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

Gila Cliff Dwellings National Monument

GRI Ancillary Map Information Document

Produced to accompany the Geologic Resources Inventory (GRI) Digital Geologic Data for Gila Cliff Dwellings National Monument

gicl_geology.pdf

Version: 2/2/2026

Geologic Resources Inventory Map Document for Gila Cliff Dwellings National Monument

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Geologic Resources Inventory Map Document

Gila Cliff Dwellings National Monument, New Mexico

Document to Accompany Digital Geologic-GIS Data

gicl_geology.pdf

Version: 2/2/2026

This document has been developed to accompany the digital geologic-GIS data developed by the Geologic Resources Inventory (GRI) program for Gila Cliff Dwellings National Monument, New Mexico (GICL).

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) **Digital Geologic-GIS Map of Gila Cliff Dwellings National Monument and Vicinity, New Mexico (*GRI MapCode GICL*)**

   A) Map Unit List – A listing of all geologic map units present on the Digital Geologic-GIS Map of Gila Cliff Dwellings National Monument, generally listed from youngest to oldest.

   B) Map Unit Descriptions – Descriptions for all geologic map units present on the Digital Geologic-GIS Map of Gila Cliff Dwellings National Monument.

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

   D) Ancillary Source Map Information – Additional source map information including a

correlation of units, map legend, figures, a table, photographs, and references.

4) **Digital Reconnaissance Geologic-GIS Map of the Gila Wilderness Study Area, New Mexico (*GRI MapCode GICL*)**

A) Map Unit List – A listing of all geologic map units present on the Digital Reconnaissance Geologic-GIS Map of the Gila Wilderness Study Area, generally listed from youngest to oldest.

B) Map Unit Descriptions – Descriptions for all geologic map units present on the Digital Reconnaissance Geologic-GIS Map of the Gila Wilderness Study Area.

C) Geologic Cross Sections – A cross section schematic of the map area.

D) Ancillary Source Map Information – Additional source map information including a correlation of units, map legend, index map, and references.

5) **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:

Rebecca Port
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About the NPS Geologic Resources Inventory Program

Background

The Geologic Resources Inventory (GRI) provides geologic map data and pertinent geologic information to support resource management and science-informed decision making in more than 270 natural resource parks throughout the National Park System. 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 GRI is one of 12 inventories funded by the National Park Service (NPS) Inventory and Monitoring Program. The Geologic Resources Division of the NPS Natural Resource Stewardship and Science Directorate administers the GRI. The NPS Geologic Resources Division partners with the Colorado State University Department of Geosciences to produce GRI products. Many additional partners participate in the GRI process by contributing source maps or reviewing products.

The GRI team undertakes three tasks for each park in the Inventory and Monitoring program: (1) conduct a scoping meeting and provide a summary document, (2) provide digital geologic map data in a geographic information system (GIS) format, and (3) provide a GRI report. These products are designed and written for nongeoscientists.

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: https://www.nps.gov/articles/gri-geodatabase-model.htm

Geologic Reports: GRI reports synthesize discussions from the original scoping meeting, follow up conference call(s), and subsequent research. Chapters of each report discuss the geologic setting of the park, distinctive geologic features and processes within the park, highlight geologic issues facing resource managers, and describe the geologic history leading to the present-day landscape. Each report also includes a poster illustrating these GRI digital geologic-GIS data.

For a complete listing of GRI products visit the GRI publications webpage: https://go.nps.gov/gripubs. GRI digital geologic-GIS data is also available online at the NPS Data Store: https://irma.nps.gov/DataStore/Search/Quick. 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 visit the GRI webpage: https:// www.nps.gov/subjects/geology/gri.htm. At the bottom of that webpage is a “Contact Us” link if you need additional information. You may also directly contact the inventory coordinator:

Rebecca Port
Inventory Coordinator
National Park Service Geologic Resources Division
email: rebecca_port@nps.gov

The Geologic Resources Inventory (GRI) is funded by the National Park Service (NPS) Inventory and Monitoring (I&M) Division. Learn more about I&M and the 12 baseline inventories at the I&M webpage: https://www.nps.gov/im/inventories.htm.

GRI Digital Maps and Source Map Citations

The GRI digital geologic-GIS maps for Gila Cliff Dwellings National Monument, New Mexico (GICL):

Digital Geologic-GIS Map of Gila Cliff Dwellings National Monument and Vicinity, New Mexico (*GRI MapCode GICL*)

> Ratté, J.C., Gaskill, D.L., and Chappell, J.R., 2014, Geologic Map of the Gila Hot Springs 7.5' Quadrangle and the Gila Cliff Dwellings National Monument, Catron and Grant Counties, New Mexico: U.S. Geological Survey, OF 1024-1036, scale 1:24,000 (Gila Hot Springs 7.5' Quadrangle). (*GRI Source Map ID 75624*).

The full extent of this source map was used, and all geologic features within this extent were captured

Digital Reconnaissance Geologic-GIS Map of the Gila Wilderness Study Area, New Mexico (*GRI MapCode GWSA*)

Note: The GRI recommends using this map for work outside the Gila Hot Springs 7.5' Quadrangle or when a broader mapping scope is needed. While this map contains relevant geologic data, it does not contain the detail presented in the other map produced for this park (Digital Geologic-GIS Map of Gila Cliff Dwellings National Monument and Vicinity, New Mexico).

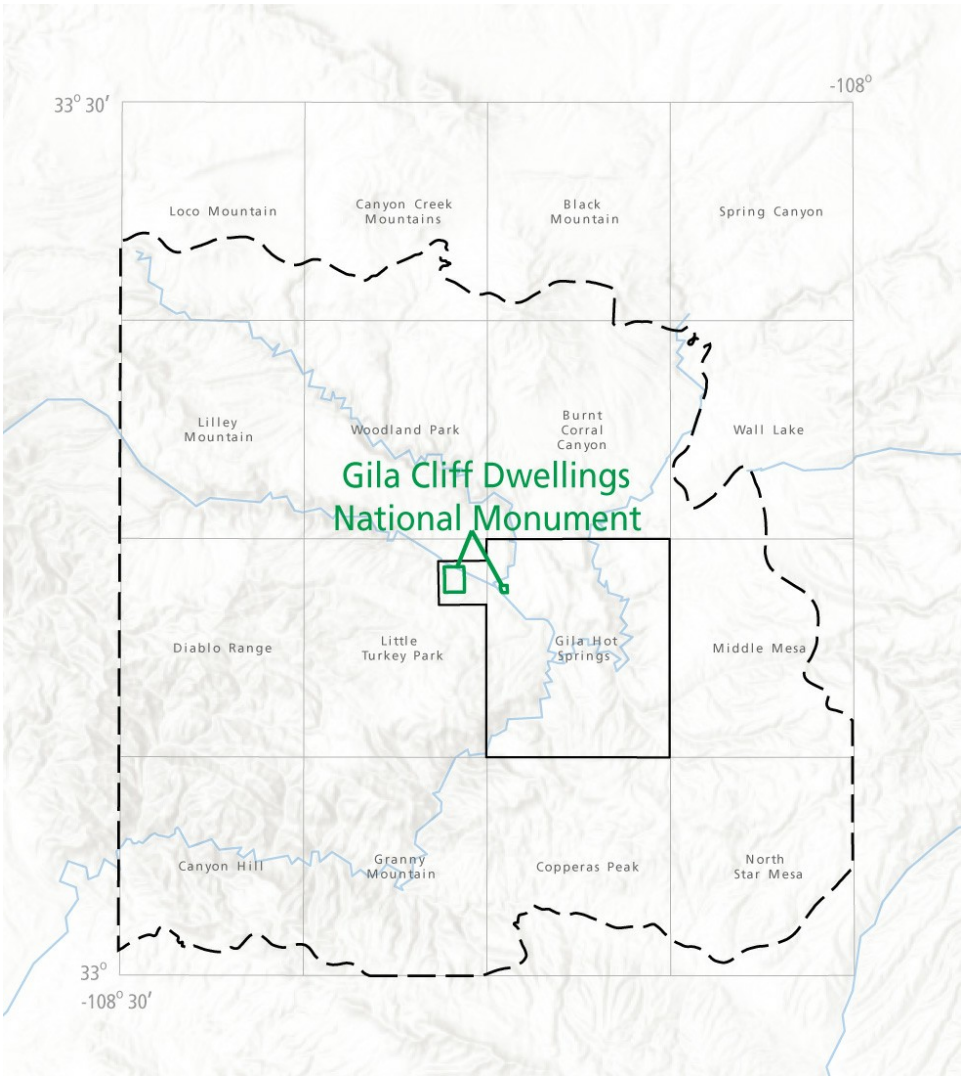
> Ratté, J.C., and Gaskill, D.L., 1975, Reconnaissance Geologic Map of the Gila Wilderness Study Area, Southwestern New Mexico: U.S. Geological Survey, Miscellaneous Investigations Series Map I-886, scale 1:62,500 (Gila Wilderness Study Area (Reconnaissance Geologic Map)). (*GRI Source Map ID 3077*).

A partial extent of this source map was used, but all geologic features within this extent were captured. Only the eastern sheet was digitized for the GRI digital geologic-GIS map.

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

Index Map

The following index map displays the extents of the GRI digital geologic-GIS maps produced for Gila Cliff Dwellings National Monument (GICL). The boundaries for Gila Cliff Dwellings National Monument (as of July 2025) are labeled and outlined in solid green. The 7.5' quadrangles overlapping with GRI GIS data for Gila Cliff Dwellings National Monument are labeled. The Digital Geologic-GIS Map of Gila Cliff Dwellings National Monument and Vicinity is outlined in a solid black line. The Digital Reconnaissance Geologic-GIS of the Gila Wilderness Study Area is outlined in a dashed black line. Base map credits: NASA, NGA, USGS, TomTom, Garmin, FAO, NOAA, and OpenStreetMap.



Index map by Jim Chappell (Colorado State University)

Digital Geologic-GIS Map of Gila Cliff Dwellings National Monument and Vicinity

Map Unit List

The geologic units present in the digital geologic-GIS data produced for Gila Cliff Dwellings National Monument, New Mexico (GICL) are listed below. Units are listed with their assigned unit symbol and unit name (e.g., Qa - Alluvium). Units are listed from youngest to oldest. Information about each geologic unit is also presented in the GRI Geologic Unit Information (GICLUNIT) table included with the GRI digital geologic-GIS data. Some source unit symbols as well as names and/or ages may have been changed in this document and in the GRI digital geologic-GIS data. This was done to conform to Geologic Resources Inventory Geology–GIS Geodatabase Data Model unit symbol and naming standards. Unit symbols, names and/or ages in unit descriptions, correlation figures, and other source map figures 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

Qa - Alluvium
Qf - Alluvial fan deposit
Ql - Landslide deposits
Qt - Alluvial terrace deposits
- Qt1 - Highest perched terrace deposits
- Qt2 - Middle perched terrace deposits
- Qt3 - Lowest perched terrace deposits

Quaternary and Tertiary Periods

QTg - Gila Conglomerate
- QTgps - Gila Conglomerate, pumiceous sandstone

Tertiary Period

Tmd - Andesitic to dacitic lava flows of the Middle Fork
Tav - Volcaniclastic rocks of Adobe Canyon
Tba - Bearwallow Mountain Andesite
Tbt - Bloodgood Canyon Tuff
Tmh - Andesite of Murtocks Hole
Tsp - Shelley Peak Tuff
Tao - Older ignimbrites, undivided
Tcu - Lava flows and flow breccia

Volcanic rocks of the volcanic complex at Copperas Creek
- Tgf - Lava flows and associated volcanic rocks of Gila Flat
- Tgfss - Lava flows and associated volcanic rocks of Gila Flat, sandstone member
- Tgfb - Lava flows and associated volcanic rocks of Gila Flat, basaltic lava flows
- Taa - Rhyolite of the Alum Mountain eruptive center

Tad - Andesite dikes
Thd - Andesite dikes, hornblende bearing

Map Unit Descriptions

Descriptions of all geologic map units, generally listed from youngest to oldest, are presented below. All unit descriptions from source map: Gila Hot Springs 7.5' Quadrangle

Qa - Alluvium (Holocene)

Unconsolidated deposits of the floodplains of major streams. Maximum thickness is several meters.

Qf - Alluvial fan deposit (Holocene)

Unconsolidated deposits at the mouths of secondary streams and gullies. As much as several meters thick.

Ql - Landslide deposits (Holocene and (or) Pleistocene)

Includes slopewash and talus in areas of slumped topography marked by numerous small and major headwall scarps. Displaced bedrock blocks shown locally within the slumped area where they are critical to interpreting the geologic relationships. A few meters to tens of meters thick.

Qt - Alluvial terrace deposits (Holocene? and Pleistocene)

Alluvial deposits of minor, undetermined thickness at several levels above the Gila River floodplain. Qt1, Qt2, and Qt3 refer to relative levels of floodplain deposits, with Qt1 being the highest perched deposit and Qt3 the lowest above the present floodplain.

Qt1 - Highest perched terrace deposits (Holocene? and Pleistocene)

Qt2 - Middle perched terrace deposits (Pleistocene)

Qt3 - Lowest perched terrace deposits (Pleistocene)

QTg - Gila Conglomerate (Pleistocene? and Miocene?)

Volcaniclastic fanglomerate and river gravels as much as 1,100- 1,200 ft (about 300 m) thick in the deepest parts of the Gila Hot Springs graben. The base of the Gila near the head of Jordan Canyon, in the southeastern part of the quadrangle, is marked by laminated cross-bedded, pumiceous sandstone deposits (QTgps), as much as 100ft (about 30 m) thick. Andesitic lava flows a few meters thick (Bearwallow Mountain andesite (Tba?)) are interlayered in the lower part of the Gila Group near the junction of Apache Creek and Black Canyon.

QTgps - Gila Conglomerate, pumiceous sandstone (Pleistocene? and Miocene?)

Laminated cross-bedded, pumiceous sandstone deposits, as much as 100ft (about 30 m) thick.

Tmd - Andesitic to dacitic lava flows of the Middle Fork (Oligocene to Miocene)

Lava flows similar to the older Bearwallow Mountain Andesite (Tba) flows but distinguished from them by sparse but conspicuous, bright green pyroxene phenocrysts and quartz xenocrysts. These flows were tentatively, but erroneously correlated (see Ratté, 2008) with the Wall Lake flows of Elston (1968). Mixing of these flows with the underlying volcaniclastic sediments at the mouth of Adobe canyon resulted in a peperite-like breccia. Thickness as much as about 100 ft (30 m) above the hot spring in the northwestern part of the map area, but pinches out toward the mouth of the Middle Fork Gila River.

Tav - Volcaniclastic rocks of Adobe Canyon (Oligocene)

Orangey-brown, locally pumiceous sandstone. Along the Middle Fork Gila River; 0 to 100 ft (30 m) thick.

Tba - Bearwallow Mountain Andesite (Oligocene)

Andesitic to basaltic-andesite lava flows likely derived from shield volcanoes centered at Black Mountain to the north, and Brushy Mountain to the west of the quadrangle. Commonly characterized by tiny reddish-brown, measles-like olivine phenocrysts that have been altered to iddingsite. Maximum thickness about 800 ft (250 m), as measured in the “Trailer park” geothermal well in the Gila Hot Springs graben (Witcher and Lund, 2002; Summers and Colpitts, 1980).

Tbt - Bloodgood Canyon Tuff (Oligocene)

Light-gray rhyolite ignimbrite (ash-flow tuff) containing abundant phenocrysts of quartz and sanidine, minor biotite, and rare but conspicuous honey-yellow sphene in a eutaxitic, pumice-rich matrix. Thickness about 0 to about 600 ft (180 m) in the “Trailer park” geothermal well.

Tmh - Andesite of Murtocks Hole (Oligocene)

Andesite flows and breccias that separate the younger Bloodgood Canyon Tuff (Tbt) from the older Shelly Peak tuff (Tsp).

Tsp - Shelley Peak Tuff (Oligocene)

Reddish-brown ignimbrite (ash-flow tuff) containing abundant plagioclase, biotite, and sparse green pyroxene phenocrysts in a fine-grained eutaxitic pumiceous matrix. Present only west of the Gila River in the southwest part of the quadrangle in discontinuous lenses a few meters thick, and where lapping on to the flank of the Copperas Creek volcanic complex.

Tao - Older ignimbrites, undivided (Oligocene)

Composed of the Caballo Blanco Tuff (lower) and Davis Canyon Tuff (upper). Only a few small exposures on north side of Alum Mountain. Undifferentiated on this map.

Davis Canyon Tuff (Oligocene) - Light-gray ignimbrite (ash-flow tuff) containing sparse, tiny phenocrysts of quartz and sanidine in a fine grained vitroclastic matrix characterized by white to reddish-brown eutaxitic pumice lapilli and flattened blocks commonly several centimeters long. Occurs only in isolated patches within the area of general landslide topography where remnants of the younger volcanic rocks that overlapped the Copperas Creek volcanic complex are found on the northern flanks of the Alum Mountain eruptive center.

Caballo Blanco Tuff (Oligocene) - Gray, crystal-rich ignimbrite (ash-flow tuff) found only on the north flanks of the Alum Mountain eruptive center in association with the Davis Canyon Tuff, and as mixed with rubble of the lava flows of Gila Flat (Tgf), where the Caballo Blanco Tuff laps on to the older volcanic rock. A few meters thick.

Tcu - Lava flows and flow breccia (Oligocene)

Similar to the flows of Gila Flat (Tgf). In cross section only.

Volcanic rocks of the volcanic complex at Copperas Creek

Tgf - Lava flows and associated volcanic rocks of Gila Flat (Oligocene?)

Mainly andesitic to dacitic lava flows and flow breccias, including black vitrophyre layers at several levels. Andesitic flows are generally porphyritic and contain abundant plagioclase and pyroxene phenocrysts; dacitic flows have plagioclase and minor biotite phenocrysts. Tan-colored volcanic(?) sandstone (referred to as Tgfss), as much as 10- 20 m thick, present locally at the base of lava flows; best exposed along New Mexico Highway 15 in the southern part of the quadrangle, and under Buck Hannen Mountain and Copperas Peak in the Copperas Peak quadrangle to the south (fig. 1). Gypsum veinlets in the in the basal volcanic (?) sandstone could be interpreted as indicating that the pervasive Alum Mountain alteration and mineralization is younger than the Gila Flat lava flows, or, as preferred here, the gypsum is related to supergene fluids unrelated to the rhyolite dome-forming event. Aggregate thickness on the order of 100- 200 m.

Tgfss - Lava flows and associated volcanic rocks of Gila Flat, sandstone member (Oligocene)

Tan-colored volcanic (?) sandstone as much as 10 - 20 meters thick, present locally at the base of lava flows; best exposed along New Mexico Highway 15 in the southern part of the quadrangle, and under Buck Hannen Mountain and Copperas Peak in the Copperas Peak quadrangle to the south.

Tgfb - Lava flows and associated volcanic rocks of Gila Flat, basaltic lava flows (Oligocene)

Two thin basaltic (?) lava flows, each a few meters thick, are interlayered with the basal part of the sandstone member (Tgfss).

Note: Unit Tgfb is omitted from the source publication due to scale, but it was documented in the original field map, referenced in the report, and confirmed by the map author.

Taa - Rhyolite of the Alum Mountain eruptive center (Oligocene)

Bright-colored, red, yellow, white, pervasively silicified and solfatarically altered rhyolite dome, largely surrounded by slumped, incoherent layers of the overlying volcanic rocks of Gila Flat (Tgf). Chalky-white altered rhyolite is the dominant facies on Alum Mountain and west of the Gila River, where it occurs as coarse carapace breccia. Local, more coherent dike-like masses are also present. Most enigmatic are the granular, layered rocks that look most like pyroclastic beds, and are tentatively interpreted as such.

Tad - Andesite dikes (Oligocene?)

Occurs mainly in the vicinity of Alum Mountain along both sides of the Gila River. Age relative to the Bearwallow Mountain Andesite and the older volcanic complex of Copperas Creek are uncertain. A few meters to several meters thick.

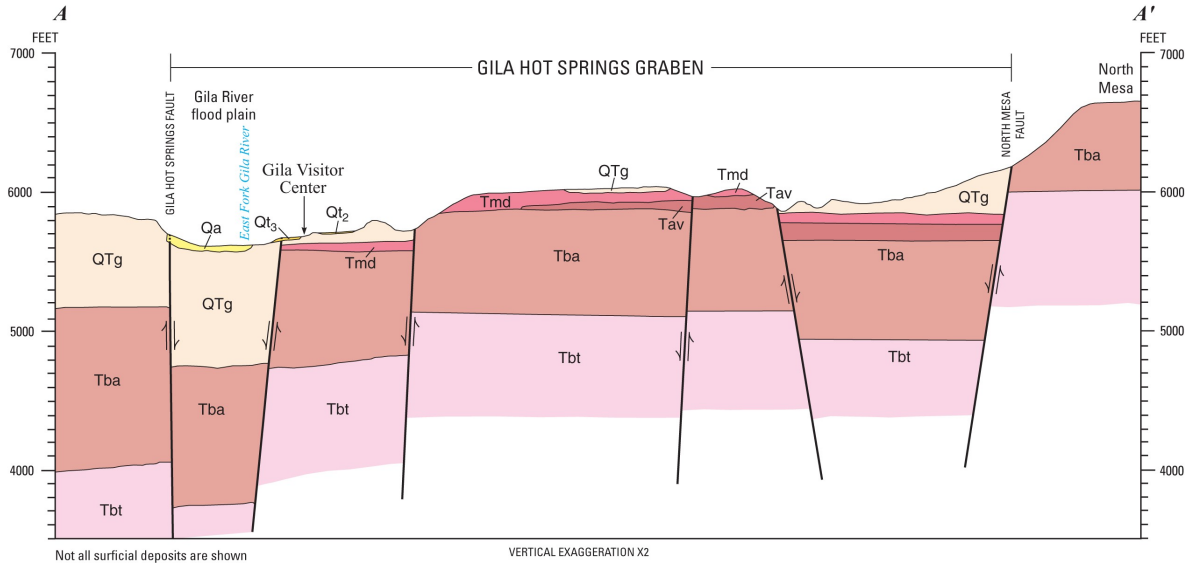
Thd - Andesite dikes, hornblende bearing (Oligocene?)

Occur mainly in the vicinity of Alum Mountain along both sides of the Gila River. Age relative to the Bearwallow Mountain Andesite and the older volcanic complex of Copperas Creek are uncertain. A few meters to several meters thick.

Geologic Cross Sections

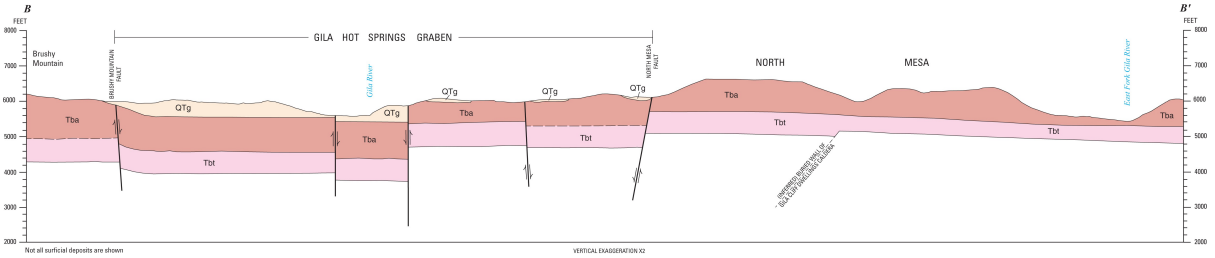
The geologic cross sections present in the GRI Digital Geologic-GIS Map of the Gila Hot Springs 7.5' quadrangle produced for Gila Cliff Dwellings National Monument, New Mexico (GICL) are presented below. Cross section graphics were scanned at a high resolution and can be viewed in more detail by zooming in (if viewing the digital format of this document).

Cross Section A-A'



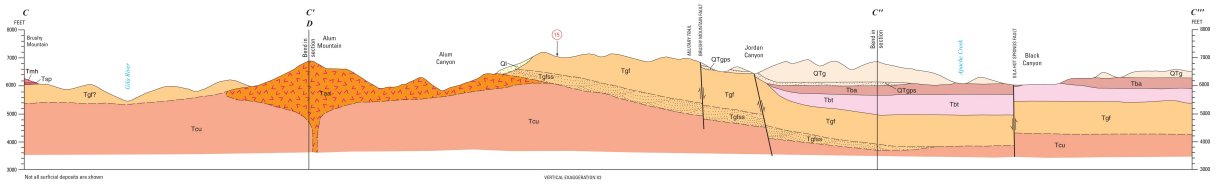
Graphic from source map: Gila Hot Springs 7.5' Quadrangle.

Cross Section B-B'



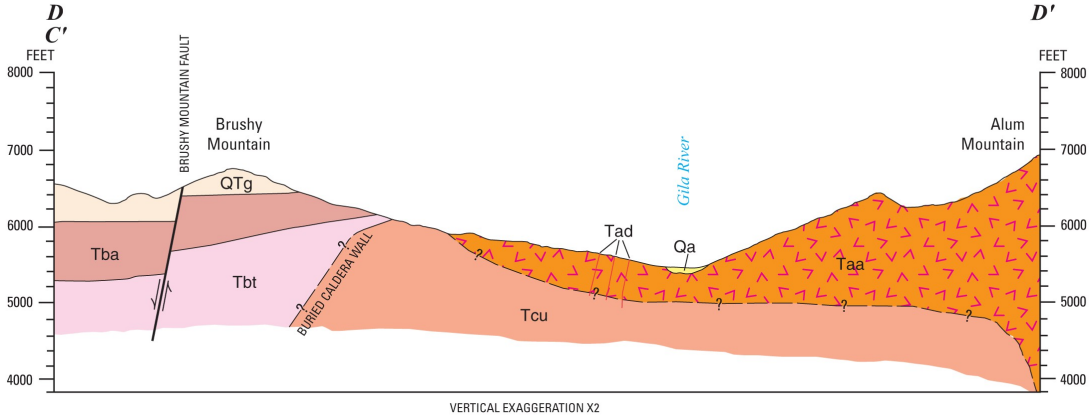
Graphic from source map: Gila Hot Springs 7.5' Quadrangle.

Cross Section C-C'-C''



Graphic from source map: Gila Hot Springs 7.5' Quadrangle.

Cross Section D-D'



Graphic from source map: Gila Hot Springs 7.5' Quadrangle.

Ancillary Source Map Information

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

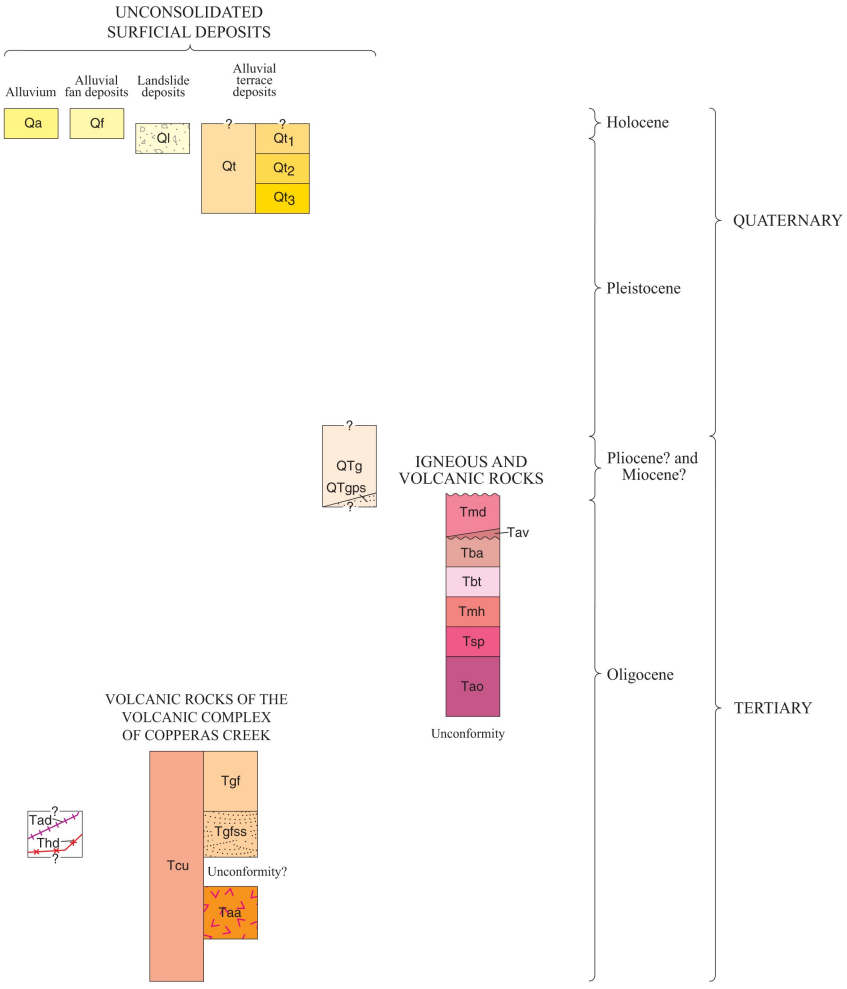
Gila Hot Springs 7.5' Quadrangle

The formal citation for this source.

> Ratté, J.C., Gaskill, D.L., and Chappell, J.R., 2014, Geologic Map of the Gila Hot Springs 7.5' Quadrangle and the Gila Cliff Dwellings National Monument, Catron and Grant Counties, New Mexico: U.S. Geological Survey, OF 1024-1036, scale 1:24,000 (*GRI Source Map ID 75624*).

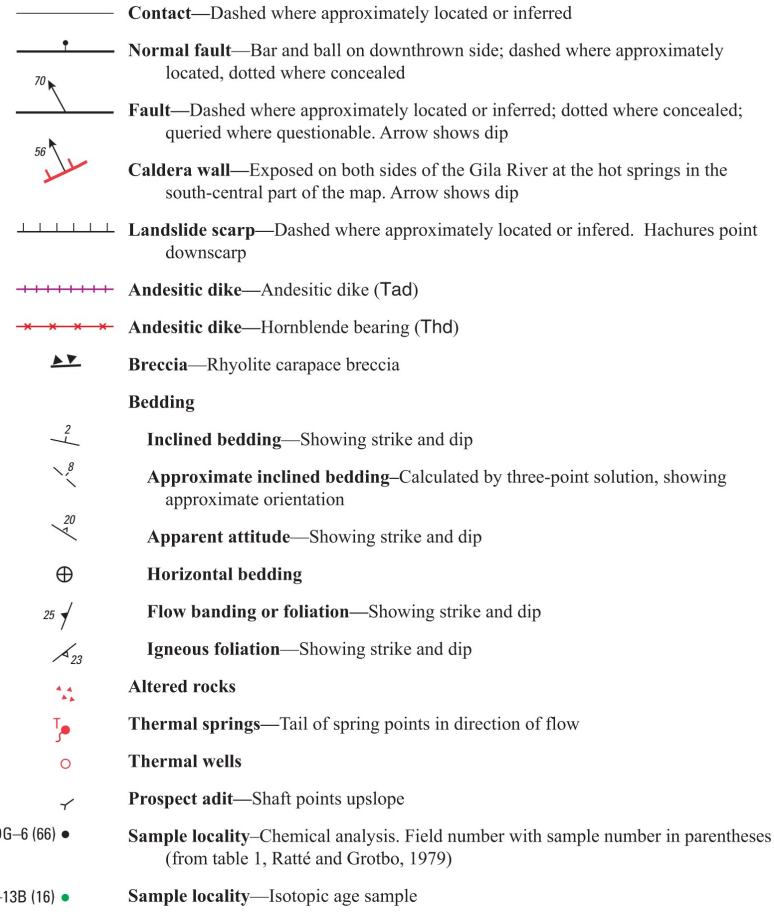
Prominent graphics and text associated with this source:

Correlation of Map Units



Graphic from source map: Gila Hot Springs 7.5' Quadrangle

Map Legend



Graphic from source map: Gila Hot Springs 7.5' Quadrangle

Report

ABSTRACT

The Gila Hot Springs quadrangle is of geologic interest with respect to four major features, which are:

(1) The caves of the Gila Cliff Dwellings National Monument
(2) The hot springs associated with the faults of the Gila Hot Springs graben
(3) The Alum Mountain rhyolite dome and eruptive center
(4) A proposed segment of the southeastern wall of the Gila Cliff Dwellings caldera

The Gila Cliff Dwellings National Monument consists of two tracts. The caves that were inhabited by the Mogollon people in the 14th century are in the main tract near the mouth of Cliff Dweller Canyon in the Little Turkey Park 7.5' quadrangle adjoining the northwest corner of the Gila Hot Springs quadrangle. The second tract includes the Cliff Dwellings National Monument Visitor Center at the confluence of the West

and Middle Forks of the Gila River in the northwest corner of the Gila Hot Springs quadrangle. Both quadrangles are within the Gila National Forest and the Gila Wilderness except for a narrow corridor that provides access to the National Monument and the small ranching and residential community at Gila Center in the Gila River valley (fig.1).

The caves in Cliff Dweller Canyon were developed in the Gila Conglomerate of probable Miocene? and Pleistocene? age in this area (Mack, 2008) by processes of lateral corrosion and spring sapping along the creek in Cliff Dweller Canyon. The hot springs in the Gila River valley are localized along faults in the deepest part of the Gila Hot Springs graben, which cuts diagonally northwest-southeast across the central part of the quadrangle. Some of the springs provide domestic hot water for space heating and agriculture in the Gila River valley and represent a possible thermal resource for development at the Cliff Dwellings National Monument.

The Alum Mountain rhyolite dome and eruptive center in the southwestern part of the quadrangle is a colorful area of altered and mineralized rocks that is satellitic to the larger Copperas Canyon eruptive center, both being part of the composite Copperas Creek volcano, or volcanic complex in the Copperas Peak quadrangle to the south (Ratté, 2008). The altered rocks of the Alum Mountain eruptive center have been prospected by means of several short adits, or tunnels, for alum, a mixture of the iron and aluminum sulfate minerals alunite and halotrichite (Hayes, 1907). A fault on the west side of the Gila River, opposite the hot springs in the south-central part of the quadrangle, just north of Alum Mountain, is tentatively interpreted as a segment of the wall of the Gila Cliff Dwellings caldera (Rhodes, 1970; Ratté and Gaskill, 1975). The fault, which dips about 55 degrees northwest, has a footwall of the andesitic and dacitic lava flows and flow breccias of Gila Flat. The hanging wall consists of Bloodgood Canyon Tuff overlain by Bearwallow Mountain Andesite flows. However, these rocks are not faulted against the older rocks but apparently abut and locally overlap the footwall. These are the major geologic features of the quadrangle, about three-quarters of which is covered by Bearwallow Mountain Andesite lava flows and overlying volcaniclastic rocks of the Gila Conglomerate.

GEOLOGIC SUMMARY

LOCATION AND ACCESSIBILITY

The Gila Hot Springs 7.5' quadrangle is in Catron and Grant Counties in southwestern New Mexico, about 40 miles north of Silver City via New Mexico State Highway 15. The three main forks of the Gila River (West Fork, Middle Fork, and East Fork) all join within the quadrangle. Most of the quadrangle is in the Gila Wilderness, within the Gila National Forest, and includes the visitor center of the Gila Cliff Dwellings National Monument (figs. 1 and 2). The monument was established in 1907 to preserve and protect the Puebloan dwellings. Major trailheads accessing the wilderness area from the east are located within or adjacent to the western part of the quadrangle. Gila Hot Springs is the only settlement in the quadrangle; it consists of a grocery store and gift shop, gas station, trailer park, and scattered homes and ranches along the Gila River and East Fork.

GEOLOGIC SETTING

The Gila Hot Springs 7.5' quadrangle is in the southeastern part of the Mogollon-Datil volcanic field of mid-Tertiary age, and within the transition zones between the Basin and Range and the Colorado Plateau physiographic and structural provinces. It is peripheral to the Eocene and Oligocene cluster of caldera-forming supervolcanoes of the Mogollon Mountains (fig. 3).

PREVIOUS WORK

The geology of the Gila Hot Springs 7.5' quadrangle was first mapped in reconnaissance for the 1963 New Mexico State geologic map and later as part of the 1975 reconnaissance geologic map of the Gila

Wilderness, which was prepared during an appraisal of the mineral resources of the Gila Wilderness (Ratté and Gaskill, 1975). Additional detailed maps were prepared as thesis projects by students at the University of New Mexico (Rhodes, 1970; Krier, 1980; Seaman, 1988). The geothermal resources of the quadrangle have been the subject of a number of reports: Summers, 1976; Summers and Colpitts, 1980; Elston, 1981; Witcher, 1995; and Witcher and Lund, 2002.

STRATIGRAPHY AND CORRELATION OF MAP UNITS

About three-quarters of the quadrangle is covered by andesitic to basaltic lava flows of the Bearwallow Mountain Andesite (Tba) and volcaniclastic sedimentary rocks of the Gila Group (QTg). The southwest quarter consists of the Alum Mountain eruptive center of the volcanic complex of Copperas Creek, or composite volcano. The main eruptive center is in Copperas Canyon, in the Copperas Peak 7.5' quadrangle to the south.

The Alum Mountain eruptive center appears to be a domal accumulation of rhyolitic lava flows, dikes, and other small intrusive bodies, and presumed pyroclastic (tuff) deposits, all of which are hydrothermally altered and weakly mineralized. These altered rocks present a colorful mixture of yellow, red, and white rocks that are composed largely of silica, clays, hydrous sulfates, finely disseminated pyrite, and rare native sulfur. The original sulfataric-type hydrothermal alteration was followed by supergene fluids that produced extensive hydrous iron-aluminum sulfate deposits, which were mined briefly in the mid-nineteenth century for alum, and as a possible aluminum resource (Hayes, 1907). The alum minerals (halotrichite and alunogen) form crusts that commonly drape cliff faces and line the walls of mine openings with spectacular crystal growths, as can be seen in the photographs at the bottom right of this map sheet.

The rocks of the Alum Mountain eruptive center are overlain to the east by a thick sequence of andesitic to dacitic lava flows of Gila Flat (Tgf). Volcaniclastic sandstone beds, as much as 120 ft (30- 40 m) thick, and two thin basaltic (?) lava flows are present at the base of these flows near the head of Alum Canyon. Similar sandstone beds overlie coarse breccias and pyroclastic (?) beds a few meters thick in a road cut along New Mexico Highway 15 and elsewhere in the Copperas Peak 7.5' quadrangle to the south. These rocks appear to be unconformable on the underlying altered rocks, although this is disputed in some prior studies (Krier, 1980; Northrup and Whitney, 1987). Lava flows and flow breccias (Tgf?) that bound the altered rocks of the eruptive center, across the Gila River to the north and west, and in the southwest corner of the quadrangle, bear an uncertain relationship to the altered rocks. They may include rocks of the Copperas Creek volcanic complex that are older than those of the Alum Mountain eruptive center, as well as Gila Flat flows, which are younger than those of the eruptive center. Such older andesitic lava flows and flow breccias are believed to be prevalent in the Copperas Peak quadrangle, where they are related to the main Copperas Canyon eruptive center of the volcanic complex.

The rocks of the Copperas Creek volcanic complex in this quadrangle are unconformably overlapped by younger volcanic rocks. These rocks include outflow deposits of caldera-forming ignimbrites (ash-flow tuffs) of the Datil Group and Last Chance Andesite (Cather and others, 1994); a thick sequence of Bearwallow Mountain (Tba) andesitic to basaltic-andesite lava flows from nearby shield volcanoes; and finally, thick volcaniclastic sedimentary deposits of the Gila Conglomerate (QTg). These overlap relationships are best exposed west of the Gila River, opposite Alum Mountain, where Shelley Peak Tuff (Tsp), Bloodgood Canyon Tuff (Tbt), Bearwallow Mountain Andesite (Tba), and Gila Conglomerate (QTg) can all be seen overlying altered rocks of the Alum Mountain eruptive center.

On the eastern flanks of Alum Mountain, the altered rocks are generally separated from the overlying younger rocks by areas of slumped and debris-covered slopes, but scattered outcrops within the northeast sector of this area have preserved some critical geologic relationships. Rocks tentatively identified as Caballo Blanco Rhyolite and Davis Canyon Tuffs are in contact with underlying Gila Flat lava flows.

Elsewhere, as at the forks of Jordan Canyon, east of New Mexico Highway 15, Gila Flat flows are overlain by basal Gila Conglomerate beds consisting of cross-bedded (windblown?) light- to dark-colored sandstone beds. The color reflects the presence or absence of white pumice fragments, which are believed to have been derived from erosion of the Bloodgood Canyon Tuff (Tbt). Locally, the basal layers consist of a regolith of angular fragments of the underlying Gila Flat flows (Tgf) in a sandy matrix.

STRUCTURE

The Gila Hot Springs graben is the main structural feature in the quadrangle. It is a north-northwest, south-southeast trending asymmetrical graben that appears to be hinged on the southwest side. Dips in the basin-fill Gila Conglomerate (QTg) range from sub-horizontal to about 8 degrees northeast (see cross sections A- A' and B- B'). The Brushy Mountain fault, which defines the southwest side of the graben, has a maximum displacement of about 100 ft (30 m) where it intersects the Gila Hot Springs fault to the northwest in the adjoining Little Turkey Peak 7.5' quadrangle. However, the fault has little or no displacement as it extends southeast toward the Gila River and the Alum Mountain eruptive center. Although it offsets Gila Conglomerate (QTg) down against Bearwallow Mountain Andesite (Tba) and shows as a conspicuous lineament on aerial photographs, it is overlapped by Gila Conglomerate (QTg) as traced across Little Creek and Bull Spring Canyon, where no discernible offset was observed.

The North Mesa fault, which defines the northeast side of the graben, has a displacement that ranges from about 800 ft at the northern edge of the quadrangle (see cross-section A- A') to about 100 ft east of the East Fork of the Gila River. In the deepest part of the graben, along the Gila River between Gila Hot Springs and faults within the vicinity of the hot spring in the northwestern part of the map area, the top of the Bearwallow Mountain Andesite (Tba) is about 2,000 ft below its high point on North Mesa (see cross section A- A'). Part of this could be related to changes in thickness relative to two likely eruptive sources of the Bearwallow Mountain Andesite (Tba), namely Bearwallow Mountain in the quadrangle of that name to the north and Brushy Mountain in the Little Turkey Park quadrangle to the east.

A fragment of the eastern structural wall of the Gila Cliff Dwellings caldera is mapped in this study that was heretofore speculated to be buried somewhere beneath younger rocks east of the Middle Fork Gila River. The caldera wall is exposed on both sides of the Gila River at the hot springs in the south-central part of the map area, about one mile upriver from the Alum Canyon Trail, U.S. Forest Service Trail 788. Where best observed, on the west side of the river, Bloodgood Canyon Tuff (Tbt) abuts a wall of andesitic flows and flow breccias of the older Copperas Creek volcanic complex. This 56-degree contact is devoid of slickensides, fault breccia, or other indications of offsetting movement but does have glassy breccias along the contact to the southwest and across the river at the hot springs. Except at this one locality, the Bloodgood Canyon Tuff (Tbt) that laps onto the flanks of the Copperas Creek volcanic complex is thought to be outflow facies of the Gila Cliff Dwellings caldera (fig. 3). It is uncertain if the Bloodgood Canyon Tuff (Tbt) outcrops along the East Fork Gila River and at Gila Hot Springs are within or outside the caldera. However, the 600 ft thickness of Bloodgood Tuff (Tbt) intersected in the Campbell no.1 geothermal well within the Gila Hot Springs graben indicates that it is within the caldera. The Gila Cliff Dwellings caldera was originally named by Elston (1968) as the eruptive center for the Bloodgood Canyon Tuff (Tbt), but later the Bloodgood Canyon was interpreted to be filling a preexisting caldera during the caldera-forming eruptions of the Bursum caldera (Seaman and others, 1991). The Gila Cliff Dwellings caldera was then degraded by Elston (1976) to an unspecified “basin.” The caldera wall fragment described herein would seem to provide the missing evidence necessary to certify the existence of a preexisting cauldron structure filled by the Bloodgood Canyon Tuff (Tbt).

AGES

Problems remain with respect to the ages of the rocks of the Copperas Creek volcanic complex. Several radiometric ages have been acquired from these rocks, but only one from this quadrangle. The other

three are from the Copperas Peak 7.5' quadrangle (table 1). Although the ages in table 1 are quite consistent, indicating a late Oligocene age for the rocks of the Copperas Creek volcanic complex, they are of little help in clarifying the relative ages of the various rocks of the complex. However, they show that the rocks of the complex are older than most of the rocks mapped as overlapping the Copperas Creek volcanic complex. However, if future dating confirms that the 31.84 Ma Caballo Blanco Tuff (Tct) also laps onto the Gila Flat flows (Tgf) on the northeast flanks of Alum Mountain, as mapped here, then the rocks of the Copperas Creek volcanic complex must be somewhat older than the ages indicated in table 1.

MINERAL RESOURCES

Mineral resources in the Gila Hot Springs quadrangle include the geothermal waters at Gila Hot Springs (Witcher, 1995; Witcher and Lund, 2002) and the alum deposits associated with the Alum Mountain eruptive center (Northrup and Whitney, 1987). Pyrite and secondary iron oxides are the most conspicuous metallic minerals, but anomalous occurrences of precious and base metals include silver, gold, and copper (Ratté and others, 1979). Secondary, supergene, water-soluble, aluminum-iron sulfate minerals (alunogen and halotrichite) precipitate from the groundwater solutions and have been mined in the past for the experimental recovery of aluminum metal, but to date, an economic recovery process is not available. In the mid-1970s, the federal government purchased the 61 patent claims that encompassed the Alunogen Mining District and added them to the Gila Wilderness.

CROSS SECTIONS

The absence of adequate exposed sections for measuring unit thickness, and the likelihood of irregular buried topography beneath volcanic units, make the cross-sections subject to interpretation.

Cross Section A- A'

Section A–A' crosses the Gila Hot Springs graben, from the Gila River in the northeast part of the quadrangle to North Mesa, passing through the Gila Cliff Dwellings National Monument Visitor Center. Rather than a single structure, this section could be thought of as a shallow graben adjacent to North Mesa, separated from a deeper graben at the Gila River by an intervening horst block. The andesitic to dacitic flows of the Middle Fork (Tmd) pinch out, or are faulted on the east side of the river, and do not occur on the west side. The Bearwallow Mountain Andesite (Tba) is estimated to be at least 800- 900 ft thick under North Mesa based on a low-angle dip to near-horizontal dip above the top of the Bloodgood Canyon Tuff (Tbt) along the East Fork Gila River near Lyons Lodge. The total stratigraphic offset of the bottom of the Bearwallow Mountain Andesite between North Mesa and the deepest part of the graben beneath the Gila River is an estimated 1,800 ft (>500 m).

Cross Section B- B'

Section B- B' crosses the Gila Hot Springs graben from the slopes of Brushy Mountain to the East Fork Gila River. It is much like section A- A', but somewhere, it would seem, the section should cross the buried wall of the Gila Hot Springs caldera, as tentatively indicated. Although Bloodgood Canyon Tuff (Tbt) is at least 1,100 ft thick along the West Fork Gila River within the Gila Wilderness and is interpreted to be filling the Gila Cliff Dwellings caldera, it was erupted from the younger Bursum caldera. The Gila Cliff Dwellings caldera is somewhat of an enigma, recognized mainly for the thickness of Bloodgood Canyon Tuff (Tbt) in the West Fork and Middle Fork Gila River drainages, with no bottom exposed. There is no clear relationship between any of the other regional ignimbrites in this area and the Gila Cliff Dwellings caldera as its source (Seamans, 1988).

Cross Sections C- C'- C" and D- D'

These sections illustrate how the Alum Mountain eruptive center intertongues with units of the Copperas Creek volcanic complex and correlative units. Note the landslide terrain on the flanks of Alum Mountain.

Text from source map: Gila Hot Springs 7.5' Quadrangle

Figure 1 - Index map

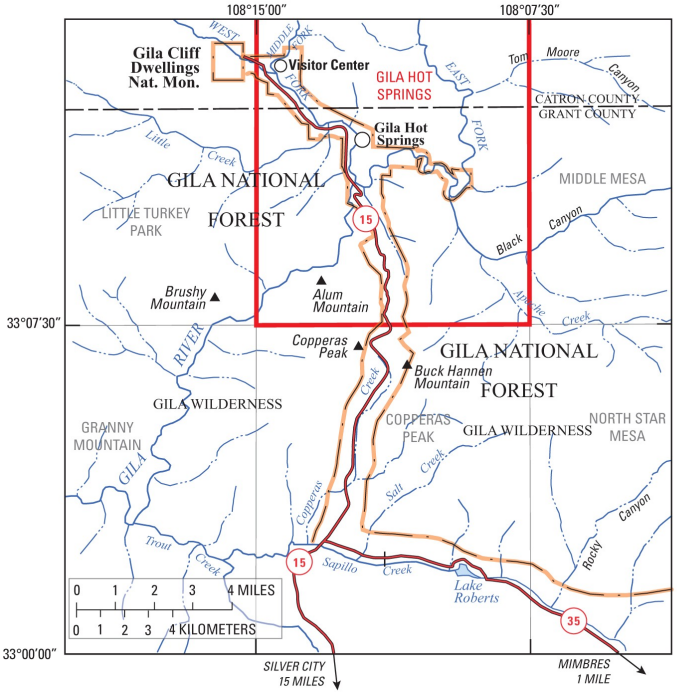


Figure 1. Index map of the Gila Hot Springs 7.5' quadrangle (red outline), and the Gila Cliff Dwelling National Monument area.

Graphic and text from source map: Gila Hot Springs 7.5' Quadrangle

Figure 2 - Gila River and Gila Hot Springs Graben



Figure 2. Oblique view looking southeast, down the Gila River and Gila Hot Springs graben. The North Mesa fault marks the northeast side of the Gila Hot Springs graben. Showing the Gila Cliff Dwellings National Monument Visitor Center; Visitor Center residence area; bridge across Gila River; Heart Bar Ranch (New Mexico Department of Game and Fish); stable area; QTg, Gila Conglomerate; Tba, Bearwallow Mountain Andesite. Photograph used by permission: Adriel Heisey.

Graphic and text from source map: Gila Hot Springs 7.5' Quadrangle

Figure 3 - Geologic Map of the Gila Wilderness Area

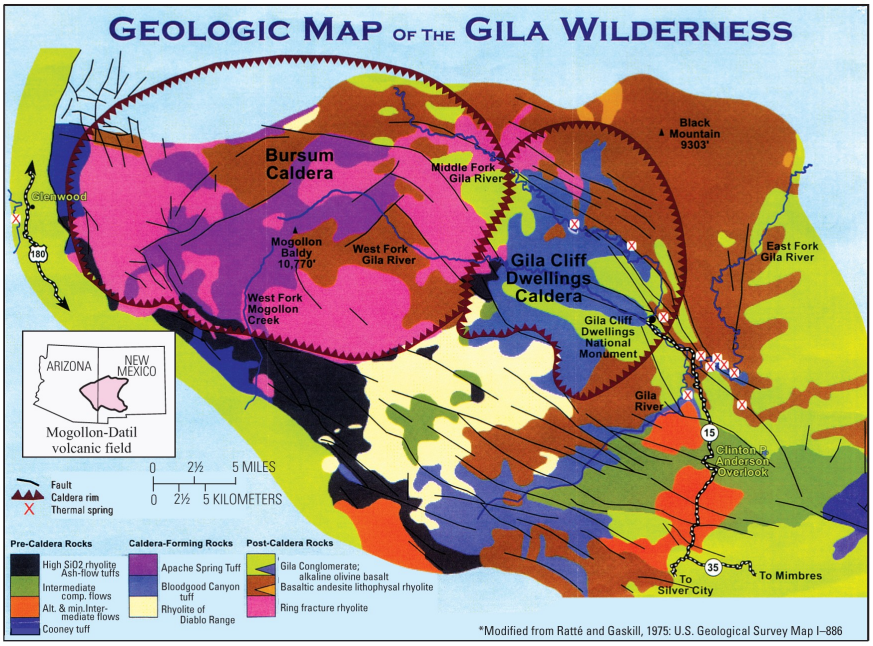


Figure 3. Geologic map of the Gila Wilderness Area. Modified from Ratté and Gaskill, 1975.

Graphic and text from source map: Gila Hot Springs 7.5' Quadrangle

Table 1 - Radiometric ages of samples

Table 1. Radiometric ages of the rocks of the volcanic complex at Copperas Creek.
(Only sample GR-13B (16) is from the Gila Hot Springs quadrangle. The other thee dates are from localities in the Tgf unit of the Copperas Creek quadrangle, directly adjacent to the south, and are provided to indicate a continuity of ages.)

Sample	Unit	Quadrangle	Method	Age	Reference
GR–13B (16)	Hornblende dacite (Tgf?)	Gila Hot Springs	$^{39}Ar/^{40}Ar$	Groundmass 30.2 ± .02	1
	Vitrophyre (Tgf?)	Copperas Peak	$^{39}Ar/^{40}Ar$	Plagioclase 31.3 ± 0.13	1
	Quartz dacite (Tgf?)	Copperas Peak	$^{40}K/^{40}Ar$	Sanidine 30.0 ± .07, Biotite 30.3 ± 0.7	2
	Rhyolite dike	Copperas Peak	$^{40}K/^{40}Ar$	K-feldpar 30.4 ± 0.7	2

[1]W.C. McIntosh, New Mexico Bureau of Mines and Mineral Resources, personal commun., 2010.
[2]Marvin and others, 1987 (table 1, entry no. 98, 99)

Graphic and text from source map: Gila Hot Springs 7.5' Quadrangle

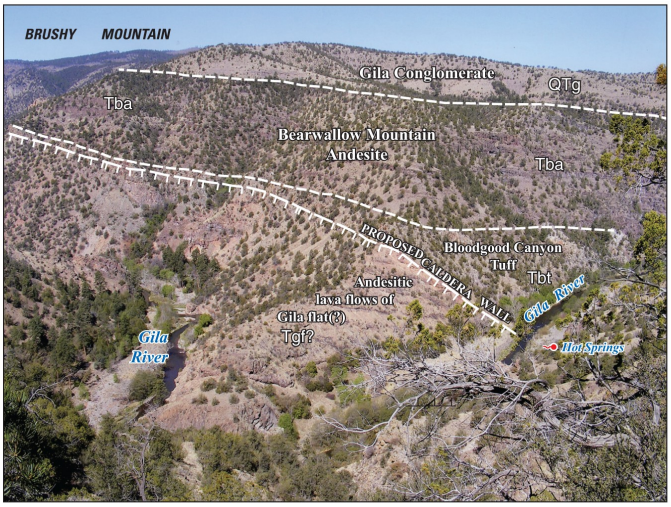
Photograph 1 - Alum Mountain rhyolite dome and Gila River canyon



The Alum Mountain rhyolite dome and Gila River canyon as viewed from the Alum Canyon Trailhead (U. S. Forest Service Trail no. 788). The Alum Mountain eruptive center is a dome of pervasively altered and weakly mineralized rhyolite, partially encircled by a rim of younger dacitic lavas. The dome may appear to be filling a crater, but the moat-like valley around its east side may actually have been an earlier course of the Gila River. Photograph by Sonya Berger, National Park Service, May 2007.

Graphic and text from source map: Gila Hot Springs 7.5' Quadrangle

Photograph 2 - Contact between Gila Conglomerate and Bearwallow Mountain Andesite



Contact between the Gila Conglomerate and the Bearwallow Mountain Andesite, looking northwest from Alum Mountain. The rocks of the volcanic complex of Copperas Creek in this quadrangle are

unconformably overlapped by younger volcanic rocks. These rocks include outflow deposits of caldera-forming ignimbrites (ash-flow tuffs) of the Datil Group (Cather and others, 1994); a thick sequence of Bearwallow Mountain (Tba) andesitic to basaltic-andesite lava flows from nearby shield volcanoes; and finally, thick volcaniclastic sedimentary deposits of the Gila Conglomerate (QTg). These overlap relationships are best exposed west of the Gila River, opposite Alum Mountain, where Shelley Peak tuff (Tsp), Bloodgood Canyon Tuff (Tbt), Bearwallow Mountain Andesite (Tba), and Gila conglomerate (QTg) can all be seen overlying altered rocks of the Alum Mountain eruptive center.

Graphic and text from source map: Gila Hot Springs 7.5' Quadrangle

Photograph 3 - Chalky-white altered rhyolite



Chalky-white altered rhyolite (Taa) is the dominant facies on Alum Mountain and west of the Gila River, where it occurs as coarse carapace breccia. Local, more coherent dike-like masses are also present. Most enigmatic are the granular, layered rocks that look most like pyroclastic beds and are tentatively interpreted as such.

Graphic and text from source map: Gila Hot Springs 7.5' Quadrangle

Photograph 4 - Observation point for volcanic complex of Copperas Creek



Observation point for the volcanic complex at Copperas Creek.

Graphic from source map: Gila Hot Springs 7.5' Quadrangle

Photograph 5 - Large clasts in Gila Conglomerate



Large clasts in Gila Conglomerate.

Graphic from source map: Gila Hot Springs 7.5' Quadrangle

Photograph 6 - Contact between Gila Conglomerate and Bearwallow Mountain Andesite



Contact between the Gila Conglomerate (QTg) and Bearwallow Mountain Andesite (Tba) west of the bridge over the Gila River to the Visitor Center. The road is by the confluence of the Gila River and the East Fork Gila River by New Mexico Highway 15. Photograph by Jim Ratté, 2004.

Graphic and text from source map: Gila Hot Springs 7.5' Quadrangle

Photograph 7 - Sample of Halotrichite



Sample of Halotrichite. Collected from mine wall, Alum Canyon. Photographs by Jim Ratté, 2008.

Graphic and text from source map: Gila Hot Springs 7.5' Quadrangle

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References from source map: Gila Hot Springs 7.5' Quadrangle

Digital Reconnaissance Geologic-GIS Map of the Gila Wilderness Study Area

Map Unit List

The geologic units present in the digital geologic-GIS data produced for Gila Cliff Dwellings National Monument, New Mexico (GICL) are listed below. Units are listed with their assigned unit symbol and unit name (e.g., Qag - Valley alluvium and terrace gravels). Units are listed from youngest to oldest. Information about each geologic unit is also presented in the GRI Geologic Unit Information (GICLUNIT) table included with the GRI digital 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 to conform to Geologic Resources Inventory Geology–GIS Geodatabase Data Model unit symbol and naming standards. Unit symbols, names and/or ages in unit descriptions, correlation figures or other source map figures 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

Qag - Valley alluvium and terrace gravels
Qls - Landslide deposits

Quaternary and Tertiary Periods

QTs - Sedimentary rocks

Tertiary Period

Tb - Alkali olivine basalt flows
Tya - Younger andesitic and latitic lava flows
Tri - Rhyolite flows of Indian Creek
Trb - Rhyolite flows of Beaver Creek
Trr - Rhyolite flows of Rocky Canyon
Tps - Rhyolitic pyroclastic and volcaniclastic rocks
Tad - Dikes of intermediate or mafic composition
Tr - Rhyolite dikes
Tpy - Rhyolitic pyroclastic and volcaniclastic rocks
Tmf - Bedded volcaniclastic deposits
Try - Younger rhyolite flows and domes
Tcb - Breccia of Bloodgood Canyon Rhyolite Tuff
Tmc - Mineral Creek Andesite
Tvu - Tertiary volcanic rocks, undivided
Tas - Tuff of Apache Spring
Tbc - Bloodgood Canyon Rhyolite Tuff of Elston (1968)
Tvs - Volcaniclastic sedimentary rocks

Trd - Rhyolite of the Diablo Range
    Tpd - Pyroclastic or volcaniclastic facies of the rhyolite of the Diablo Range
    Trw - Welded tuff facies of the rhyolite of the Diablo Range

Tmh - Andesitic flows and breccias of Murtocks Hole
Tmhst - Discontinuous tuff layer within unit Tmh

Tsp - Tuff of Shelley Peak
Tdc - Tuff of Davis Canyon
Tgf - Latitic and andesitic lava flows of Gila Flat
Tfc - Tuff of Fall Canyon
Tvb - Volcanic Complex of Brock Canyon
Tvi - Rhyolitic dikes and sills
Tva - Andesitic flows and breccias, pyroclastic and volcaniclastic rocks, and associated small intrusive bodies
Trc - Ash-flow tuffs of Rocky Canyon
Trs - Sedimentary rocks
Ttc - Andesitic flows and breccias of Turkey Cienega Canyon

Paleozoic Era

Pennsylvanian Period

PNs - Syrena Formation

Map Unit Descriptions

Descriptions of all geologic map units, generally listed from youngest to oldest, are presented below. All unit descriptions from source map: Gila Wilderness Study Area (Reconnaissance Geologic Map)

Qag - Valley alluvium and terrace gravels (Holocene)

No additional description provided with source map.

QTs - Sedimentary rocks (Holocene, Pleistocene, Pliocene and Miocene)

Mainly Gila Conglomerate of Pleistocene and Pliocene age, and possibly older; also includes pediment gravels, colluvium, and valley alluvium, and terrace gravels where they are not mapped separately. Gila Conglomerate along Sapillo Creek, west of New Mexico highway 15 may include some volcaniclastic deposits of Oligocene age.

Qls - Landslide deposits (Pleistocene)

May be older and (or) younger than Pleistocene.

Tb - Alkali olivine basalt flows (Pliocene)

Flows occur on top of the Gila Conglomerate in the southeast corner of the mapped area but probably correlate with 6 m.y. (million year) old basalt (Damon and others, 1969, p. 27) found interlayered just beneath the top of the Gila Conglomerate in the Mimbres River valley about 10 miles (16 km) east of the area of this map.

Tya - Younger andesitic and latitic lava flows (Miocene and Miocene?)

Includes the Bearwallow Mountain Formation and Wall Lake Latite of Elston and others (1968), Double Springs Andesite of Elston, Coney, and Rhodes (1970), and Mogollon and Last Chance Andesites of the Mogollon mining district (Ferguson, 1927).

Tri - Rhyolite flows of Indian Creek (Miocene)

Lithophysal rhyolite flows in north-central part of study area, just north of the Gila Cliff Dwellings caldera. Flows probably accumulated around a local vent; contain fluorite, pseudobrookite, and bixbyite in local lithophysal cavities.

Trb - Rhyolite flows of Beaver Creek (Miocene)

Tin-bearing flow-banded lithophysal rhyolite in northeastern part of study area.

Trr - Rhyolite flows of Rocky Canyon (Miocene)

A lithophysal rhyolite present only in eastern part of study area; may be same as the rhyolite of Beaver Creek **Trb** and other rhyolite lavas in vicinity of the Taylor Creek tin district northeast of Wall Lake.

Tps - Rhyolitic pyroclastic and volcaniclastic rocks (Miocene and Miocene?)

Interlayered with the younger andesitic and latitic lava flows (Tya); rocks probably correlate with similar deposits mapped as part of the younger rhyolite flows and domes (Try), and rhyolites of Indian Creek (Tri), Beaver Creek (Trb), and Rocky Canyon (Trr).

Tad - Dikes of intermediate or mafic composition (Miocene and Oligocene)

Intermediate or mafic composition.

Tr - Rhyolite dikes (Miocene? and/or Oligocene?)

Felsitic to porphyritic rhyolitic dikes a few feet to a few tens of feet (1-10 in) thick. Most are probably same age as younger rhyolite flows and domes (Try), but some may be as old as rhyolite of the Diablo Range (Trd).

Tpy - Rhyolitic pyroclastic and volcaniclastic rocks (Miocene?)

Interlayered with the younger rhyolite flows and domes (Try); mainly within the Bursum caldera.

Tmf - Bedded volcaniclastic deposits (Miocene?)

Rocks that locally fill the moat between the Bursum caldera wall and its interior resurgent dome.

Try - Younger rhyolite flows and domes (Miocene?)

Mainly lava flows and domes of flow-banded rhyolite confined largely within the Bursum caldera. Includes the felsitic rhyolite flows of the Jerky Mountains, the more porphyritic quartz-sanidine rhyolite of the Mogollon Mountains southeast of Mogollon Baldy Peak, the felsitic Fanney Rhyolite of the Mogollon mining district (Ferguson, 1927) and the Nabours Mountain flows of Rhodes (1970). These rhyolites are all defined as lava flows that postdate resurgence of the Bursum caldera. Structural relationships both extrusive and intrusive.

Tcb - Breccia of Bloodgood Canyon Rhyolite Tuff (Miocene?)

Local monolithologic breccia deposits of Bloodgood Canyon Rhyolite Tuff of Elston (1968) in the Hells Hole area of the West Fork Gila River. These deposits were most likely formed by avalanches off the interior walls of the Bursum caldera and represent a marginal caldera-fill deposit.

Tmc - Mineral Creek Andesite (Miocene?)

Andesitic lava flows and flow breccia. Mapped along Whitewater Creek in northwest corner of the map and elsewhere within the Bursum caldera.

Tvu - Tertiary volcanic rocks, undivided (Miocene? and/or Oligocene)

Mapped in areas of complex geology-mainly along the southwest flank of the Mogollon Mountains. Rocks included probably are mainly pre-Bursum caldera but may include some postcaldera rocks.

Tas - Tuff of Apache Spring (Miocene? or Oligocene?)

Densely welded phenocryst-rich ash-flow tuff identified within the Bursum caldera (not recognized outside the caldera in the mapped area). Contains abundant quartz, sanidine, plagioclase, and biotite phenocrysts; accessory sphene common. Biotite K-Ar age of 27.3 ± 0.8 m.y. (Elston, 1968); sphene fission-track ages range between 25.9 ± 4.1 and 29.0 ±4.6 m.y. (C. W. Naeser, written commun., 1973). As mapped, may include some rhyolite of Sacaton Mountain (Ts), especially in upper Spider and Spruce Creeks.

Tbc - Bloodgood Canyon Rhyolite Tuff of Elston (1968) (Miocene? or Oligocene?)

Mainly phenocryst-rich densely welded ash-flow tuff containing abundant quartz and sanidine phenocrysts and sparse biotite and honey-yellow sphene. K-Ar ages of 26.2 ± 1.5 m.y. for biotite and 25.3 ±1 .5 m.y. for sanidine (Bikerman, 1972) are representative of several age determinations on rocks believed to correlate with this tuff. Tuff fills the Gila Cliff Dwellings caldera and forms outflow sheet along

Gila River canyon south and southeast of the caldera.

Tvs - Volcaniclastic sedimentary rocks (Oligocene?)

Fluvial volcaniclastic beds, consisting of rock fragments derived largely from latitic lava flows in the western wall of the Gila Cliff Dwellings caldera, are found beneath the Bloodgood Canyon Rhyolite Tuff (Tbc) at head of Little Creek.

Trd - Rhyolite of the Diablo Range (Oligocene?)

Mainly flow-banded rhyolite in lava flows and domes in the Diablo Range southwest of the Gila Cliff Dwellings caldera. Quartz and sanidine phenocrysts commonly are large and conspicuous. Locally occurs in sill-like rhyolite breccia bodies, as on the south slope of Watson Mountain west of the canyon of the Gila River. The rhyolite of the Diablo Range may be petrographically indistinguishable from the younger rhyolite flows and domes (Try) in some places. The rhyolite of the Diablo Range is defined by its stratigraphic position beneath the Bloodgood Canyon Rhyolite Tuff of Elston (1968) (Tbc). A dike connected with this rhyolite east of Davis Canyon (age sample locality SA-5) has yielded a fission track zircon age of 27.6 ± 4.5 m.y. (written commun., C. W. Naeser, 1973) and K-Ar ages of biotite (27.6± 0.9 m.y.) and sanidine (26.2 ± 0.9 m.y.) (written commun., R. F. Marvin, 1974).

Tpd - Pyroclastic or volcaniclastic facies of the rhyolite of the Diablo Range (Oligocene?)

Mainly a pyroclastic or volcaniclastic facies of the rhyolite of the Diablo Range (Trd).

Trw - Welded tuff facies of the rhyolite of the Diablo Range (Oligocene?)

Virtually identical mineralogically to Bloodgood Canyon Rhyolite Tuff (Tbc); correlation therefore is uncertain.

Tmh - Andesitic flows and breccias of Murtocks Hole (Oligocene?)

Unit separates the younger Bloodgood Canyon Rhyolite Tuff (Tbc) from the older tuff of Shelley Peak (Tsp) mainly along and south of the Gila River canyon in southern part of the study area.

Tmhst - Discontinuous tuff layer within unit Tmh (Oligocene?)

st - Discontinuous tuff layer within unit Tmh (Oligocene?)
Thin discontinuous tuff layer, containing small sanidine phenocrysts, within the andesitic flows and breccias of Murtocks Hole (Tmh).

Tsp - Tuff of Shelley Peak (Oligocene?)

Compositionally zoned ash-flow tuff; contains abundant biotite and plagioclase phenocrysts and sparse green pyroxene crystals in most outcrops; sanidine phenocrysts occur locally in lower part of tuff. 600-700 feet (183-213 in) thick on Shelley Peak.

Tdc - Tuff of Davis Canyon (Oligocene)

Phenocryst-poor partially welded ash-flow tuff containing conspicuous eutaxitic pumice and small quartz and sanidine (moonstone) phenocrysts; interlayered with latitic and andesitic lava flows that are tentatively correlated with the lava flows of Gila Flat (Tgf).

Tgf - Latitic and andesitic lava flows of Gila Flat (Oligocene)

K-Ar ages of biotite (29.6 ± 1.0 m.y.) and of sanidine (29.3 ± 1.0 m.y.) were obtained from quartz latite vitrophyre from sample locality SA-1 located south of Sapillo Creek and west of Sapillo Loop Road (R. F. Marvin, written commun., 1972).

Tfc - Tuff of Fall Canyon (Oligocene)

Partially to densely welded ash-flow tuff containing about 20 percent quartz, sanidine, and plagioclase phenocrysts; sparse biotite and other mafic crystals; interlayered with latitic and andesitic lava flows that are tentatively correlated with the lava flows of Gila Flat (Tgf).

Tvb - Volcanic Complex of Brock Canyon (Oligocene)

Mainly fresh to intensely altered latitic and andesitic lava flows, flow breccia, and minor volcaniclastic and pyroclastic materials. Some rocks may be intrusive. Complex is host to quartz-fluorite veins of Gila fluorspar district, which probably are younger than the hydrothermally altered and mineralized rocks along Brock and Brushy Canyons and adjoining areas straddling the Gila River. K-Ar ages on biotite of 30-34 m.y. (R. F. Marvin, written commun., 1972) from unaltered quartz latite flow breccia near the Clum mine and zircon fission-track ages of 30.2± 5.3 m.y. (C. W. Naeser, written commun., 1973) from altered and mineralized rock in Brushy Canyon indicate that the sulfide-mineralized and altered rocks are comparable in age to the unaltered lava flows of the complex. The sulfide mineralization thus is mid-Tertiary or younger. The zircons in the altered rocks were previously reported to have a fission-track age of 49± 2 m.y. (Ratte and others, 1972), but new work on the zircons from these rocks (sample localities SA-3, SA-4) has shown the age reported earlier to have been in error.

Tvi - Rhyolitic dikes and sills (Oligocene)

Potassium feldspar from one dike (sample locality SA-2) gives a K-Ar age of 29.7 ± 1.0 m.y. (R. F. Marvin, written commun., 1972).

Tva - Andesitic flows and breccias, pyroclastic and volcaniclastic rocks, and associated small intrusive bodies (Oligocene)

Unit includes all the hydrothermally altered rocks in the Copperas Creek and Alum Mountain areas.

Trc - Ash-flow tuffs of Rocky Canyon (Oligocene)

Includes at least two ash-flow tuff sheets that may correlate with the Caballo Blanco Tuff of Elston (1957) and Kneeling Nun Tuff (Jicha, 1954).

Trs - Sedimentary rocks (Oligocene)

Sediments mapped locally between the sheets of ash-flow tuffs of Rocky Canyon (Trc).

Ttc - Andesitic flows and breccias of Turkey Cienega Canyon (Oligocene or older)

Present only in southeast corner of mapped area.

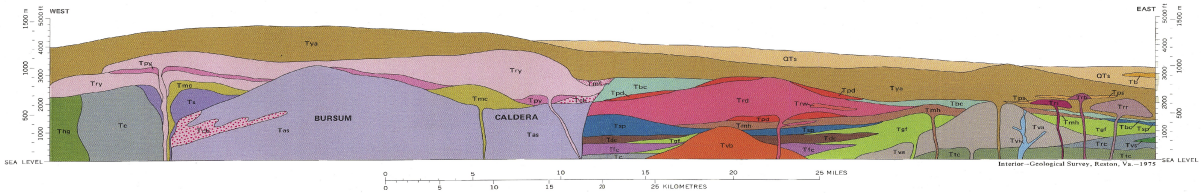
PNs - Syrena Formation (Upper Pennsylvanian)

Limestone and some argillaceous beds. Present only in southeast corner of mapped area between Terry Canyon and Turkey Cienega Canyon. Outcrop configuration taken from a geologic map by Aldrich (1972).

Geologic Cross Sections

The geologic cross section present in the GRI Digital Reconnaissance Geologic-GIS Map produced for Gila Cliff Dwellings National Monument, New Mexico (GICL) is presented below. The cross section graphic was 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 Schematic cross section showing volcanic relationships in the mapped area



Graphic from source map: Gila Wilderness Study Area (Reconnaissance Geologic Map).

Ancillary Source Map Information

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

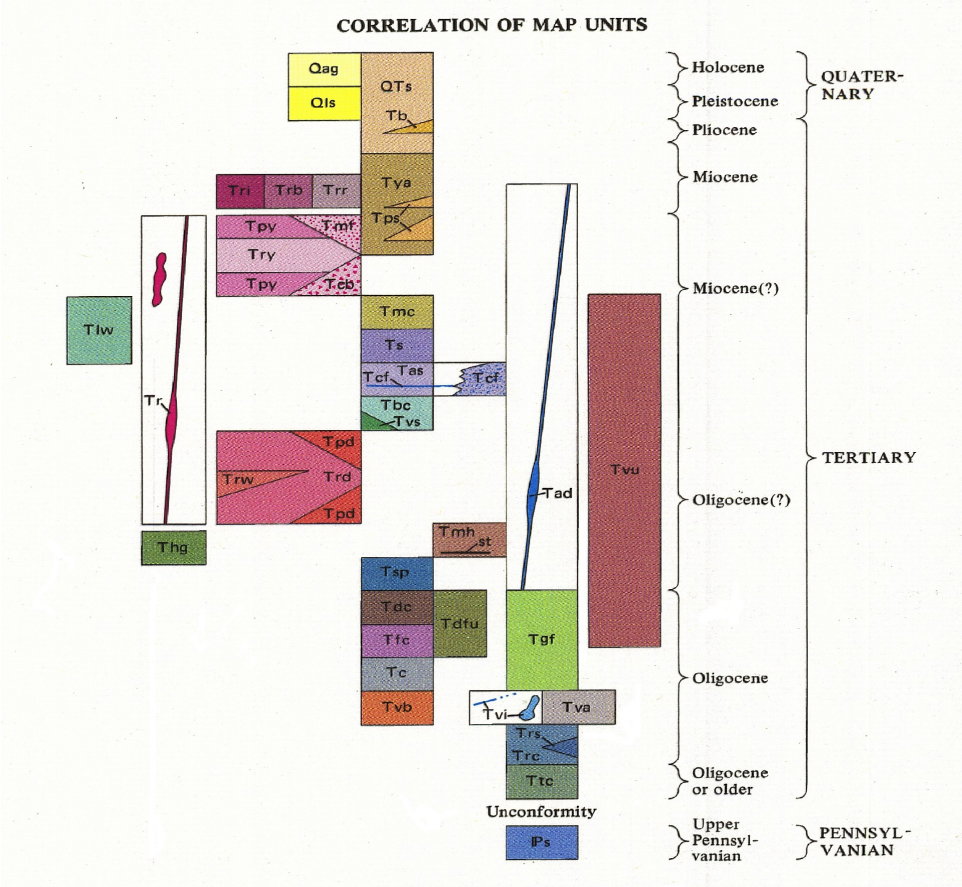
Gila Wilderness Study Area (Reconnaissance Geologic Map)

The formal citation for this source.

> Ratté, J.C., and Gaskill, D.L., 1975, Reconnaissance Geologic Map of the Gila Wilderness Study Area, Southwestern New Mexico: U.S. Geological Survey, Miscellaneous Investigations Series Map I-886, scale 1:62,500 (*GRI Source Map ID 3077*).

Prominent graphics and text associated with this source:

Correlation of Map Units



Graphic from source map: Gila Wilderness Study Area (Reconnaissance Geologic Map)

Map Legend

CONTACT

FAULT – Dashed where approximately located or inferred; dotted where concealed. Direction and amount of dip shown by arrow where known. Bar and ball on downthrown side

PROPOSED PRE-MIDDLE TERTIARY AXIS OF UPLIFT AND/(OR) INTRUSION – From Elston, Coney, and Rhodes (1970)

STRIKE AND DIP OF BEDS
- Inclined
- Horizontal
- Apparent strike and dip

STRIKE AND DIP OF FOLIATION IN FLOW-BANDED ROCKS OR COMPACTION FOLIATION IN WELDED TUFFS
- Inclined
- Vertical
- Apparent strike and dip

CALDERA WALL – Hachured where topographic wall is exposed and has been mapped in detail; stippled where topographic or structural wall is approximately located

ADIT

TRENCH

PROSPECT PIT

MINE SHAFT

DDH DIAMOND DRILL HOLE

SA-3.4 ISOTOPIC-AGE SAMPLE LOCALITY – Showing map number

VOLCANIC CENTER

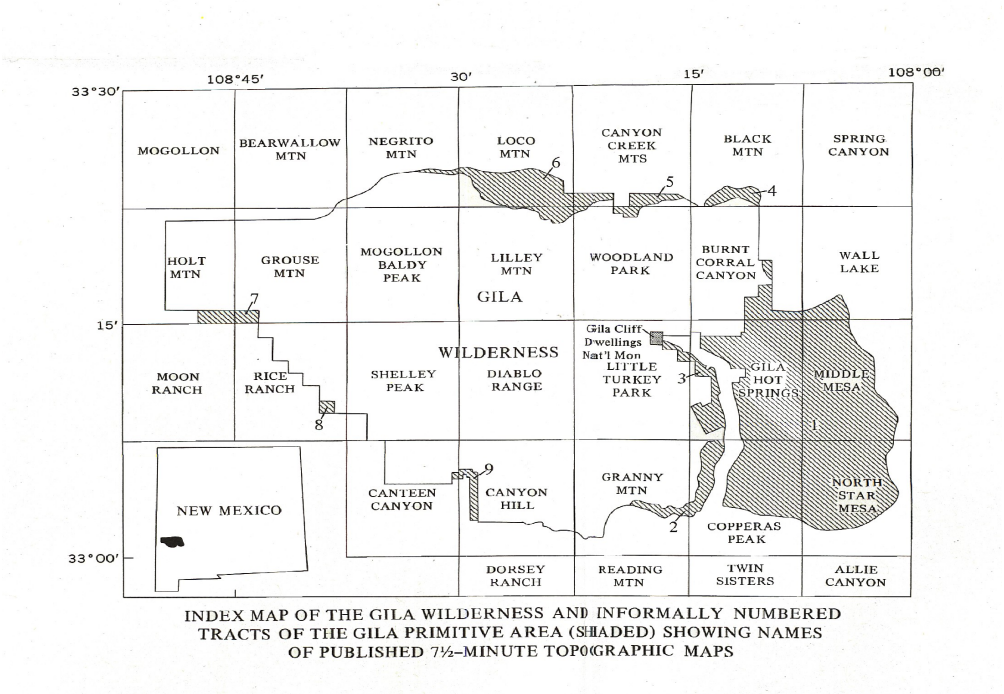
ts THERMAL SPRING

AREA OF HYDROTHERMALLY ALTERED ROCK

VEINS
- F Fluorite vein – Dashed where approximately located
- Q Quartz vein
- Meerschaum vein

Graphic from source map: Gila Wilderness Study Area (Reconnaissance Geologic Map)

Index map of the Gila Wilderness Area



INDEX MAP OF THE GILA WILDERNESS AND INFORMALLY NUMBERED TRACTS OF THE GILA PRIMITIVE AREA (SHADED) SHOWING NAMES OF PUBLISHED 7½-MINUTE TOPOGRAPHIC MAPS

Graphic from source map: Gila Wilderness Study Area (Reconnaissance Geologic Map)

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References from source map: Gila Wilderness Study Area (Reconnaissance Geologic Map)

GRI Digital Data Credits

This document was developed and completed by Jim Chappell (Colorado State University) for the NPS Geologic Resources Division (GRD) Geologic Resources Inventory (GRI) Program. Quality control of this document by Suzanne McKetta (Colorado State University).

The information in this document was compiled from GRI source maps, and is intended to accompany the digital geologic-GIS maps and other digital data for Gila Cliff Dwellings National Monument, New Mexico (GICL) developed by Jim Chappell (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).

Legacy data associated with this project was produced by Jim Chappell, Max Jackl, Ian Hageman, and Ron Karpilo.

GRI finalization by Jim Chappell (Colorado State University).

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