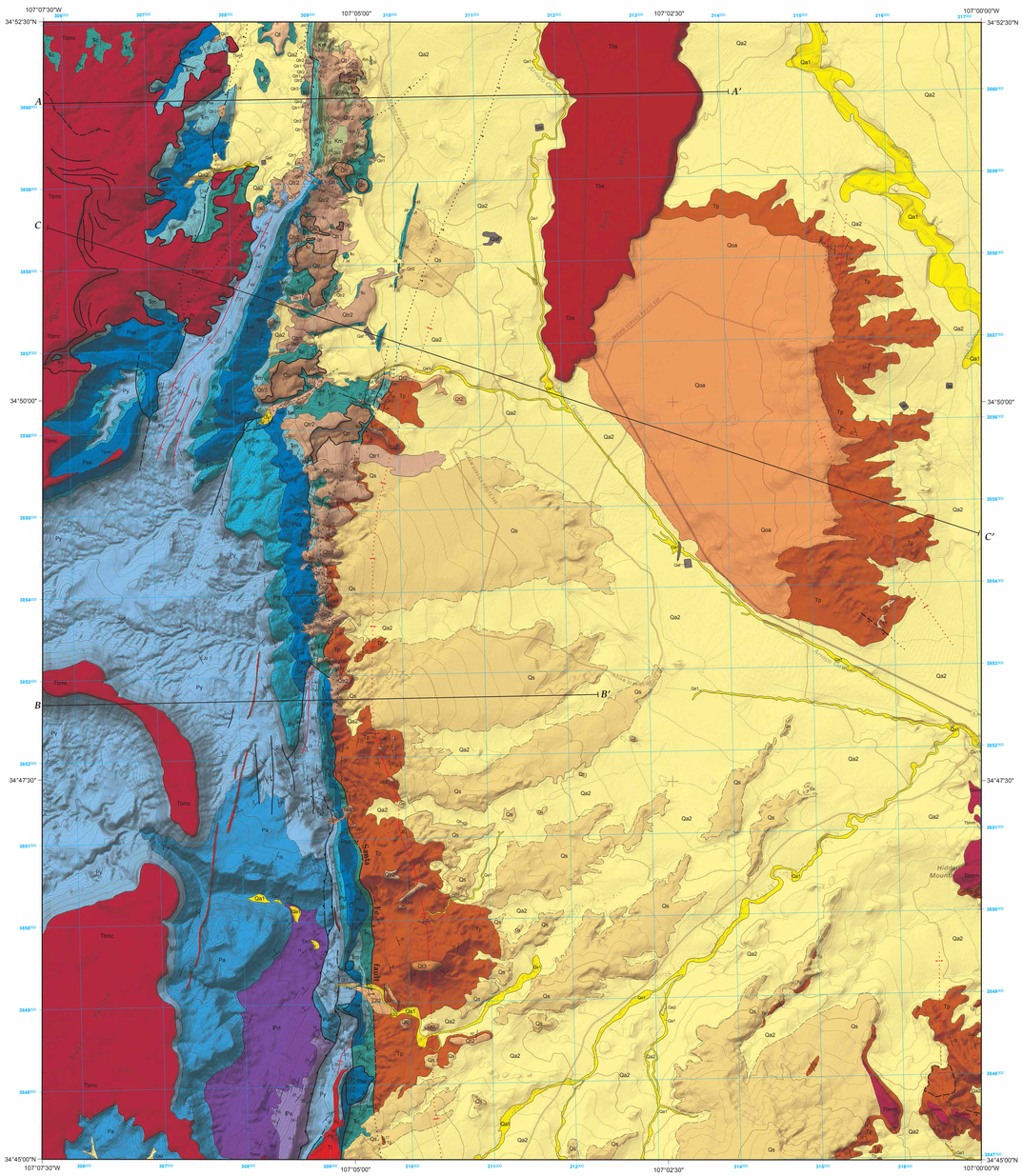


View looking north towards Carrizo Arroyo of the Lucero monocline. Flat-lying Pennsylvanian Atrasado (**Pa**) and Red Tanks (**Prt**) Formations are exposed in the valley to the west, and are capped by Permian Abo (**Pa**) and Yeso (**Py**) Formations. The Mesa Carrizo basalt flow (**Tbmc**) caps Yeso Formation in the background. The steeply-dipping eastern limb of the monocline is made up of Permian Glorieta (**Pg**) and San Andres (**Psa**) Formations. The Albuquerque basin is to the east.

Map Unit Descriptions

Quaternary

Qaf **Artificial fill**

Qa1 **Youngest stream alluvium (Historic to Holocene)** — Unconsolidated deposits of silt, sand, and gravel in intermittent stream channels draining the Lucero uplift to the east and within the Rio Puerco to the west. Gravel consists of locally-derived clasts of sandstone and limestone derived from the underlying Paleozoic stratigraphy, chert from the Chinle Formation, basalt, and travertine.

Qa2 **Older colluvium, alluvium between active channels, and minor eolian sand (Holocene to upper Pleistocene)** — Unconsolidated, well-sorted, fine-grained sand and minor silt. Up to 5 m thick.

Qoa **Older alluvial deposits, calcic soils, and eolian cover of piedmont areas (upper Pleistocene).**

Qs **Deposits associated with elevated geomorphic surfaces (upper Pleistocene)** — Unlithified to moderately lithified, poorly sorted sand and gravel with minor silt and clay. Clasts are angular and locally derived, and include travertine, basalt, limestone, and sandstone. Deposits occur at several levels above **Qa2**. Generally 1-3 m thick.

Qt **Qtr3** **Qtr2** **Qtr1** **Terraces (Pleistocene)** — Well-cemented, poorly sorted, clast to matrix supported, angular to sub-angular conglomeratic deposits situated above **Qa2**. Gravels are pebble- to-cobble-sized clasts of sandstone, limestone, and basalt that are sometimes cemented with thin rims of travertine or cemented with thicker (>3 cm to several meters) accumulations of flowstone travertine. Terraces occur at several levels, where **Qt1** is the lowest and relatively youngest deposit, and **Qt3** is the highest and relatively oldest deposit (Kolomaznik et al., 2013).

Qtr **Qtr1** **Qtr2** **Qtr3** **Travertine (Pleistocene)** — Terrace deposits consisting of banded travertine and/or sandstone to pebble-cobble conglomerate which is well-cemented with travertine. Banded travertine shows flowstone morphologies with typically well-preserved dam and spillover geometry. Sandstone and pebble-cobble conglomerate is composed of locally derived sandstone and limestone clasts from the Paleozoic section, and minor basalt. Clasts are typically coated with thin (~1-3 mm) travertine rinds. East of the Santa Fe fault, travertine deposits are typically flat-lying and elevated above modern drainages. West of the Santa Fe fault the travertine deposits mantle the topography and slope towards the east. Different travertine terrace heights are observed. **Qtr1** consists of recently-precipitated to actively-precipitating travertine in drainages with active springs. These deposits are typically associated with salt deposits. Higher order travertine terraces correspond to higher relative elevations in the local drainage.

Neogene

Tbmc **Suwanee basalt flow (Pliocene)** — Basalt flow which follows the modern Rio San Jose drainage system. It has a reported K-Ar age of 0.32 ± 0.2 Ma (Bachman and Mehnert, 1978).

Tbmm **Mesa Carrizo basalt flow (Pliocene)** — Dark-gray basalt with euhedral plagioclase and olivine and minor clinopyroxene and opaque minerals (Zilinski, 1976). K-Ar age of 3.7 ± 0.4 Ma (Bachman and Mehnert, 1978).

Tbs **Basalt of Mohinas Mountain (Miocene)** — Black to dark-gray, dense basalt and olivine diabase. Occurs as cone sheet within mountain and as sills and dikes around mountain (Lozinsky and Tedford, 1991). To the north of Mohinas Mountain at Hidden Mountain, Baldridge et al. (1987) report a basalt K-Ar age of 8.2 ± 02 Ma.

Ts **Popotosa Formation of the Santa Fe Group (Miocene)** — Poorly to well-indurated, poorly sorted, brown to reddish-brown, fine- to very coarse grained sand, conglomeratic sand, silty sand, clayey sand, and conglomerate. Locally cross bedded. Clasts are angular to subrounded and include ash-flow tuff, calcareous shale, basalt, limestone, quartz, granite, and quartzite (Lozinsky and Tedford, 1991).

Paleogene

Tp **Intrusive complex (Oligocene)** — An intrusive suite of rocks, located mainly in the southern region of the map area, intrudes into the Comanche monocline, generally following the NS-trending fabric. In the south, the intrusive rocks form a stock, while to the north these rocks are exposed as NS- to NE-SW-trending dikes that cross-cut the Paleozoic rocks. Petrologically, the southern stock ranges from a biotite-rich olivine gabbro, to a microdiorite, to a biotite-rich diorite. These rocks are intruded by younger quartz monzonite (Callender and Zilinksi, 1976). A sample of biotite-rich diorite gives a biotite $^{39}Ar/^{40}Ar$ age of 27.51 ± 0.04 Ma, which was analyzed at the New Mexico Geochronology Research Laboratory at New Mexico Tech in Socorro, New Mexico. Sample location: 13S 308729 m E, 3846054 m N. Elevation 5809 ft.

Cretaceous

Km **Mancos Formation** — Dusky yellow to moderate olive brown mudstone, siltstone, and sandstone.

Kd **Dakota Formation** — Very pale-orange to grayish-orange, well-sorted, rounded to subrounded, medium to coarse-grained quartz arenite with some ~5-10 cm thick beds of granule conglomerate. Clasts in conglomerate are subrounded to angular quartz and feldspar ~1-2 mm in diameter. Quartz arenite displays trough cross-bedding. At the base of this unit is a distinctive 0.5-1 m thick matrix supported pebble conglomerate. Clasts are rounded to sub-angular quartzite and chert ~3-20 mm in diameter.

Jurassic

Jm **Morrison Formation** — Brushy Basin Member of the Morrison Formation which consists of grayish-yellow-green mudstone and siltstone with minor sandstone lenses. Sandstone is well-sorted, rounded to subrounded, medium-grained quartz arenite with ~5-10 cm high cross-beds.

Jb **Bluff Sandstone** — Well-sorted, rounded to subrounded, medium to coarse-grained, grayish-orange to dark-yellowish-orange quartz arenite. Contains ~1-2 m high cross-beds.

Jt **Todilto Formation** — Dark-gray, thinly bedded, fetid shale and limestone with intraformational folds, faults, and breccia.

Je **Entrada Formation** — Pale-yellow to grayish-yellow, medium-grained, well-sorted and well-cemented sandstone.

Triassic

Tic **Chinle Formation** —At the base of the Chinle Formation, ~1-5 m of pebble conglomerate containing subrounded to subangular clasts of quartzite, chert, quartz, and limestone of the Shinarump Member are exposed. Above the Shinarump Member the Chinle Formation consists of moderate reddish-brown to pale-purple or whitish-gray bentonitic mudstone and siltstone with minor medium- to coarse-grained sandstone beds. This unit contains the Ojo Huelos limestone, a ridge-forming limestone unit ~2-4 m thick.

Tem **Moenkopi Formation** —Well-sorted, fine-grained, moderate reddish-brown to dark reddish brown sandstone and siltsone. Composed mostly of thin (1-2 cm) beds that commonly display ripples.

Permian

Psa **San Andres Formation** — Contains multiple lithologies, including medium to light-gray nonfossiliferous limestone, grayish-white gypsum and argillaceous gypsum with gypsiferous shale and secondary selenite, and minor light-brown shale (Zilinski, 1976). The San Andres is commonly interbedded with the underlying Glorieta Formation, and the contact between the two is placed at the lowermost limestone bed.

Pg **Glorieta Formation** — Buff, medium-grained sandstone with hematite staining and cross-bedding (Zilinski, 1976).

Py **Yeso Formation** — The upper Yeso formation consists of interbedded, reddish-brown to orangeish-brown shale, siltstone, and sandstone with gray to white gypsum and limestone. The lower Yeso Formation is a reddish-brown, well-indurated, massively bedded, fine-grained, well-sorted sandstone with spotty reduction zones (Zilinski, 1976).

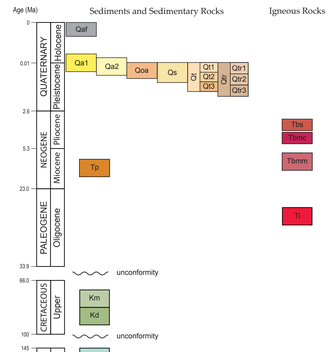
Pa **Abo Formation** — Deep-brown to reddish-brown siltstone and shale interbedded with ridge forming sandstone. The upper part is brown to light-reddish-brown, medium- to thick-bedded arkosic sandstone and siltstone with minor shale.

Pennsylvanian

IPrt **Red Tanks Formation** — Grayish-white to reddish-brown shale and sandstone interbedded with gray limestone and limestone-pebble conglomerate. The lower part of the Red Tanks consists of dark-red shale, siltstone, and sandstone, with minor buff sandstone and limestone conglomerate. The upper part consists of whitish-gray, thin-bedded, nodular limestone and gray shale (Kelley and Wood, 1946). Fossil assemblages in the Red Tanks Formation include fresh water plant-eurypterid-insect, brackish water bivalve, and marginal marine Myalina gastropod (Kues and Kietzke, 1976). Approximately 450 feet thick.

IPa **Atrasado Formation** — Ridge forming, gray limestone and cherty limestone, with minor light-gray to reddish-brown shale, sandstone and conglomerate (Zilinski, 1976).

Correlation Of Map Units

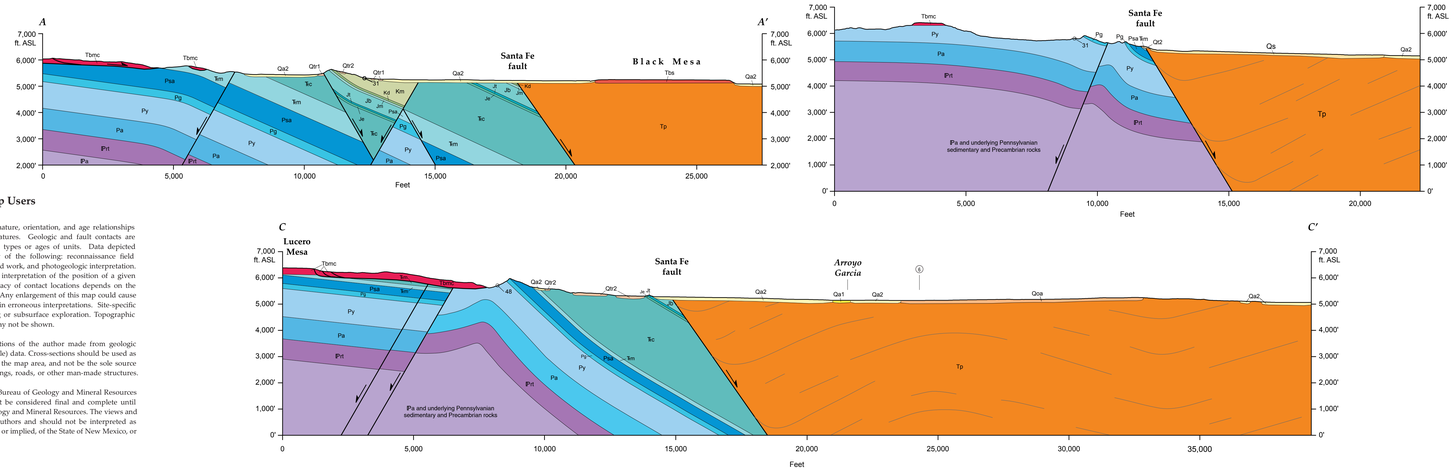


View looking south of the Santa Fe fault, separating Santa Fe Group (**Tsf**) rift fill on the east (left side of photo) from Triassic Chinle Formation (**Tic**) on the west. Perched travertine deposits (**Qtr2**) cover both the Chinle Formation and Santa Fe Group at this location.

Explanation of Map Symbols

- A — A′ Location of geologic cross section
- Geologic contact - certain, location accurate
- Geologic contact - certain, location approximate
- Geologic contact - certain, location concealed
- Fault - certain, location certain
- Fault - certain, location approximate
- Fault - certain, location concealed
- Normal fault - certain, location accurate, bar and ball on downthrown block, tick shows dip (52)
- Normal fault - certain, location approximate, bar and ball on downthrown block
- Normal fault - certain, location concealed, bar and ball on downthrown block
- Reverse fault - certain, location accurate, teeth on upthrown block
- Reverse fault - certain, location approximate, teeth on upthrown block
- Reverse fault - certain, location concealed, teeth on upthrown block
- Detachment fault - certain, location accurate, hachures on upthrown side
- Detachment fault - certain, location approximate, hachures on upthrown side
- Anticline - certain, location accurate
- Anticline - certain, location approximate
- Anticline - certain, location concealed
- Syncline - certain, location accurate
- Syncline - certain, location approximate
- Syncline - certain, location concealed
- Inclined bedding, showing strike and dip (18 others, 79 others)
- Overturned bedding, showing strike and dip

Geologic Cross Sections



Comments To Map Users

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

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

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

Base map from U.S. Geological Survey 2010.
North American Datum of 1983 (NAD83) World Geodetic System of 1984 (WGS84). Reprojected to NAD27.
Projection and 1000-meter grid: Universal Transverse Mercator, Zone 13S
10,000-foot ticks: New Mexico Coordinate System of 1927(west zone), shown in blue

Roads.....©2006-2010 Tele Atlas
Names.....GNIS, 2008
Hydrography.....National Hydrography Dataset, 2009
Contours.....National Elevation Dataset, 1999

QUADRANGLE LOCATION

New Mexico Bureau of Geology and Mineral Resources
New Mexico Tech
801 Leroy Place
Socorro, New Mexico
87801-4796

[575] 835-5490

This and other STATEMAP quadrangles are available for free download in both PDF and ArcGIS formats at:

http://geoinfo.nmt.edu

1:24,000

1 0.5 0 1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 0.5 0 1 KILOMETER

CONTOUR INTERVAL 20 FEET

NATIONAL GEODETIC VERTICAL DATUM OF 1988

DRAFT

New Mexico Bureau of Geology and Mineral Resources
Open-file Geologic Map 246

Mapping of this quadrangle was funded by a matching-funds grant from the STATEMAP program of the National Cooperative Geologic Mapping Act (Award Number: G13AC00186), administered by the U. S. Geological Survey, and by the New Mexico Bureau of Geology and Mineral Resources, (L. Greer Price, *Director and State Geologist*, Dr. J. Michael Timmons, *Geologic Mapping Program Manager*).

Geologic map of the South Garcia SE 7.5-minute quadrangle, Valencia County, New Mexico

June, 2014

by
Jason W. Ricketts[1], and Karl E. Karlstrom[1]

[1]*Dept. of Earth and Planetary Sciences, University of New Mexico, Albuquerque, NM 87131*