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

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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: 8/11/2014

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.

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

For information about the status of GRI digital geologic-GIS data for a park contact:

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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 maps for Gila Cliff Dwellings National Monument, New Mexico (GICL):

Geologic Map of Gila Cliff Dwellings National Monument and Vicinity, New Mexico

Note: This map provides the most geologic detail for the Gila Cliff Dwellings National Monument area and the Gila Hot Springs 7.5' Quadrangle. At the time that this dataset was produced, the source map below had not been formally published by the U.S. Geological Survey.

Ratte, 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, Open File Report OFR-2014-1036, 1:24,000 scale. (Gila Hot Springs 7.5' Quadrangle). (*GRI Source Map ID* 75624).

Reconnaissance Geologic Map of the Gila Wilderness Study Area, southwestern New Mexico

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 (Geologic Map of Gila Cliff Dwellings National Monument and Vicinity, New Mexico).

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

> *This source publication is divided into eastern and western mapped areas. Only the eastern area was digitized for the GRI digital geologic-GIS map. As a result, some features and geologic units from the source publication may not be included in the GRI data*.

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

GRI Digital Geologic Map of Gila Cliff Dwellings National Monument

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. No description for water is provided. Information about each geologic unit is also presented in the Geologic Unit Information (UNIT) table included with the GRI geology-GIS data.

Geologic Map Units

QUATERNARY

Holocene

- **Qa** - Alluvium
- **Qf** - Alluvial fan deposit

Holocene and Pleistocene

- **Ql** - Landslide deposits
- **Qt** - Alluvial terrace deposits
  - **Qt1** - Highest perched terrace deposits
  - **Qt2** - Middle perched terrace deposits
  - **Qt3** - Lowest perched terrace deposits

Pleistocene and Oligocene

- **QTg** - Gila Conglomerate
  - **QTgps** - Gila Conglomerate, sandstone facies

TERTIARY

Oligocene

- **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
- **Tad** - Andesite dikes
- **Thd** - Andesite dikes, hornblende bearing
- **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
- **Tcu** - Lava flows and flow breccias
- **Taa** - Rhyolite of the Alum Mountain eruptive center

Map Unit Descriptions

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

Qa - Alluvium (Holocene)

Unconsolidated deposits of the floodplains of major streams. Maximum thickness is several meters. (*GRI Source Map ID 75624)* (Gila Hot Springs 7.5' Quadrangle).

Qf - Alluvial fan deposit (Holocene)

Unconsolidated deposits at the mouths of secondary streams and gullies. As much as several meters thick. (*GRI Source Map ID 75624)* (Gila Hot Springs 7.5' Quadrangle).

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. (*GRI Source Map ID 75624)* (Gila Hot Springs 7.5' Quadrangle).

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. (*GRI Source Map ID 75624)* (Gila Hot Springs 7.5' Quadrangle).

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

(*GRI Source Map ID 75624)* (Gila Hot Springs 7.5' Quadrangle).

Qt2 - Middle perched terrace deposits (Pleistocene)

(*GRI Source Map ID 75624)* (Gila Hot Springs 7.5' Quadrangle).

Qt3 - Lowest perched terrace deposits (Pleistocene)

(*GRI Source Map ID 75624)* (Gila Hot Springs 7.5' Quadrangle).

QTg- Gila Conglomerate (Oligocene to 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. (*GRI Source Map ID 75624)* (Gila Hot Springs 7.5' Quadrangle).

QTgps - Gila Conglomerate, sandstone facies (Miocene to Oligocene)

Laminated cross-bedded, pumiceous sandstone deposits, as much as 100ft (about 30 m) thick. (*GRI Source Map ID 75624)* (Gila Hot Springs 7.5' Quadrangle).

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. (*GRI Source Map ID 75624)* (Gila Hot Springs 7.5' Quadrangle).

Tav - Volcaniclastic rocks of Adobe Canyon (Oligocene to Miocene)

Orangey-brown, locally pumiceous sandstone. Along the Middle Fork Gila River; 0 to 100 ft (30 m) thick. (*GRI Source Map ID 75624)* (Gila Hot Springs 7.5' Quadrangle).

Tba - Bearwallow Mountain Andesite (Oligocene to Miocene)

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). (*GRI Source Map ID 75624)* (Gila Hot Springs 7.5' Quadrangle).

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. (*GRI Source Map ID 75624)* (Gila Hot Springs 7.5' Quadrangle).

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). (*GRI Source Map ID 75624)* (Gila Hot Springs 7.5' Quadrangle).

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. (*GRI Source Map ID 75624)* (Gila Hot Springs 7.5' Quadrangle).

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.

(*GRI Source Map ID 75624)* (Gila Hot Springs 7.5' Quadrangle).

Tad - Andesite dikes (Oligocene?)

Occur mainly in the vicinity of Alum Mountain along both sides of the Gila River. Their ages relative to the Bearwallow Mountain Andesite and the older Copperas Creek volcanic complex is uncertain. A few meters to several meters thick. (*GRI Source Map ID 75624)* (Gila Hot Springs 7.5' Quadrangle).

Thd - Andesite dikes, hornblende bearing (Oligocene?)

Occur mainly in the vicinity of Alum Mountain along both sides of the Gila River. Their ages relative to the Bearwallow Mountain Andesite and the older Copperas Creek volcanic complex is uncertain. A few meters to several meters thick. (*GRI Source Map ID 75624)* (Gila Hot Springs 7.5' Quadrangle).

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. (*GRI Source Map ID 75624)* (Gila Hot Springs 7.5' Quadrangle).

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. (*GRI Source Map ID 75624)* (Gila Hot Springs 7.5' Quadrangle).

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

Two basaltic lava flows, each a few meters thick, are interlayered with the basal part of the sandstone member (Tgfss). (*GRI Source Map ID 75624)* (Gila Hot Springs 7.5' Quadrangle).

Tcu - Lava flows and flow breccias (Oligocene)

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

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. (*GRI Source Map ID 75624)* (Gila Hot Springs 7.5' Quadrangle).

GRI Digital Reconnaissance Geologic 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., Qa - Alluvium). Units are listed from youngest to oldest. No description for water is provided. Information about each geologic unit is also presented in the Geologic Unit Information (UNIT) table included with the GRI geology-GIS data.

Geologic Map Units

QUATERNARY

Holocene

Qag - Valley alluvium and terrace gravels

Holocene and Pleistocene

Qls - Landslide deposits

Holocene - Miocene

QTv - Meerschaum vein

QTs - Sedimentary rocks

TERTIARY

Pliocene

Tb - Alkali Olivine Basalt Flows

Miocene

Tya - Younger andesitic and latitic lava flows

Tps - Rhyolitic pyroclastic and volcaniclastic rocks

Tri - Rhyolite flows of Indian Creek

Trb - Rhyolite flows of Beaver Creek

Trr - Rhyolite flows of Rocky Canyon

Tad - Dikes of intermediate or mafic composition

Tr - Rhyolite dikes

Tpy - Rhyolitic pyroclastic and volcaniclastic rocks

Try - Younger rhyolite flows and domes

Tmf - Bedded volcaniclasitc deposits

Tcb - Breccia of Bloodgood Canyon Rhyolite Tuff

Tmc - Mineral Creek Andesite

Miocene and/or Oligocene

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 Diablo Range Rhyolite

Trw - Welded tuff facies of the Diablo Range Rhyolite

Tmh - Andesitic flows and breccias of Murtocks Hole

Tmhst - Discontinuous tuff layer within unit Tmh

Tvu - Tertiary volcanic rocks, undivided

Tsp - Shelley Peak Tuff

Tdc - Tuff of Davis Canyon

Tfc - Tuff of Fall Canyon

Tvb - Volcanic Complex of Brock Canyon

Tgf - Latitic and andesitic lava flows of Gila Flat
Tvi - Rhyolitic dikes and sills
Tva - Andesitic flows and breccias, pyroclastic and volcaniclastic rocks
Trc - Ash-flow tuffs of Rocky Canyon
Trs - Sedimentary rocks
Ttc - Andesitic flows and breccias of Turkey Cienega Canyon

PERMIAN
Pennsylvanian
PNs - Syrena Formation

Map Unit Descriptions

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

Qag - Valley alluvium and terrace gravels (Holocene)

No additional description provided with source map. (*GRI Source Map ID 3077)* (I-886).

Qls - Landslide deposits (Holocene and/or Pleistocene)

May be older and (or) younger than Pleistocene. (*GRI Source Map ID 3077)* (I-886).

QTv - Meerschaum vein (Holocene(?) and/or Pleistocene(?) and/or Pliocene(?) and/or Miocene(?))

Displayed as a linear feature on source map. Exact composition and age of vein is not certain. (*GRI Source Map ID 3077)* (I-886).

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. (*GRI Source Map ID 3077)* (I-886).

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. (*GRI Source Map ID 3077)* (I-886).

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). (*GRI Source Map ID 3077)* (I-886).

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). (*GRI Source Map ID 3077)* (I-886).

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. (*GRI Source Map ID 3077)* (I-886).

Trb - Rhyolite flows of Beaver Creek (Miocene)

Tin-bearing flow-banded lithophysal rhyolite in northeastern part of study area. (*GRI Source Map ID 3077)* (I-886).

Trr - Rhyolite flows of Rocky Canyon (Miocence)

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. (*GRI Source Map ID 3077)* (I-886).

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

Intermediate or mafic composition. (*GRI Source Map ID 3077)* (I-886).

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). (*GRI Source Map ID 3077)* (I-886).

Tpy - Rhyolitic pyroclastic and volcaniclastic rocks (Miocene?)

Interlayered with the younger rhyolite flows and domes (Try); mainly within the Bursum caldera. (*GRI Source Map ID 3077)* (I-886).

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. (*GRI Source Map ID 3077)* (I-886).

Tmf - Bedded volcaniclasitc deposits (Miocene?)

Rocks that locally fill the moat between the Bursum caldera wall and its interior resurgent dome. (*GRI Source Map ID 3077)* (I-886).

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. (*GRI Source Map ID 3077)* (I-886).

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. (*GRI Source Map ID 3077)* (I-886).

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. (*GRI Source Map ID 3077)* (I-886).

Tbc - Bloodgood Canyon Rhyolite Tuff of Elston (1968) (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. (*GRI Source Map ID 3077)* (I-886).

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. (*GRI Source Map ID 3077)* (I-886).

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). (*GRI Source Map ID 3077)* (I-886).

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

Mainly a pyroclastic or volcaniclastic facies of the rhyolite of the Diablo Range (Trd). (*GRI Source Map ID 3077)* (I-886).

Trw - Welded tuff facies of the Diablo Range Rhyolite (Oligoocene?)

Virtually identical mineralogically to Bloodgood Canyon Rhyolite Tuff (Tbc); correlation therefore is uncertain. (*GRI Source Map ID 3077)* (I-886).

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. (*GRI Source Map ID 3077)* (I-886).

Tmhst - 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). (*GRI Source Map ID 3077)* (I-886).

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. (*GRI*

Source Map ID 3077) (I-886).

Tsp - Shelley Peak Tuff (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. (*GRI Source Map ID 3077)* (I-886).

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). (*GRI Source Map ID 3077)* (I-886).

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). (*GRI Source Map ID 3077)* (I-886).

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. (*GRI Source Map ID 3077)* (I-886).

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). (*GRI Source Map ID 3077)* (I-886).

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). (*GRI Source Map ID 3077)* (I-886).

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. (*GRI Source Map ID 3077)* (I-886).

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). (*GRI Source Map ID 3077)* (I-886).

Trs - Sedimentary rocks (Oligocene)

Sediments mapped locally between the sheets of ash-flow tuffs of Rocky Canyon (Trc). (*GRI Source Map ID 3077)* (I-886).

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

Present only in southeast corner of mapped area. (*GRI Source Map ID 3077)* (I-886).

PNs - Syrena Formation (Upper Pennsylvanian)

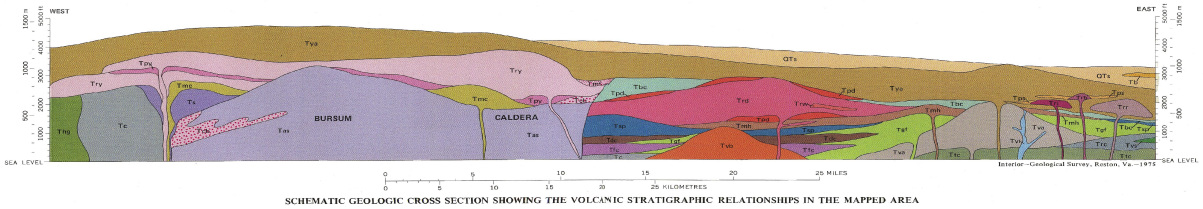
Limestone and some argillaceous beds. Present only in southeast corner of mapped area between Terry Canyon and Turkey Cienega Canyon. Outcrop configuration taken from a geologic map by Aldrich (1972). (*GRI Source Map ID 3077)* (I-886).

Geologic Cross Sections

The geologic cross section present in the GRI digital geologic-GIS data produced for Gila Cliff Dwellings National Monument, New Mexico (GICL) is presented below. Cross section graphics were scanned at a high resolution and can be viewed in more detail by zooming in (when viewing the digital format of this document). Colors and unit symbols might not exactly match those found in the GRI GIS data.

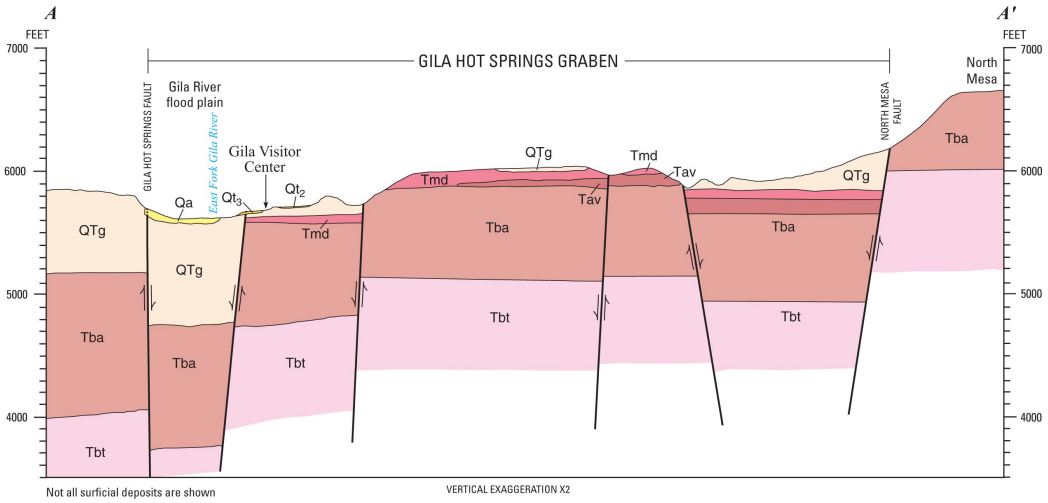
The absence of adequate exposed sections for measuring unit thickness, and the likelihood of irregular buried topography beneath volcanic units, make the cross-sections subject to interpretation.

Schematic Cross Section (Gila Wilderness Study Area)



Extracted from: GRI Source Map ID 3077 (Gila Wilderness Study Area). Cross Section West to East on source map.

A-A' (Gila Hot Springs 7.5' Quadrangle)

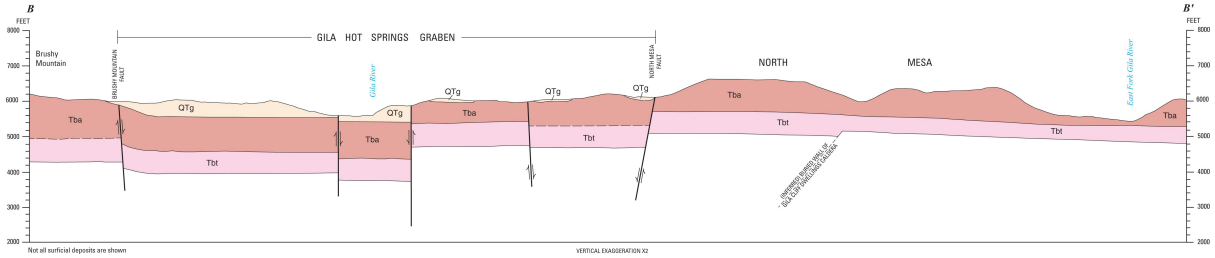


Section A-A' crosses the Gila Hot Springs graben, from the Gila River in the northeast part of the quadrangle, to North Mesa, passing through the Gila Cliff Dwellings National Monument Visitor Center. Rather than a single structure, this section could be thought of as a shallow graben adjacent to North 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. 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).

Extracted from: GRI Source Map ID 75624 (Gila Hot Springs 7.5' Quadrangle).

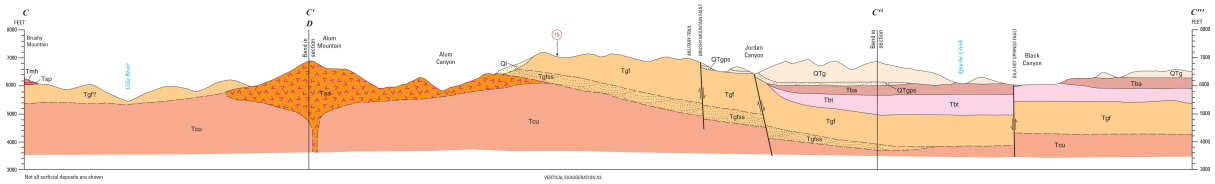
B-B' (Gila Hot Springs 7.5' Quadrangle)



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, which is recognized based mainly on the thickness of Bloodgood Canyon Tuff (Tbt) in the West Fork and Middle Fork Gila River drainages, with no bottom exposed, is somewhat of an enigma. 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).

Extracted from: GRI Source Map ID 75624 (Gila Hot Springs 7.5' Quadrangle).

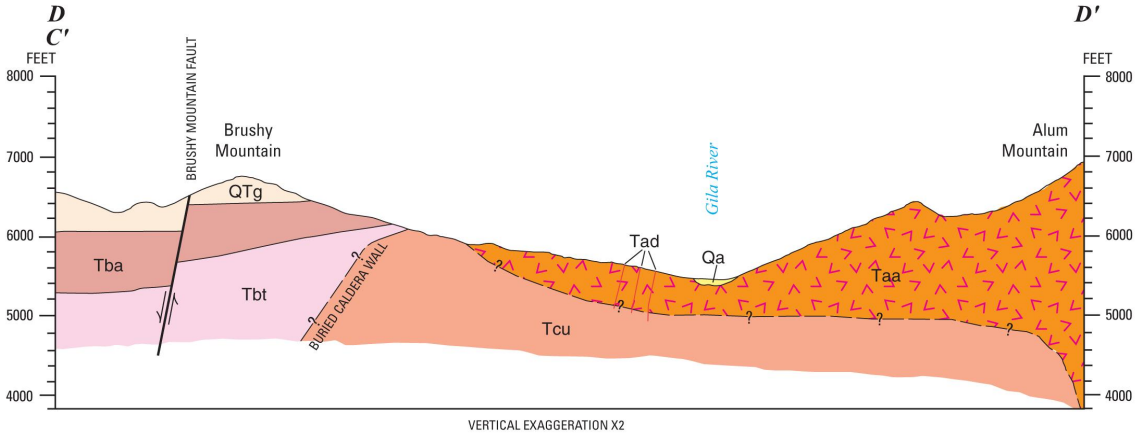
C-C''' (Gila Hot Springs 7.5' Quadrangle)



This section shows the relationship of the Alum Mountain eruptive center that intertongues with units of the Copperas Creek volcanic complex and correlative units. Note the landslide terrain on the flanks of Alum Mountain.

Extracted from: GRI Source Map ID 75624 (Gila Hot Springs 7.5' Quadrangle).

D-D' (Gila Hot Springs 7.5' Quadrangle)



This section shows the relationship of the Alum Mountain eruptive center that intertongues with units of the Copperas Creek volcanic complex and correlative units. Note the landslide terrain on the flanks of Alum Mountain.
Extracted from: GRI Source Map ID 75624 (Gila Hot Springs 7.5' Quadrangle).

GRI Source Map Information

Gila Hot Springs 7.5' Quadrangle

Ratte, 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, Open File Report OFR-2014-1036, 1:24,000 scale. (*GRI Source Map ID* 75624).

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 (Ratte, 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; Ratte 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.

Extracted from: GRI Source Map ID 75624 (Gila Hot Springs 7.5' Quadrangle).

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, that was prepared during an appraisal of the mineral resources of the Gila Wilderness (Ratte 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 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), and by a thick sequence of Bearwallow Mountain (Tba) andesitic to basaltic-andesite lava flows from nearby shield volcanoes, and finally by 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 section 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 Gila River. In the deepest part of the graben, along the Gila River between Gila Hot Springs and 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 up-river 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 clearly are older than most of the rocks mapped as overlapping the Copperas Creek volcanic complex.

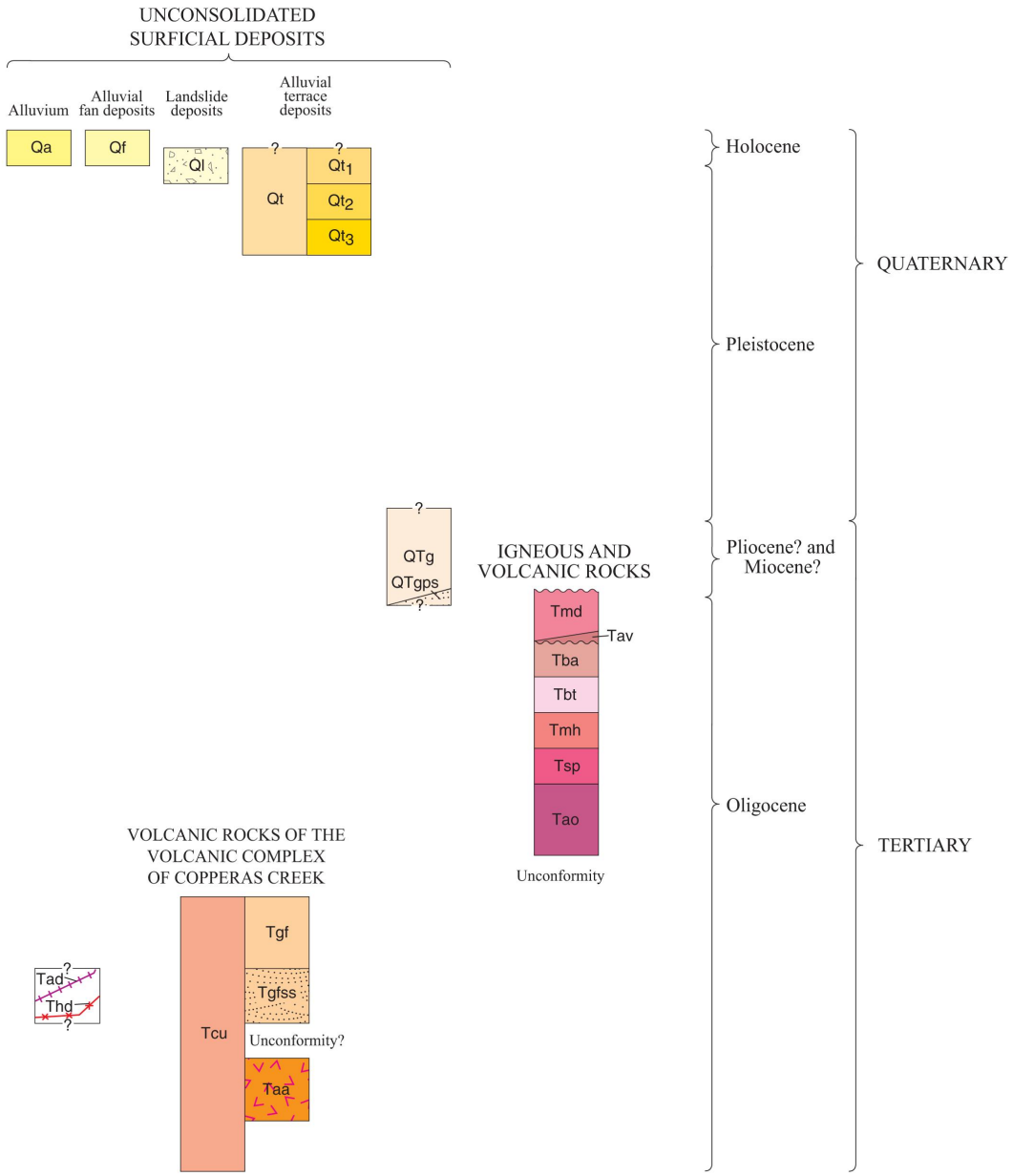
However, if future dating confirms that the 31.84 Ma Caballo Blanco Tuff (Tct) also laps onto the Gila Flat flows (Tgf) on the northeast flanks of Alum Mountain, as mapped here, then the rocks of the Copperas Creek volcanic complex must be somewhat older than the ages indicated in table 1.

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 (Ratte 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.

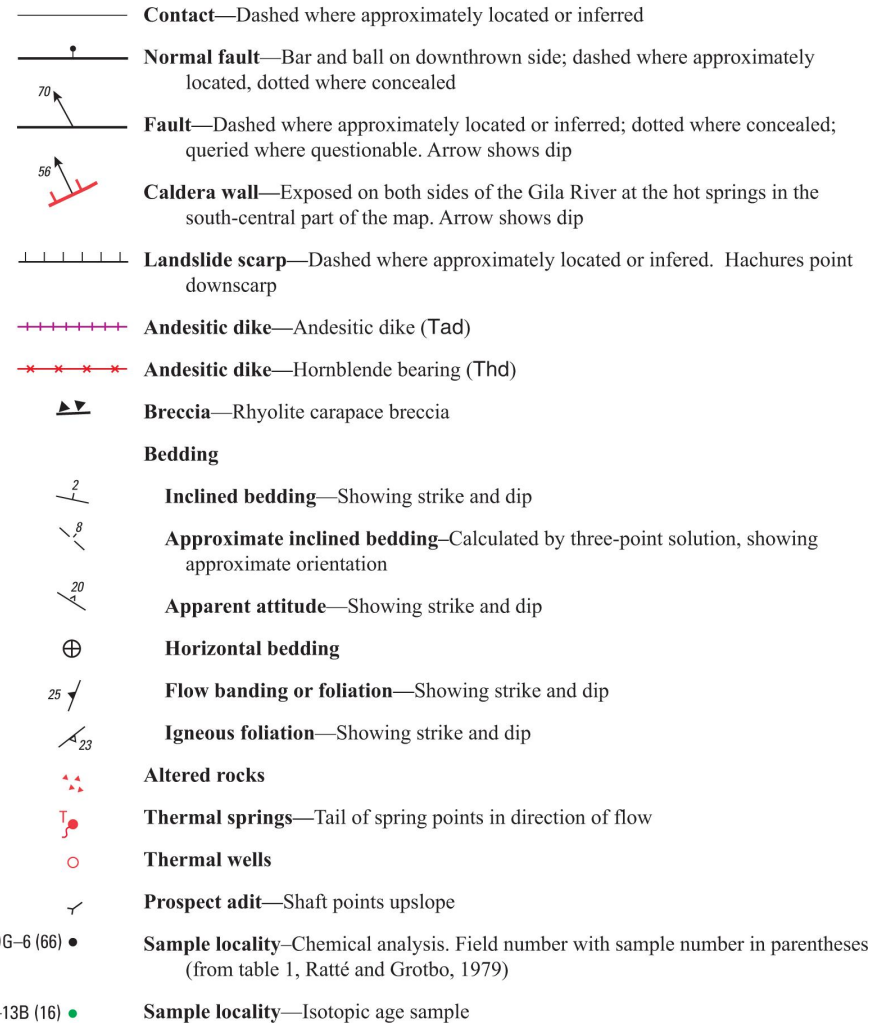
Extracted from: GRI Source Map ID 75624 (Gila Hot Springs 7.5' Quadrangle).

Correlation of Mapped Units



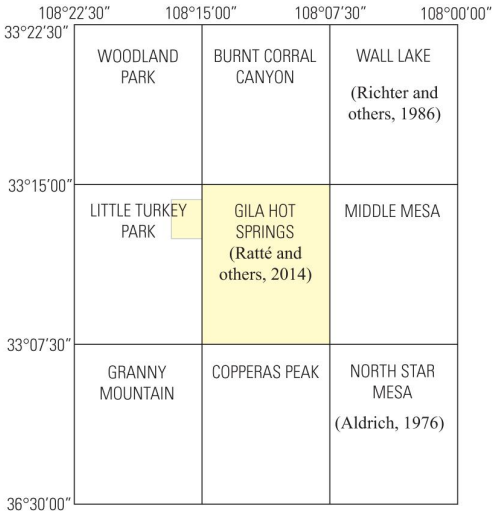
Extracted from: GRI Source Map ID 75624 (Gila Hot Springs 7.5' Quadrangle).

Legend



Extracted from: GRI Source Map ID 75624 (Gila Hot Springs 7.5' Quadrangle).

Quadrangle Index Map



Index map showing map area in yellow, and adjacent 7.5' quadrangles. Author and year of publication are shown for published geologic quadrangles.

Extracted from: GRI Source Map ID 75624 (Gila Hot Springs 7.5' Quadrangle).

Figure 1 - Index Map of National Monument Area

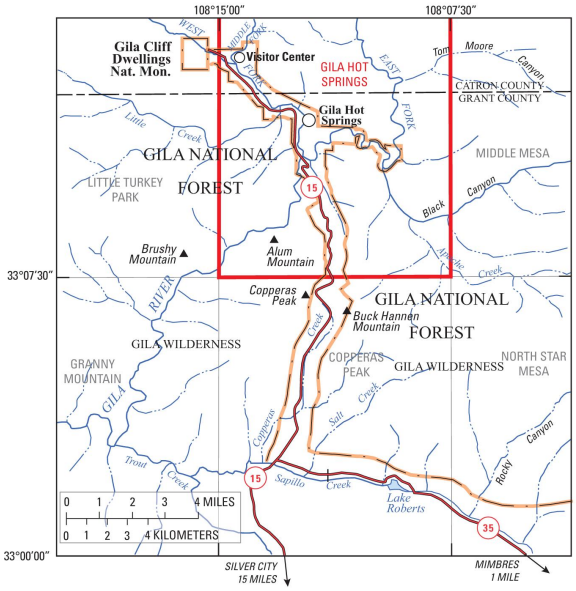


Figure 1. Index map of the Gila Hot Springs 7.5' quadrangle (red outline), and the Gila Cliff Dwellings National Monument area.

Extracted from: GRI Source Map ID 75624 (Gila Hot Springs 7.5' Quadrangle).

Figure 2 - Aerial oblique view of Gila Hot Springs Graben



Figure 2. Oblique view looking southeast, down the Gila River and Gila Hot Springs graben. North Mesa fault marks the northeast side of 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.

Extracted from: GRI Source Map ID 75624 (Gila Hot Springs 7.5' Quadrangle).

Figure 3 - Geologic map of the Gila Wilderness Area

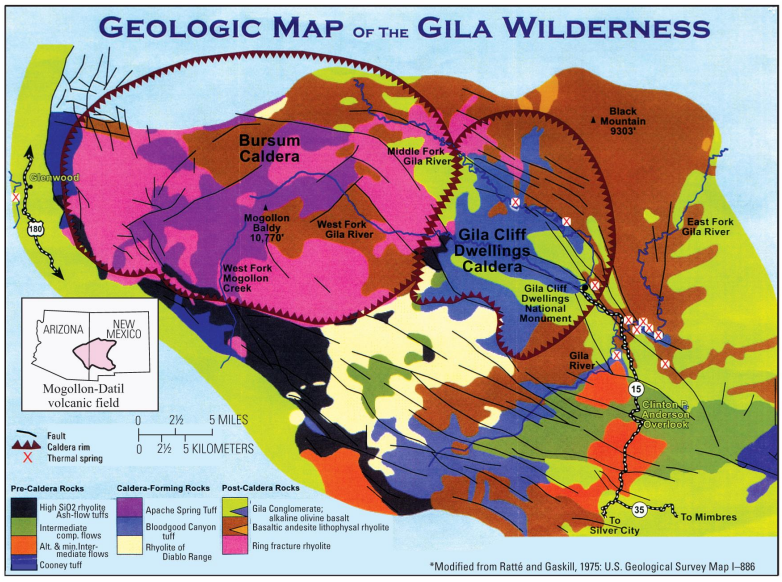


Figure 3. Geologic map of the Gila Wilderness Area, modified from Ratté and Gaskill, 1975.

Extracted from: GRI Source Map ID 75624 (Gila Hot Springs 7.5' Quadrangle).

Table 1 - Radiometric Age Dates

Table 1. *Radiometric ages of the rocks of the volcanic complex of Copperas Creek.*
[Only sample GR–13B (16) is from the Gila Hot Springs quadrangle. The other three 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

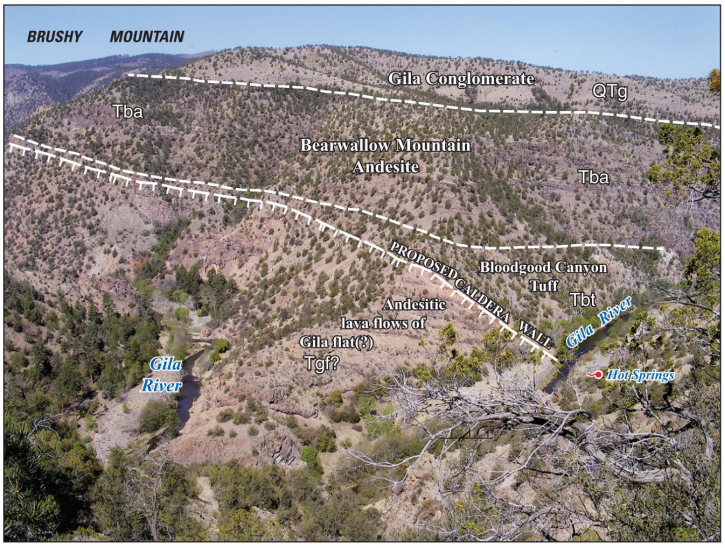
[1]W.C. McIntosh, New Mexico Bureau of Mines and Mineral Resources, personal commun., 2010.
[2]Marvin and others, 1987 (table 1, entry no. 98, 99)

Extracted from: GRI Source Map ID 75624 (Gila Hot Springs 7.5' Quadrangle).

Photographs



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.



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), and by a thick sequence of Bearwallow Mountain (Tba) andesitic to basaltic-andesite lava flows from nearby shield volcanoes, and finally by 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.



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.



Contact between the Gila Conglomerate (QTg) and Bearwallow Mountain Andesite (Tba) west of the bridge over the Gila River to the Visitor Center. 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.



Large clasts in Gila Conglomerate.



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

Extracted from: GRI Source Map ID 75624 (Gila Hot Springs 7.5' Quadrangle).

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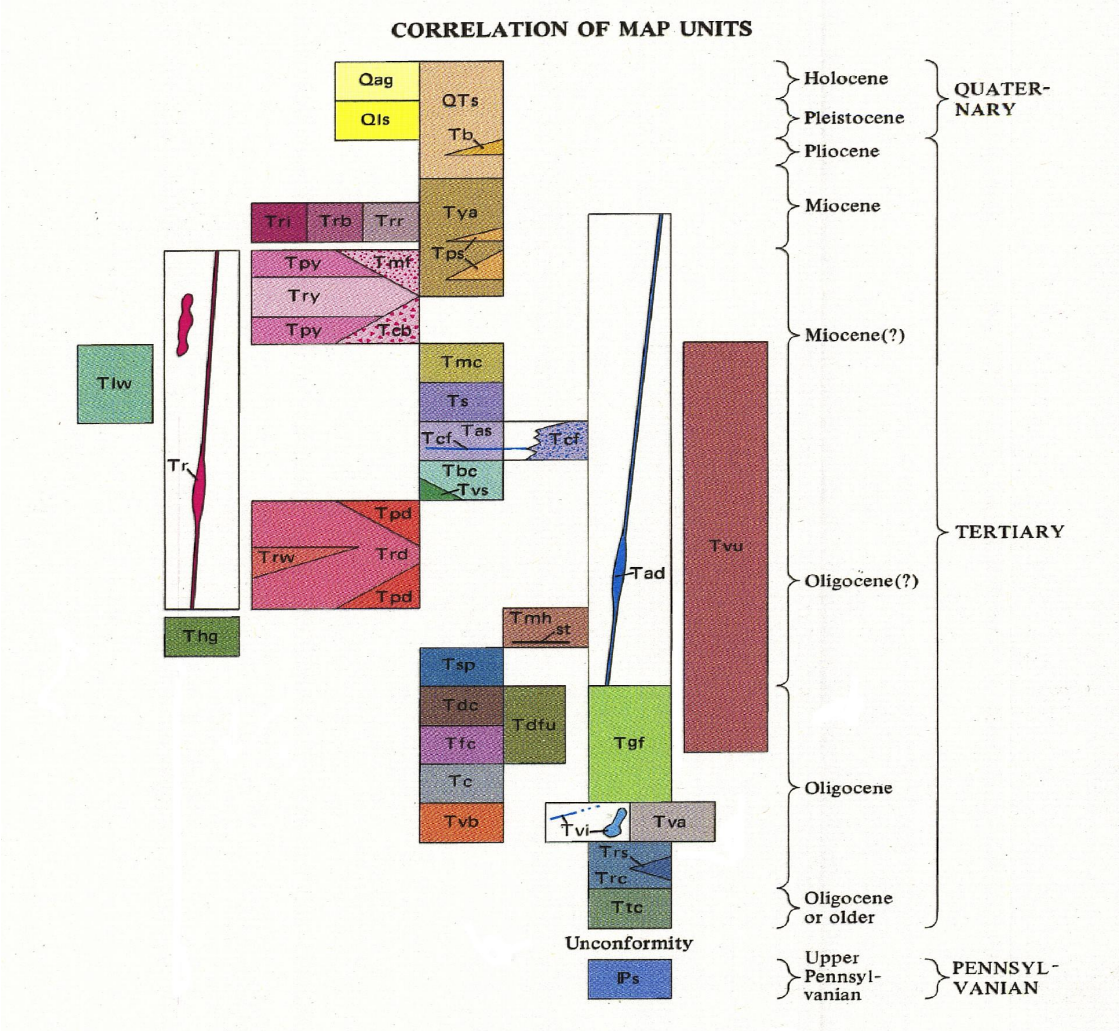
Extracted from: GRI Source Map ID 75624 (Gila Hot Springs 7.5' Quadrangle).

Reconnaissance Geologic Map of the Gila Wilderness Study Area

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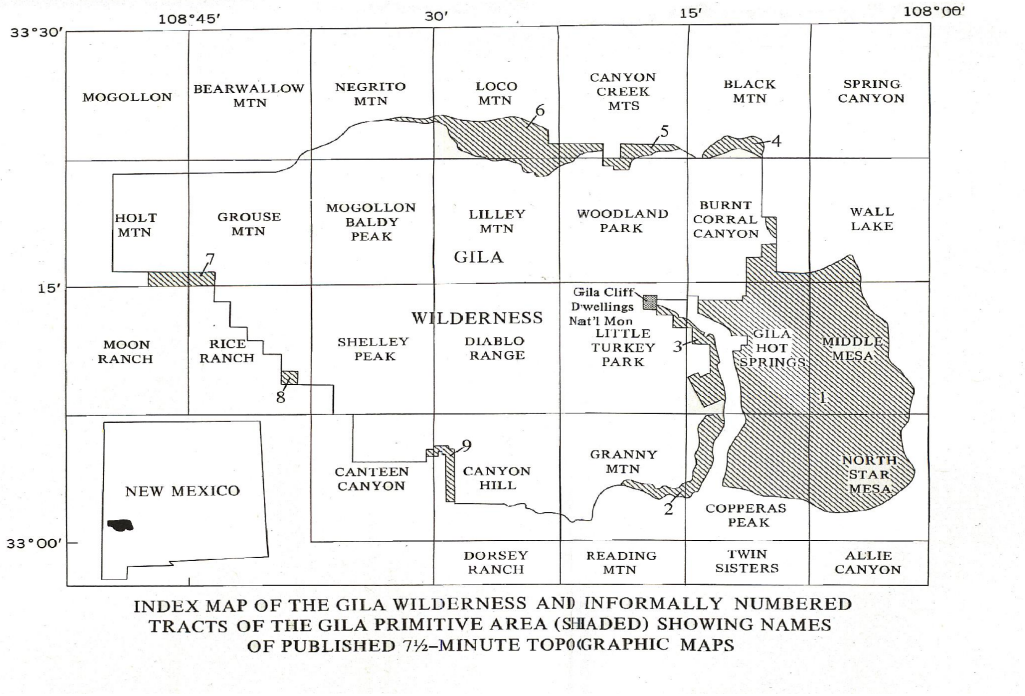
** The source publication is divided into eastern and western mapped areas. Only the eastern area was digitized for the GRI digital geologic-GIS map.

Correlation of Mapped Units



Extracted from: GRI Source Map ID 3077 (Gila Wilderness Study Area).

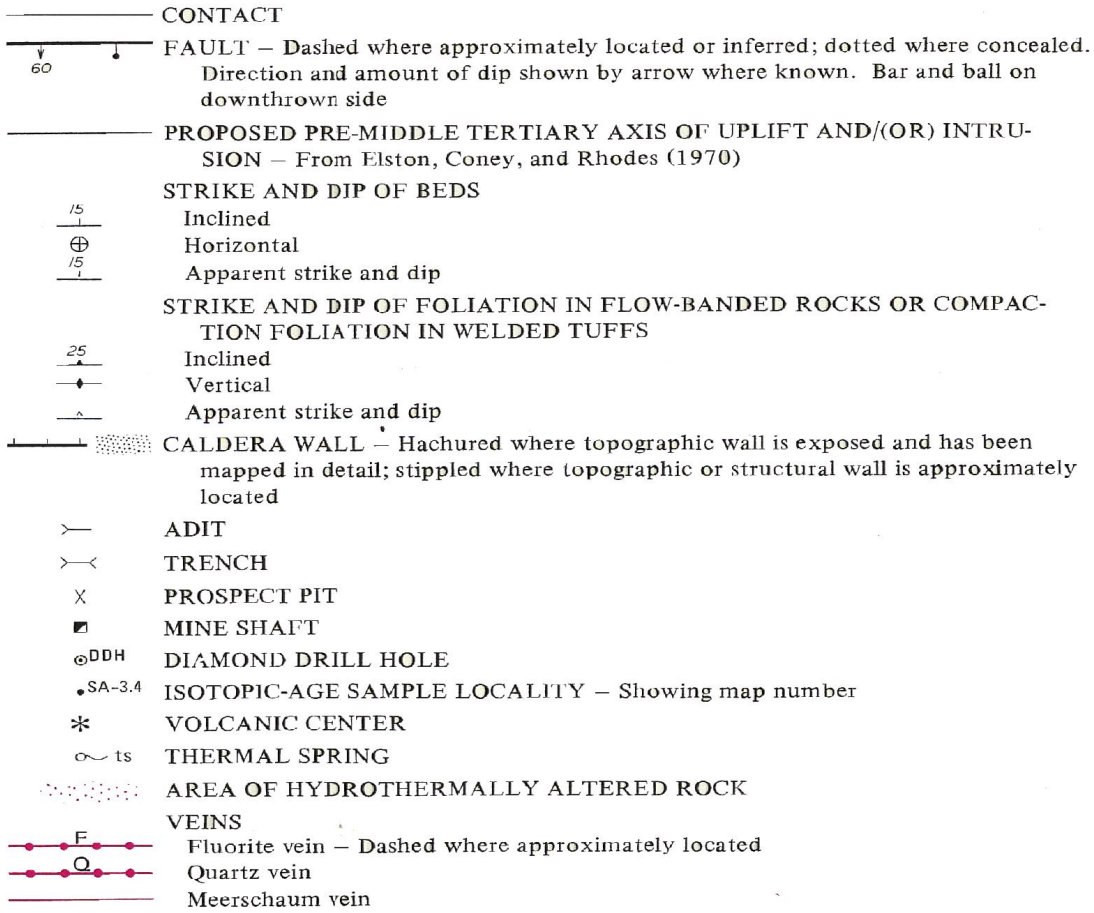
Index Map of the Gila Wilderness



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

Extracted from: GRI Source Map ID 3077 (Gila Wilderness Study Area).

Legend



Extracted from: GRI Source Map ID 3077 (Gila Wilderness Study Area).

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Extracted from: GRI Source Map ID 3077 (Gila Wilderness Study Area).

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The information contained here was compiled to accompany the digital geologic-GIS map(s) and other digital data for Gila Cliff Dwellings National Monument, New Mexico (GICL) developed by Max Jackl, Ian Hageman and James Chappell (Colorado State University) using source data (see the GRI Source Map Citations section of this document for all sources used by the GRI in the completion of this map).

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