mark A., 2001, Geology of the Theodore Roosevelt National Park, South Unit, Billings County: North Dakota Geological Survey, Miscellaneous Series No. 86, Plate 1, scale 1:24,000 (*GRI Source Map ID 2156*).

Prominent graphics and text associated with this source.

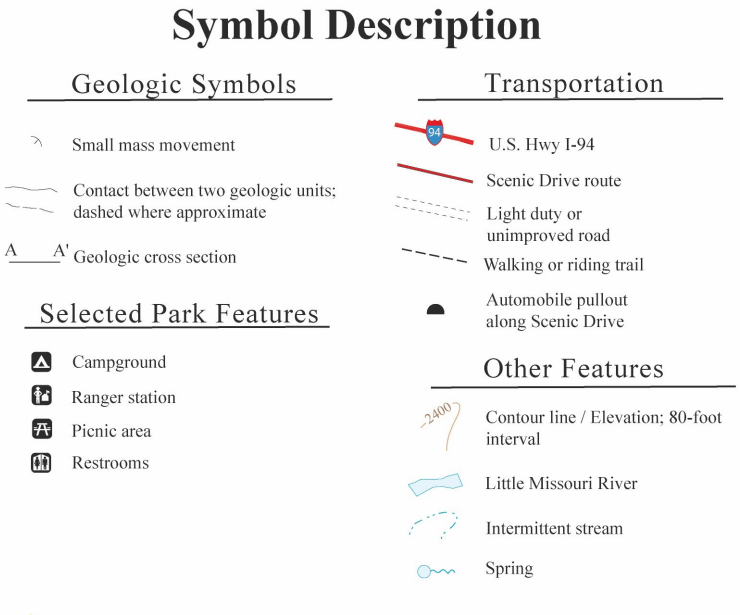
Correlation of Map Units



Graphic from source map: Theodore Roosevelt National Park, South Unit.

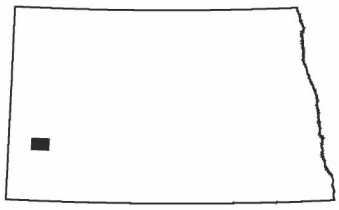
* Unit ck - unnamed clinker beds appears on the correlation but does not appear in the geologic data or on the geologic cross section for this map so the GRI did not include it in the unit listing.

Map Legend



Graphic from source map: Theodore Roosevelt National Park, South Unit. Note that non-geologic features such as Transportation and Selected Park Features were not captured in the GRI digital geologic-GIS data. See the source map publication for this information.

Quadrangle Location



Theodore Roosevelt National Park
South Unit, North Dakota

Graphic from source map: Theodore Roosevelt National Park, South Unit.

Map Notes

The North Dakota Geologic Survey compiled this map according to conventional cartographic standards, using what is thought to be the most reliable information available. The North Dakota Geological Survey does not guarantee freedom from errors or inaccuracies and disclaims any legal responsibility or liability for interpretations made from the map, or decisions based thereon.

This map is Plate I from North Dakota Geological Survey Miscellaneous Serious 86 (MS-86). The field work required to produce this map was conducted by Robert F. Biek and Mark A. Gonzalez, with additional work done by Edward C. Murphy. This project was carried out under Assistance Award

1434-95-A-1374, from the USGS, Department of the Interior.

Text from source map: Theodore Roosevelt National Park, South Unit.

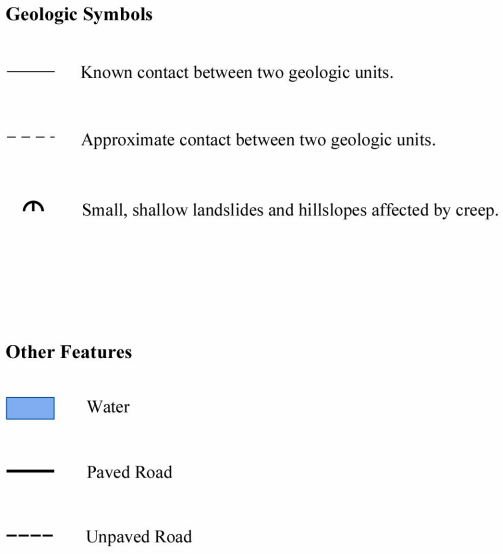
Eagle Draw Quadrangle

The formal citation for this source.

Gonzalez, M.A., 2004, Surface Geology - Eagle Draw Quadrangle, North Dakota: North Dakota Geological Survey, 24K Series, EglD-sg, scale 1:24,000 (*GRI Source Map ID 75953*).

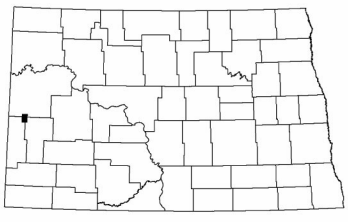
Prominent graphics and text associated with this source.

Map Legend



Graphic from source maps: Eagle Draw Quadrangle. Note that non-geologic features such as roads were not captured in the GRI digital geologic-GIS data. See the source map publication for this information.

Quadrangle Location



Eagle Draw, North Dakota Quadrangle

Graphic from source map: Eagle Draw Quadrangle

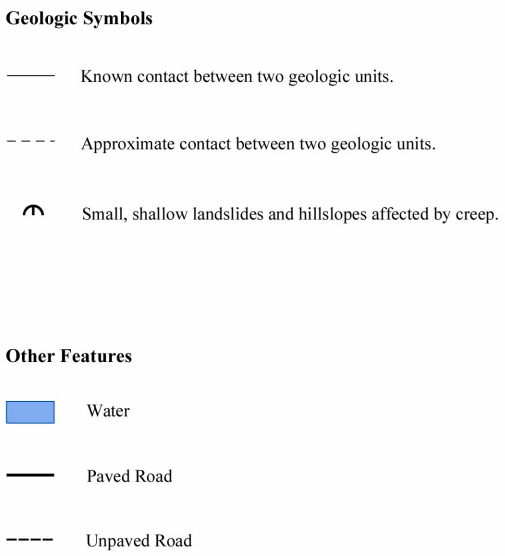
Hanks Gully Quadrangle

The formal citation for this source.

Gonzalez, M.A., 2004, Surface Geology - Hanks Gully Quadrangle, North Dakota: North Dakota Geological Survey, 24K Series, HnkG-sg, scale 1:24,000 (*GRI Source Map ID 75954*).

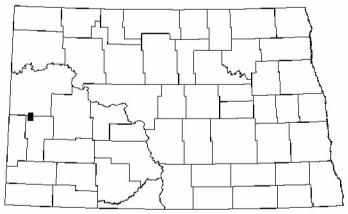
Prominent graphics and text associated with this source.

Map Legend



Graphic from source map: Hanks Gully Quadrangle. Note that non-geologic features such as roads were not captured in the GRI digital geologic-GIS data. See the source map publication for this information.

Quadrangle Location



Hanks Gully, North Dakota Quadrangle

Graphic from source map: Hanks Gully Quadrangle

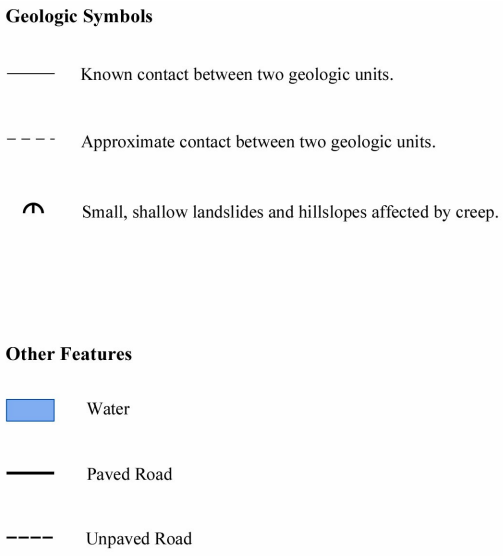
Roosevelt Creek East Quadrangle

The formal citation for this source.

Gonzalez, M.A., 2004, Surface Geology - Roosevelt Creek East Quadrangle, North Dakota: North Dakota Geological Survey, 24K Series, RsvC E-sg, scale 1:24,000 (*GRI Source Map ID 75955*).

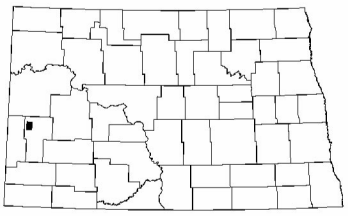
Prominent graphics and text associated with this source.

Map Legend



Graphic from source map: Roosevelt Creek East Quadrangle. Note that non-geologic features such as roads were not captured in the GRI digital geologic-GIS data. See the source map publication for this information.

Quadrangle Location



Roosevelt Creek East Quadrangle, North Dakota

Graphic from source map: Roosevelt Creek East Quadrangle.

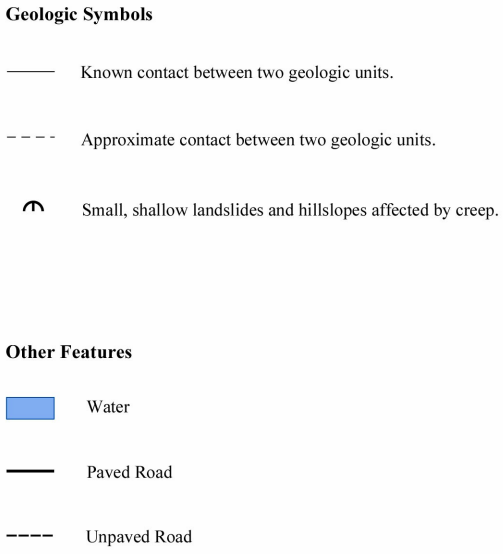
Roosevelt Creek West Quadrangle

The formal citation for this source.

Gonzalez, M.A., 2004, Surface Geology - Roosevelt Creek West Quadrangle, North Dakota: North Dakota Geological Survey, 24K Series, RsvC W-sg, scale 1:24,000 (*GRI Source Map ID 75956*).

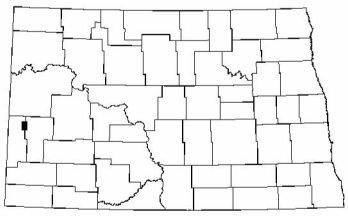
Prominent graphics and text associated with this source.

Map Legend



Graphic from source map: Roosevelt Creek West Quadrangle. Note that non-geologic features such as roads were not captured in the GRI digital geologic-GIS data. See the source map publication for this information.

Quadrangle Location



Roosevelt Creek West, North Dakota Quadrangle

Graphic from source map: Roosevelt Creek West Quadrangle

GRI Digital Data Credits

This document was developed and completed by James Winter (Colorado State University) for the NPS Geologic Resources Division (GRD) Geologic Resources Inventory (GRI) Program. Quality control of this document by Stephanie O'Meara (Colorado State University).

The information in this document was compiled from GRI source maps, and is intended to accompany the digital geologic-GIS map(s) and other digital data for Theodore Roosevelt National Park, North Dakota (THRO) developed by James Winter and Stephanie O'Meara (Colorado State University) (see the GRI Digital Maps and Source Map Citations section of this document for all sources used by the GRI in the completion of this document and related GRI digital geologic-GIS maps).

GRI finalization by Stephanie O'Meara (Colorado State University).

GRI program coordination and scoping provided by Jason Kenworthy and Tim Connors (NPS GRD, Lakewood, Colorado).