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

Pecos National Historical Park

GRI Ancillary Map Information Document

Produced to accompany the Geologic Resources Inventory (GRI) Digital Geologic Data for Pecos National Historical Park

peco_geology.pdf

Version: 3/18/2015

Geologic Resources Inventory Ancillary Map Information Document for Pecos National Historical Park

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Geologic Resources Inventory Map Document

Pecos National Historical Park, New Mexico

Document to Accompany Digital Geologic-GIS Data

peco_geology.pdf

Version: 3/18/2015

This document has been developed to accompany the digital geologic-GIS data developed by the Geologic Resources Inventory (GRI) program for Pecos National Historical Park, New Mexico (PECO).

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 Map and Source Map Citations

The GRI digital geologic-GIS map for Pecos National Historical Park, New Mexico (PECO):

GRI Digital Geologic Map of Pecos National Monument, New Mexico (GRI MapCode PECO)

The GRI digital geologic-GIS map was produced from the following source maps,

Ilg, B.R., Bauer, P.W., Ralser, Steven, Rogers, J.B., and Kelley, Shari, 1997 (Revised: 12/1/97), Preliminary Geologic Map of the Glorieta 7.5-Minute Quadrangle, Santa Fe County, New Mexico: New Mexico Bureau of Geology and Mineral Resources, Open-File Geologic Map OF-GM 11, scale 1:12,000, (CD-ROM on demand and PDF file). (*GRI Source Map ID 72954*). (Glorieta Quadrangle).

Read, A., and Rawling, G., 2002, Preliminary Geologic Map of the Pecos 7.5-minute Quadrangle, San Miguel and Santa Fe Counties, New Mexico: New Mexico Bureau of Geology and Mineral Resources, Open-File Geologic Map OF-GM 52, scale 1:24,000. (CD-ROM on demand and PDF file). (*GRI Source Map ID 6674*). (Pecos Quadrangle).

Geologic features were produced from digital data from each source map. A source map scan was then used to check features and their attribution, as well as capture/digitize map symbology features.

*** It is worth noting that both source maps, open-file geologic maps, have very incomplete and misleading unit listings. Numerous units are present on each map that don't appear in the map's unit listing, and many units are listed (complete with unit descriptions) in the unit listing but are not actually present in the map extent.*

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

Map Unit List

The geologic units present in source maps used for Pecos National Historical Park, New Mexico (PECO) are listed below. Units are listed with their assigned unit symbol then unit name (e.g., Qa then Alluvium). Units are generally listed from youngest to oldest. No description for water is provided. Information about each geologic unit is also presented in the Geologic Unit Information (PECOUNIT) table included with the GRI geology-GIS data.

Cenozoic Era

Quaternary Period

Recent
Qaf - Artificial fill

Quaternary Period
Qa - Alluvium
Qc - Colluvium
Qca - Colluvium and alluvium, undivided
Qvf - Valley fill
Ql - Landslide deposits
Qt - Terrace deposits

Quaternary and Tertiary Periods
QTg - Gravel deposits, older
QTa - Ancha Formation

Tertiary Period
Tg - Galisteo Formation
Tgv - Gravel deposits
Santa Fe Group
    Tt - Tesuque Formation

Mesozoic Era

Triassic Period

TRc - Chinle Group, undivided
    TRs - Santa Rosa Formation
        TRsu - Santa Rosa Formation, upper member
        TRsm - Santa Rosa Formation, middle member
        TRsl - Santa Rosa Formation, lower member
TRm - Moenkopi Formation

Mesozoic Era and Paleozoic Eras

Triassic and Permian Periods

TRm+Pa - Moenkopi Formation and Artesia Formation, undivided**

*** Units TRm and Pa are also mapped together in the GIS data as TRm+Pa.*

Paleozoic Era

Permian Period
Pa - Artesia Formation
Psa - San Andres Formation
Pg - Glorieta Formation
Py - Yeso Formation

Permian and Pennsylvanian Periods
PPNsc - Sangre de Cristo Formation

Pennsylvanian Period
Madera Group
- PNm - Madera Formation
- PNal - Alamitos Formation
- PNlp - La Posada Formation

PNs - Sandia Formation

Mississippian Period
Mt - Tererro Formation
Mes - Espiritu Santo Formation
Map - Arroyo Peñasco Group - only shown in cross section

Precambrian

Early Proterozoic

Xgg	Granite to granitic gneiss
Xg	Biotite granitoid
Xgr	Granodiorite
Xmg	Megacrystic granitoid
Xd	Diorite
Xa+Xd	Amphibolite and diorite**
Xa	Amphibolite
Xqms	Quartz muscovite schist
Xf	Felsic schist and phyllite
Xbp	Biotite and pelitic schist
Xms	Muscovite schist

XYu - Proterozoic basement (only shown in cross section)

** *Units Xa and Xd are also mapped together in the GIS data as Xa+Xd.*

Map Unit Descriptions

Descriptions of all geologic map units, generally listed from youngest to oldest, are presented below. Unit symbol, name and age are only listed with a unit description if the unit has multiple unit descriptions and/or if any these (the unit symbol, name and/or age) were changed on the GRI digital geologic-GIS map.

Qaf - Artificial fill (Recent)

No additional unit description provided on source map. (*GRI Source Map ID 6674*). (Pecos Quadrangle).

***Unit is comprised of areas mapped on the source map as dams and a millsite.*

Qa - Alluvium (Quaternary-Holocene)

Qa - Quaternary alluvium (Quaternary)
Unconsolidated valley fill composed of clay, silt, sand and gravel. Grades into minor colluvial and alluvial fans at valley margins. Includes terrace deposits, whose treads lie within 6 m of grade, and human disturbances, such as dams, roadbeds and raised railroad beds. Predominantly Holocene in age. (*GRI Source Map ID 72954*). (Glorieta Quadrangle).

QHa - Quaternary-Holocene alluvium (Quaternary-Holocene)
Unconsolidated sediments in active perennial and ephemeral stream channels and flood plain deposits composed of clay, silt, sand and gravel. Grades into minor colluvial or alluvial fans and older valley fills (Qvf). May include terrace deposits whose treads lie within 20 feet of grade. Note that much of the mapping this unit was based on photointerpretation. Thickness: 0 to 25(?) feet. (*GRI Source Map ID 6674*). (Pecos Quadrangle).

Qc - Colluvium (Quaternary)

Qc - Quaternary colluvium (Quaternary)
Unconsolidated sand, silt and clay deposits along upper hill slopes or broad, flat hill crests. A few feet in maximum thickness. (*GRI Source Map ID 72954*). (Glorieta Quadrangle).

Qc - Quaternary colluvium (Quaternary)
Primarily talus, locally derived. Commonly occurs as a veneer of variable thickness on slope-forming bedrock. Thickness: 0 to 30 (?) feet. (*GRI Source Map ID 6674*). (Pecos Quadrangle).

Qca - Colluvium and alluvium, undivided (Quaternary)

Qca - Quaternary colluvium/alluvium (Quaternary)
Sand, silt and clay in abandoned stream channels, flood plains, and lower valley slopes. (*GRI Source Map ID 72954*). (Glorieta Quadrangle).

Qvf - Valley Fill (Quaternary)

Qvf - Quaternary valley fill (Quaternary)
Unconsolidated to consolidated fine grained valley fills composed of clay, silt, and sand along the margins of active stream channels and in areas of low relief or where runoff is not channelized. Deposits likely formed by a combination of alluvial, eolian, and hillslope processes. These fills may form terraces

when incised by modern arroyos. Note that much of the mapping this unit was based on photointerpretation. Thickness: 0 to 40(?) feet. (*GRI Source Map ID 6674*). (Pecos Quadrangle).

Ql - Landslide deposits (Quaternary)

Qls - Quaternary landslides (Quaternary)
No additional unit description provided on source map. (*GRI Source Map ID 72954*). (Glorieta Quadrangle).

*** This unit is present on the Glorieta Quadrangle source map as a mapped unit (unit Ql and Qls), however, the unit is not present on the source map's lithologic unit listing. Unit name from the New Mexico Bureau of Geology and Mineral Resources.*

Qt - Terrace deposits (Quaternary)

Qt - Terrace gravel (Quaternary)
Rounded pebbles and cobbles of Precambrian granite, commonly containing abundant epidote, granite pegmatite, muscovite and biotite schist, and Phanerozoic chert and sandstone in a sand or silt matrix. Terraces generally lie 20 to 40 ft above valley floors.. (*GRI Source Map ID 72954*). (Glorieta Quadrangle).

Qt - Quaternary terrace deposits (Quaternary)
Undivided, gravel-capped terrace deposits along the Pecos River and Glorieta Creek. See Karas (1988) for more detail on these deposits. Note that some of the mapping these terraces was based on photointerpretation. Thickness: 0 to 25 (?) feet. (*GRI Source Map ID 6674*). (Pecos Quadrangle).

QTg - Gravel deposits, younger (Quaternary and Tertiary)

Qtg - Quaternary-Tertiary gravel deposits (Quatneary and Tertiary)
Gravel and cobble deposits composed of rounded Proterozoic and Paleozoic clasts. These gravels were deposited prior to the establishment of the incised modern Pecos River and Glorieta Creek. Thickness: 0 to 30 feet. (*GRI Source Map ID 6674*). (Pecos Quadrangle).

QTa - Ancha Formation (Quaternary and Tertiary)

Qta - Ancha Formation (Quaternary-Tertiary?)
Buff to moderate orange pink and grayish pink, generally poorly sorted and poorly consolidated beds of sand, gravel and cobbles. Derived from Precambrian granitic and metamorphic and Paleozoic sedimentary terrains in the Sangre de Cristo Mountains. Strongly cemented by caliche near Lamy. Thickness To 60 ft. (*GRI Source Map ID 72954*). (Glorieta Quadrangle).

Tg - Galisteo Formation (Tertiary)

Note (on Source Map): Two subdivisions of this unit are possible: The traditional one would require a three-fold subdivision of the Galisteo Fm into Upper, Middle and Lower units. The recent separation of the lower portion as the Diamond Tail Formation (Lucas et al., 1997) allows an alternative of Upper and Lower Galisteo and Diamond Tail Formation. What is the preference of the Bureau?

Tgu - Upper unit
Tan to white, massively bedded, friable, well sorted, cross bedded sandstone and interbeds of red, rose, tan, and gray-green mudstone. Contains silicified logs to 4 feet diameter and 30 ft lengths. Thickness 346 ft in uranium drill hole #2-4 and 425 ft in drill hole 1-35.

Tgm- Middle unit (or Tgl - Lower unit)
Alternating pink to red colored beds of arkosic sandstone, siltstone, and mudstone with extensive lenses of conglomerate. The conglomerate beds contain rounded cobbles and pebbles of Precambrian granite and schist and Paleozoic sedimentary rocks in which the relative percentage of Precambrian clasts increases upward through the section. Thickness approximately 3,500 ft.

Tgl - Lower unit (or Tdt - Diamond Tail Formation)
Variegated sandstone, conglomerate, mudstone and local limestone beds. Sandstone beds are massive, friable, usually cross bedded and composed of medium- to coarse-grained, subrounded, poorly sorted quartz and lesser chert. Kaolin, limonite, or calcite commonly constitute the matrix. Colors are tan, brown, orange, pink, red and white. Mudstones are gray to red in color and poorly exposed. A thin, basal conglomeratic zone containing brightly colored chert is commonly present. At Lamy the section in dominantly sandstone: Stone from a quarry on the south side of Cerro Colorado was used to construct St Michels Cathedral in Santa Fe. Maximum thickness approximately 1000 ft.

(*GRI Source Map ID 72954*). (Glorieta Quadrangle).

Tgv - Gravel deposits, older (Tertiary)

Tgv - Tertiary gravel deposits (Tertiary)
Fine- to coarse-grained deposits dominated by boulder and cobble gravel composed of rounded Proterozoic clasts with fewer clasts of Paleozoic age. Proterozoic clasts are heterolithic representing the varied metaigneous and metasedimentary rock types exposed throughout the Pecos Wilderness and the rest of the Santa Fe Range to the north. Deposits contain proportionally less Paleozoic rocks further to the north where exposed along the western edge of the quadrangle. Deposits are typically poorly exposed, but cobbles and boulders form highs in the landscape, up to 1500 feet above the modern Pecos River, and mantle hillsides with their colluvium. These deposits are similar to deposits found downstream in Texas and by inference are late Miocene to early Pliocene and equivalent to the Upper Ogalala (Hawley, 2002 personal communication). Thickness: 0 to 120 feet. (*GRI Source Map ID 6674*). (Pecos Quadrangle).

Tt - Tesuque Formation (Tertiary)

Tt - Santa Fe Group, Tesuque Formation (Tertiary)
Tan, pinkish-tan and orange thick-bedded, coarse-grained, arkosic sandstone and some interbedded siltstone and pebble to boulder conglomerate. Moderately well cemented by calcium carbonate. Clasts of granite, granite gneiss, and amphibolite gneiss, and Madera Formation limestone. (Booth, 1977).

*** This unit is present on the Glorieta Quadrangle source map as a mapped unit (unit Tt), however, the unit is not present on the source map's lithologic unit listing. Unit name from the New Mexico Bureau of Geology and Mineral Resources.*

TRc - Chinle Group, undivided (Triassic)

Mudstone interbedded with lenticular lavender-gray sandstone; mudstones are reddish-brown to orange-tan in upper part, and purple to reddish-brown in lower part; local limestone, pebble conglomerate lenses; light gray to grayish orange or tan, conglomeratic sandstone, and reddish-brown mudstone. Regionally 400-500 m thick. (*GRI Source Map ID 72954*). (Glorieta Quadrangle).

TRs - Santa Rosa Formation (Triassic)

TRs - Santa Rosa Formation (Triassic)
No additional unit description provided on source map. (*GRI Source Map ID 72954*). (Glorieta Quadrangle).

TRs - Santa Rosa Formation (Triassic)
Upper and middle units are not present on this quadrangle. No additional unit description provided on source map. (*GRI Source Map ID 6674*). (Pecos Quadrangle).

TRsu - Santa Rosa Formation, upper member (Triassic)

TRsu - Santa Rosa Formation, upper member (Triassic) - Buff to dark brown, thick bedded, fine-grained sandstone with limestone and chert-pebble conglomerates near base. Crossbedding is uncommon. Thickness 18-25 m. (Booth, 1977).

*** This unit is present on the Glorieta Quadrangle source map as a mapped unit (unit TRsu), however, the unit is not present on the source map's lithologic unit listing. Unit name from the New Mexico Bureau of Geology and Mineral Resources.*

TRsm - Santa Rosa Formation, middle member (Triassic)

TRsm - Santa Rosa Formation, middle member (Triassic) - Purple and green mudstone with nodular limestone, gray to buff thinly laminated siltstone, and brown to buff thick bedded, fine- to medium-grained sandstone. Thickness generally 30-40 m. (Booth, 1977).

*** This unit is present on the Glorieta Quadrangle source map as a mapped unit (unit TRsm), however, the unit is not present on the source map's lithologic unit listing. Unit name from the New Mexico Bureau of Geology and Mineral Resources.*

TRsl - Santa Rosa Formation, lower member (Triassic)

TRsl - Santa Rosa Formation, lower member (Triassic)
Light gray to buff, thick bedded, fine- to coarse-grained crossbedded sandstone with conspicuous iron oxide staining. Limestone- and chert-pebble conglomerates present in most places. Thickness 30-40 m. (Booth, 1977).

*** This unit is present on the Glorieta Quadrangle source map as a mapped unit (unit TRsl), however, the unit is not present on the source map's lithologic unit listing. Unit name from the New Mexico Bureau of Geology and Mineral Resources.*

TRsl - Santa Rosa Formation, lower member (Triassic)
Light gray to buff, thick bedded, fine- to coarse-grained crossbedded sandstone with conspicuous iron oxide staining. Limestone- and chert-pebble conglomerates present in most places, particularly along the southwest edge of the quadrangle. Fossil wood is common. Thickness: 90-120 feet. (*GRI Source Map ID 6674*). (Pecos Quadrangle).

TRm - Moenkopi Formation (Triassic)

TRm - Moenkopi Formation (Triassic)
No additional unit description provided on source map.

*** This unit is present on the Glorieta Quadrangle source map as a mapped unit (unit TRm), however, the unit is not present on the source map's lithologic unit listing. Unit name from the New Mexico Bureau of Geology and Mineral Resources.*

TRm - Moenkopi Formation (Triassic)
Grayish red to purplish-red sandstones, conglomerates, mudstones, and siltstones. Lacks gypsum. Sandstones are micaceous litharenites or lithic graywackes. Sandstones are moderately to poorly sorted, subangular to angular, and fine to coarse grained. Sandstones and conglomerates are generally trough crossbedded and lenticular. Fossils include vertebrate bones and coprolites, footprints, charophytes, and ostracods. Dark brown carbonate concretions that are up to 70 cm-diameter were found on the hill to the north of Rowe Peak. The contact with underlying Artesia Formation is disconformable. Thickness: is 75-120 feet. (about 120 feet near Rowe Peak). (*GRI Source Map ID 6674*). (Pecos Quadrangle).

Pa - Artesia Formation (Permian)

Pb - Bernal Formation (Permian)
Moderate reddish brown (orange to brick-red), sandstones, siltstones and gypsum. Sandstones and siltstones are quartzarenites and usually gypsiferous. Sandstones are well sorted, subrounded to subangular, and very fine to fine grained. Sandstones are laminated, ripple laminated, and massive (bioturbated), crossbedding is rare, and beds are laterally persistent. Unfossiliferous except for bioturbation. Thickness 10-20 m. (*GRI Source Map ID 72954*). (Glorieta Quadrangle).

***Unit is now recognized as the Artesia Formation*.

Pa - Artesia Formation (Permian)
Moderate reddish brown (orange to brick-red), sandstones, siltstones and gypsum. Sandstones and siltstones are quartzarenites and usually gypsiferous. Sandstones are well sorted, subrounded to subangular, and very fine to fine grained. Sandstones are laminated, ripple laminated, and massive (bioturbated), crossbedding is rare, and beds are laterally persistent. Unfossiliferous except for bioturbation. Mottled greenish-white reduction spots are common. Thickness: 30-60 feet. (*GRI Source Map ID 6674*). (Pecos Quadrangle).

Psa - San Andres Formation (Permian)

Psa- San Andres Limestone (Permian)
Medium to light gray, fine grained, fetid limestone and interbedded calcareous sandstone. 16 to 40 ft. (*GRI Source Map ID 72954*). (Glorieta Quadrangle).

Psa - San Andres Formation (Permian)
Buff to light gray thin-bedded dense silty limestone and interbedded calcareous sandstone. Reddish-orange chert or white aragonite satin spar (after gypsum?) is often present near the contact with the underlying Glorieta Sandstone. Thickness: 15-45 feet. (*GRI Source Map ID 6674*). (Pecos Quadrangle).

Pg - Glorieta Sandstone (Permian)

Pg - Glorieta Sandstone (Permian)
Medium to light gray, medium to fine grained, well-sorted sandstone. 65 to 110 ft. (*GRI Source Map ID 72954*). (Glorieta Quadrangle).

Pg - Glorieta Sandstone (Permian)

Yellow to buff, thick-bedded, fine- to medium-grained quartz sandstone. Grains are well rounded, well sorted, and conspicuously frosted. Thickness: 80-120 feet. (*GRI Source Map ID 6674*). (Pecos Quadrangle).

Py - Yeso Formation (Permian)

Py - Yeso Formation (Permian)
Reddish-orange to red thick-bedded mudstone and interbedded buff to reddish-orange and yellow (locally purple near Apache Canyon), fine-grained sandstone and some buff, coarse-grained, arkosic sandstone. Buff to yellow, dense, nonfossiliferous, crystalline limestone 2-3 m thick in the upper part. Thickness 22-42 m. (*GRI Source Map ID 72954*). (Glorieta Quadrangle).

Py - Yeso Formation (Permian)
Reddish-orange to red thick-bedded mudstone and interbedded buff to reddish-orange and yellow, fine-grained sandstone and some buff, coarse-grained, arkosic sandstone. Buff to yellow, dense, nonfossiliferous, crystalline limestone 2-3 m thick in the upper part. Thickness: 160-200 feet. (*GRI Source Map ID 6674*). (Pecos Quadrangle).

PPNsc - Sangre de Cristo Formation (Permian and Pennsylvanian)

Psc - Sangre de Cristo Formation (Permian)
Medium brown to dark reddish brown mudstone and buff to dark brown, conglomeratic arkose. 300 to 3,000 ft thick in the Canoncito area north of Lamy along Tijeras-Canoncito accommodation zone. (*GRI Source Map ID 72954*). (Glorieta Quadrangle).

IPPsc - Sangre de Cristo Formation (Permian and Pennsylvanian)
Brownish red to purple, thick-bedded mudstone and interbedded buff to dark brown arkosic sandstone. Sandstone beds are typically lensoidal. Also contains some gray to purple, thinbedded, dense, microcrystalline limestone and buff, thin-bedded, medium-grained quartz sandstone. Along the NW side of the quadrangle, thick arkosic conglomerates are well indurated and laterally extensive. Minimum thickness of 2600 feet. (*GRI Source Map ID 6674*). (Pecos Quadrangle).

*** Unit recognized to be Permian and Pennsylvanian in age.*

Madera Group

These units retain local formation names rather than those applied in the Sandia and Manzano Mountains (see Keyes, 2001) to reflect the unique tectonic history of these basins and their very thick deposits. (*GRI Source Map ID 6674*). (Pecos Quadrangle).

PNm - Madera Formation (Pennsylvanian)

Gray to light brown, thick bedded limestone, gray to brown calcareous sandstone and buff and dark brown fossiliferous arkose. 820 ft. (*GRI Source Map ID 72954*). (Glorieta Quadrangle).

PNal - Alamitos Formation (Pennsylvanian)

Gray medium to thin-bedded, fossiliferous marine limestone, interbedded buff to brown coarse-grained arkosic sandstone, and dark-grey to reddish shales. Many limestone and sandstone beds in the Northeast part of the quadrangle are dominantly composed of very coarse and angular K-spar fragments

but nonetheless can often remain quite fossiliferous. Contact with overlying Sangre de Cristo Formation is locally sharp just east of Pecos but is gradational or poorly exposed in most places. Basal feldspathic unit is cemented by silica or clay. Approximate thickness of 1500 feet. (*GRI Source Map ID 6674*). (Pecos Quadrangle).

PNlp - La Posada Formation (Pennsylvanian)

Gray medium to thick-bedded, fossiliferous marine limestone with banded chert layers, Thick limestone beds form cliffs where exposed near the State Fish Hatchery. Limestone is interbedded with thin shales and sandstones. Uppermost unit is quartz sandstone with calcite cement (whereas the basal Alamitos sandstone is silica cemented). Measured thickness at Dalton Bluff 973 feet (Sutherland, 1963). (*GRI Source Map ID 6674*). (Pecos Quadrangle).

PNs - Sandia Formation (Pennsylvanian)

Buff to brown sandstone, interbedded gray shale and argillaceous limestone. 160 ft. (*GRI Source Map ID 72954*). (Glorieta Quadrangle).

Mt - Tererro Formation (Mississippian)

Buff to dark brown, thick bedded, coarse grained limestone breccia in calcareous arkose matrix. 30 ft. (*GRI Source Map ID 72954*). (Glorieta Quadrangle).

Mes - Espiritu Santo Formation (Mississippian)

Gray to brown microcrystalline limestone. Restricted to local outcrops near railroad tracks between Lamy and Cañoncito in the Glorieta Quadrangle. Thickness approximately 10 m (see Miller et al., 1963). (Booth, 1977).

** *This unit is present on the* Glorieta Quadrangle *source map as a mapped unit (unit Mes), however, the unit is not present on the source map's lithologic unit listing. Unit name from the New Mexico Bureau of Geology and Mineral Resources.*

Map - Arroyo Penasco Group (Mississippian)

Undifferentiated Mississippian rocks (cross section only). Thickness is 106 feet at Dalton Bluff (Sutherland, 1963). (*GRI Source Map ID 6674*). (Pecos Quadrangle).

** *Unit shown only in cross section.*

Xgg - Granite to granitic gneiss (Early Proterozoic)

Orange colored, medium- to coarse–grained granite to gneissic granite consisting predominantly of plagioclase, K-feldspar, quartz, biotite and iron oxides. The gneiss is strongly deformed and varies from an S-tectonite to an L-tectonite. Locally, feldspar augen texture is well developed. Contains small lenses and layers of amphibolite and is intruded by numerous pegmatites. Probably consists of numerous plutons of similar compositions and textures.

** *This unit is present on the* Glorieta Quadrangle *source map as a mapped unit (unit Xgg), however, the unit is not present on the source map's lithologic unit listing. Unit name and description from the New*

Mexico Bureau of Geology and Mineral Resources.

Xg - Biotite granitoid (Early Proterozoic)

Fine- to medium-grained, orange to pink to red, fairly equigranular granitoid. Commonly contains layers and lenses of layered supracrustal rocks, aplites, and pegmatites. Ranges from strongly to weakly foliated. Exposed in the northwest corner of the quadrangle, just east of the Borrego fault zone, where it bounds the southern margin of the Thompson Peak metamorphic suite in the McClure Reservoir quadrangle. There are no inclusions of supracrustal rock in the granitoid, and no dikes intrude from the granitoid into the supracrustal rocks. The contact may represent a sheared intrusive contact or a sheared unconformable contact. This unit was mapped as Xgb, biotite granite, by Moench and others (1988); they also referred to this granitic body as the Shaggy Peak batholith. The age of the granitoid is unknown.

*** This unit is present on the Glorieta Quadrangle source map as a mapped unit (unit Xg), however, the unit is not present on the source map's lithologic unit listing. Unit name and description from the New Mexico Bureau of Geology and Mineral Resources.*

Xgr - Granodiorite (Early Proterozoic)

Pink, unfoliated, medium–grained, k-feldspar, plagioclase, quartz and lesser amounts of biotite, chlorite, muscovite, epidote, and iron oxides (Renshaw, 1988). This unit is found within, and east of, the Picuris–Pecos fault zone. Granodiorite crosscuts both diorite (Xd) and leucogranite (Xl), and inclusions of both rock types exist within the granodiorite. Within the fault zone, the rock is highly fractured and brecciated. Moench and others (1988) mapped these rocks as Xgb, biotite granite.

*** This unit is present on the Glorieta Quadrangle source map as a mapped unit (unit Xgr), however, the unit is not present on the source map's lithologic unit listing. Unit name and description from the New Mexico Bureau of Geology and Mineral Resources.*

Xmg - Megacrystic granitoid (Early Proterozoic)

Megacrystic quartz, plagioclase, K-feldspar, biotite granitoid. Megacrysts of K-feldspar are up to 5 cm long. The granitoid crops out in the SW corner of the quadrangle.

*** This unit is present on the Glorieta Quadrangle source map as a mapped unit (unit Xmg), however, the unit is not present on the source map's lithologic unit listing. Unit name and description from the New Mexico Bureau of Geology and Mineral Resources.*

Xd - Diorite (Early Proterozoic)

Medium- to fine-grained, dark greenish, hornblende, plagioclase, quartz, biotite, epidote, and iron oxides.

*** This unit is present on the Glorieta Quadrangle source map as a mapped unit (unit Xd), however, the unit is not present on the source map's lithologic unit listing. Unit name and description from the New Mexico Bureau of Geology and Mineral Resources.*

Xa - Amphibolite (Early Proterozoic)

Black to green, coarse- to fine–grained, with blue-green hornblende, plagioclase, quartz, and minor sphene, ± epidote, ± garnet, ± biotite. Includes amygdaloidal amphibolite and metavolcanic breccia.

Continuous layers and discontinuous lenses occur within the gneissic granitoid (Xgg).

*** This unit is present on the Glorieta Quadrangle source map as a mapped unit (unit Xa), however, the unit is not present on the source map's lithologic unit listing. Unit name and description from the New Mexico Bureau of Geology and Mineral Resources.*

Xqms - Quartz muscovite schist (Early Proterozoic)

Gray, fine- to medium-grained, well foliated muscovite-rich schist with variable amounts of plagioclase, biotite, quartz, and minor amounts of iron oxide and chlorite.

*** This unit is present on the Glorieta Quadrangle source map as a mapped unit (unit Xqms), however, the unit is not present on the source map's lithologic unit listing. Unit name and description from the New Mexico Bureau of Geology and Mineral Resources.*

Xf - Felsic schist and phyllite (Early Proterozoic)

Generally fine–grained, orange, brown, or light–gray in color, composed primarily of quartz, muscovite, microcline and plagioclase, with minor biotite and rare garnet. Quartz eye-bearing horizons exist locally. Amphibolite and quartzite layers are interlayered with felsic schists. This unit is interpreted as metamorphosed felsic volcanic and volcaniclastic rocks. Renshaw (1984) mapped these rocks as felsic phyllite.

*** This unit is present on the Glorieta Quadrangle source map as a mapped unit (unit Xf), however, the unit is not present on the source map's lithologic unit listing. Unit name and description from the New Mexico Bureau of Geology and Mineral Resources.*

Xbp - Biotite and pelitic schist (Early Proterozoic)

A heterogeneous unit of biotite–rich schist, pelitic schist, mafic phyllite, and feldspar–quartz–magnetite phyllite. Green–gray pelitic schist is composed of quartz, muscovite and plagioclase with lesser biotite and chlorite. Co-existing sillimanite (fibrolite), garnet and staurolite have been reported (Renshaw, 1984). A minor component of mafic schist contains hornblende, plagioclase, quartz, oxides, plus minor epidote and biotite. Contacts with muscovite schist (Xms) and quartz–feldspar schist (Xqfs) are gradational and poorly exposed. Possible protolith is aluminous shale.

*** This unit is present on the Glorieta Quadrangle source map as a mapped unit (unit Xbp), however, the unit is not present on the source map's lithologic unit listing. Unit name and description from the New Mexico Bureau of Geology and Mineral Resources.*

Xms - Muscovite schist (Early Proterozoic)

Strongly foliated and crenulated gray to brown muscovite schist composed of muscovite and quartz with lesser amounts of biotite, plagioclase, chlorite, iron oxides and ± garnet, ± staurolite, ± fibrolite. Exposed in the southern half of the Thompson Peak Metamorphic suite. Contacts with biotite and pelitic schists (Xbp) and quartz–feldspar schist (Xqfs) are gradational and generally poorly defined.

*** This unit is present on the Glorieta Quadrangle source map as a mapped unit (unit Xms), however, the unit is not present on the source map's lithologic unit listing. Unit name and description from the New Mexico Bureau of Geology and Mineral Resources.*

XYu - Proterozoic basement

Undifferentiated metaigneous and metasedimentary rocks. ** *Description provided by the New Mexico Bureau of Geology and Mineral Resources.*

** *Unit shown only in cross section.*

Geologic Cross Sections

The geologic cross sections present in the GRI digital geologic-GIS data produced for Pecos National Historical Park, New Mexico (PECO) are presented below. Note that some cross section abbreviations (e.g., A - A') have been changed from their source map abbreviation in the GRI digital geologic-GIS data so that each cross section abbreviation in the data is unique. 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'

Glorieta Cross Section A-A' *(double-click link)*

Extracted from: (Glorieta Quadrangle).

***Cross Section updated by Rebecca Taylor, April 2009.*

Cross Section B-B'

Glorieta Cross Section B-B' *(double-click link)*

Extracted from: (Glorieta Quadrangle).

***Cross Section updated by Rebecca Taylor, April 2009*

Cross Section C-C'

Glorieta Cross Section C-C' *(double-click link)*

Extracted from: (Glorieta Quadrangle).

***Cross Section updated by Rebecca Taylor, April 2009*

Cross Section D-D'

Pecos Cross Section D-D' *(double-click link)*

Extracted from: (Pecos Quadrangle).

***Cross Section updated by Rebecca Taylor, April 2009.*

Ancillary Source Map Information

The digital geologic-GIS data for Pecos National Historical Park, New Mexico (PECO) was compiled from the following sources:

Ilg, B.R., Bauer, P.W., Ralser, Steven, Rogers, J.B., and Kelley, Shari, 1997 (Revised: 12/1/97), Preliminary Geologic Map of the Glorieta 7.5-Minute Quadrangle, Santa Fe County, New Mexico: New Mexico Bureau of Geology and Mineral Resources, Open-File Geologic Map OF-GM 11, scale 1:12,000, (CD-ROM on demand and PDF file). (*GRI Source Map ID 72954*). (Glorieta Quadrangle).

Read, A., and Rawling, G., 2002, Preliminary Geologic Map of the Pecos 7.5-minute Quadrangle, San Miguel and Santa Fe Counties, New Mexico: New Mexico Bureau of Geology and Mineral Resources, Open-File Geologic Map OF-GM 52, scale 1:24,000. (CD-ROM on demand and PDF file). (*GRI Source Map ID 6674*). (Pecos Quadrangle).

*** It is worth noting that both source maps, open-file geologic maps, have very incomplete and misleading unit listings. Numerous units are present in each map extent that don't appear in the unit listing, and many units are listed (complete with unit descriptions) in the unit listing but are not actually present in the map extent.*

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

Glorieta Quadrangle (OF-GM-11)

Ilg, B.R., Bauer, P.W., Ralser, Steven, Rogers, J.B., and Kelley, Shari, 1997 (Revised: 12/1/97), Preliminary Geologic Map of the Glorieta 7.5-Minute Quadrangle, Santa Fe County, New Mexico: New Mexico Bureau of Geology and Mineral Resources, Open-File Geologic Map OF-GM 11, scale 1:12,000, (CD-ROM on demand and PDF file). (*GRI Source Map ID 72954*).

Map Comments

COMMENTS TO MAP USERS

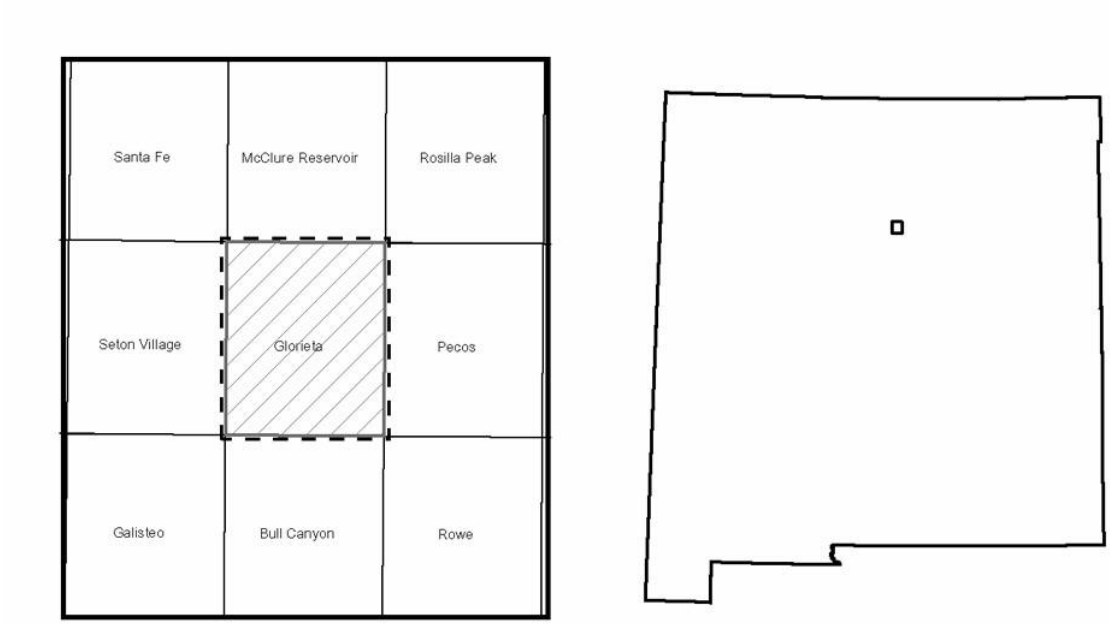
A geologic map displays information on the distribution, nature, orientation, and age relationships of rock and deposits and the occurrence of structural features. Geologic and fault contacts are irregular surfaces that form boundaries between different types or ages of units. Data depicted on this geologic quadrangle map may be based on any of the following: reconnaissance field geologic mapping, compilation of published and unpublished work, and photogeologic interpretation. Locations of contacts are not surveyed, but are plotted by interpretation of the position of a given contact onto a topographic base map; therefore, the accuracy of contact locations depends on the scale of mapping and the interpretation of the geologist(s). Any enlargement of this map could cause misunderstanding in the detail of mapping and may result in erroneous interpretations. Site-specific conditions should be verified by detailed surface mapping or subsurface exploration. Topographic and cultural changes associated with recent development may not be shown.

Cross sections are constructed based upon the interpretations of the author made from geologic mapping, and available geophysical, and subsurface (drillhole) data. Cross-sections should be used as an aid to understanding the general geologic framework of the map area, and not be the sole source of information for use in locating or designing wells, buildings, roads, or other man-made structures.

The map has not been reviewed according to New Mexico Bureau of Geology and Mineral Resources standards. The contents of the report and map should not be considered final and complete until reviewed and published by the New Mexico Bureau of Geology and Mineral Resources. The views and conclusions contained in this document are those of the authors and should not be interpreted as necessarily representing the official policies, either expressed or implied, of the State of New Mexico, or the U.S. Government.

Extracted from: (Glorieta Quadrangle).

Index Map



Extracted from: (Glorieta Quadrangle).

References

Booth, F.O., III, 1976, Geology of the Galisteo Creek area, Lamy to Cañoncito, Santa Fe County, New Mexico (M.S. thesis): Colorado School of Mines, Golden,122 p.

Booth, F.O., III, 1977, Geologic map of the Galisteo Creek area, Lamy to Cañoncito, Santa Fe County, New Mexico: U.S. Geological Survey, Miscellaneous Field Studies Map MF-823, scale 1:12,000.

Budding, A.J., 1972, Geologic map of the Glorieta Quadrangle, New Mexico: New Mexico Bureau of Mines and Mineral Resources, Geologic Map GM-24, scale 1:24,000.

Daniel, C. G., 1995, An overview of the Proterozoic geology in the Thompson Peak–Glorieta Baldy area, Santa Fe County, New Mexico: New Mexico Geological Society Guidebook 46, p. 209–218.

Fulp, M. S., 1982, Precambrian geology and mineralization of the Dalton Canyon volcanic center, Santa Fe County, New Mexico [M.S. thesis]: Albuquerque, University of New Mexico, 199 p.

Miller, J. P., Montgomery, A. and Sutherland, P. K., 1963, Geology of part of the southern Sangre de Cristo Mountains, New Mexico: New Mexico Bureau of Mines and Mineral Resources, Memoir 11, 106 pp.

Moench, R. H., Grambling, J. A., and Robertson, J. M., 1988, Geologic map of the Pecos Wilderness,

Santa Fe, San Miguel, Mora, Rio Arriba, and Taos Counties, New Mexico: U.S. Geological Survey Miscellaneous Field Investigations Map MF–1921B, scale 1:48,000.

Renshaw, J. L., 1984, Precambrian geology of the Thompson Peak area, Santa Fe County, New Mexico [M.S. thesis]: Albuquerque, University of New Mexico, 197 p.

Extracted from: (Glorieta Quadrangle).

Pecos Quadrangle (OF-GM-52)

Read, A., and Rawling, G., 2002, Preliminary Geologic Map of the Pecos 7.5-minute Quadrangle, San Miguel and Santa Fe Counties, New Mexico: New Mexico Bureau of Geology and Mineral Resources, Open-File Geologic Map OF-GM 52, scale 1:24,000. (CD-ROM on demand and PDF file). (*GRI Source Map ID 6674*). (Pecos Quadrangle).

References

Bauer, P.W., Ralser, S., Daniel, C., Ilg, B., 1996, Geology of the McClure Reservoir 7.5-min quadrangle, Santa Fe County, New Mexico: New Mexico Bureau of Mines and Mineral Resources, Open-file Geologic Map OFGM 7, scale 1:12,000. With mineral resource evaluation by M. Fulp

Ilg, B., Bauer, P.W., Ralser, S., Rogers, J., and Kelley, S., 1997, Geology of the Glorieta 7.5' quadrangle, Santa Fe County, New Mexico: New Mexico Bureau of Mines and Mineral Resources, Open-file Geologic Map OGDM11, scale 1:12,000.

Johnson, R.B., 1973, Geologic Map of the Pecos Quadrangle, San Miguel and Santa Fe Counties, New Mexico, United States Geological Survey, Map GQ-1110, scale 1:24,000.

Karas, P.A., 1988, Quaternary alluvial sequence of the upper Pecos River and a tributary, Glorieta Creek, north-central New Mexico, unpublished M.S. Thesis, University of New Mexico, 112 p. (includes 1:24,000 scale map).

Keyes, B.S., 2001, The Pennsylvanian System in New Mexico – overview with suggestions for revision of stratigraphic nomenclature, New Mexico Geology, v. 23, n. 4, p. 103-122.

Melis, E., Bauer, P.W., and Goodwin, L.B., 2000 (unfinished), Geology of the Rosilla Peak 7.5-min. quadrangle, Santa Fe and San Miguel Counties, New Mexico, New Mexico Bureau of Mines and Mineral Resources, Open-file Geologic Map OF-GM 31, scale 1:12,000.

Miller, J.P., Montgomery, A., and Sutherland, P.K., 1963, Geology of Part of the Southern Sangre de Cristo Mountains, New Mexico, New Mexico Bureau of Mines and Mineral Resources, Memoir 11, 106 p.

Sutherland, P.K, 1963, Paleozoic Rocks, in: Miller, J.P., Montgomery, A., and Sutherland, P.K., 1963, Geology of Part of the Southern Sangre de Cristo Mountains, New Mexico, New Mexico Bureau of Mines and Mineral Resources, Memoir 11, 106 p., p.22-44.

Extracted from: (Pecos Quadrangle).

GRI Digital Data Credits

This document was developed and completed by Georgia Hybels (NPS GRD, Lakewood, Colorado) for the NPS Geologic Resources Division (GRD) Geologic Resources Inventory(GRI) Program. Revisions and corrections to this document by Stephanie O'Meara (Colorado State University).

The information contained here was compiled to accompany the digital geologic-GIS map(s) and other digital data for Pecos National Historical Park, New Mexico (PECO) developed by Andrea Croskrey and Georgia Hybels (NPS GRD, Lakewood, Colorado). Revisions and corrections to the GRI digital geologic-GIS data by Stephanie O'Meara.

Additional features were captured by David Green and Aaron Rice (Colorado State University)

GRI finalization and quality control performed by Heather Stanton (Colorado State University). GRI re-finalization by Stephanie O'Meara.

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