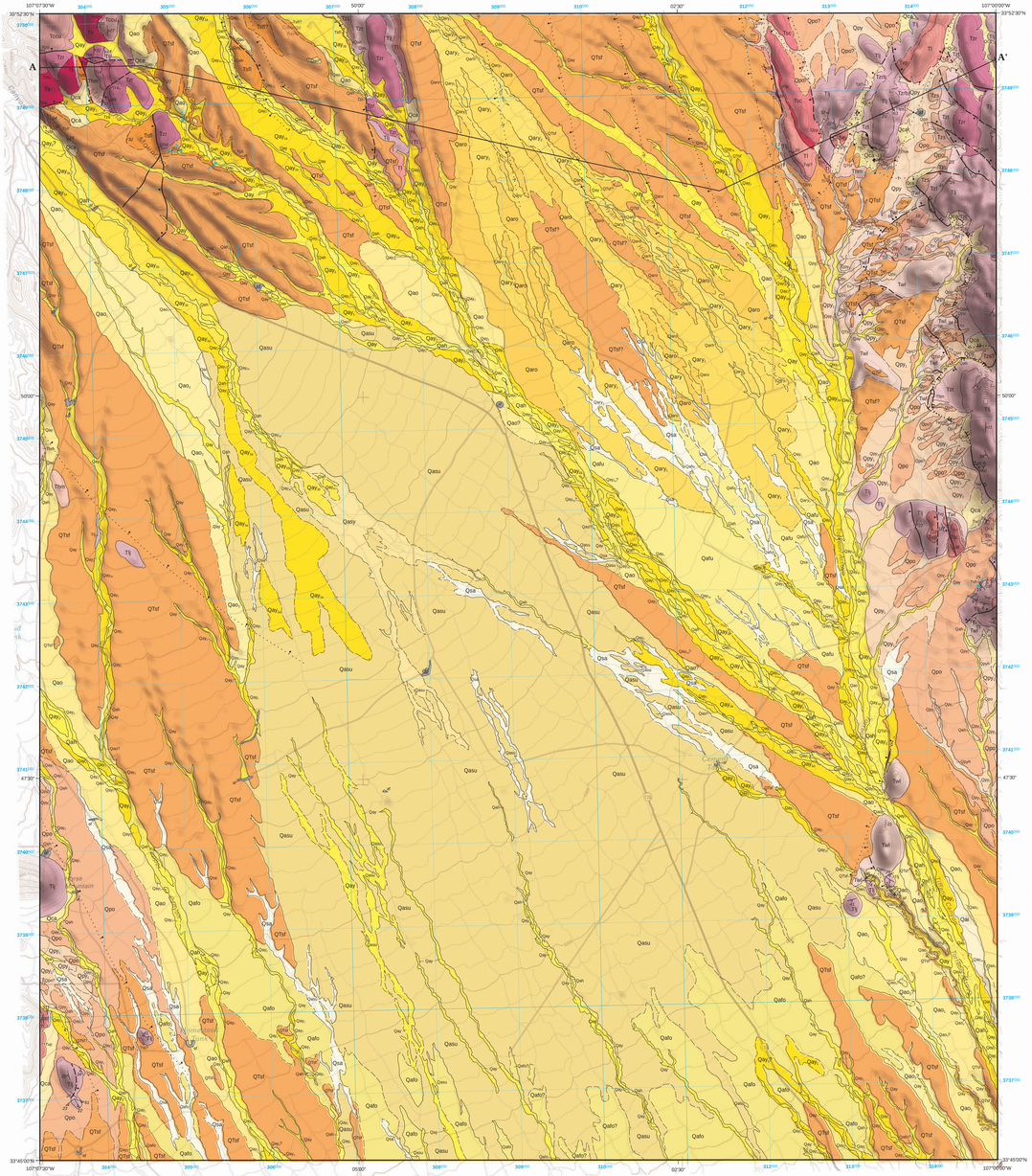
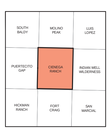


Base map from U.S. Geological Survey 1965, from photographs taken 1964. Field checked in 1965.
Polyconic projection. 1927 North American datum. Reprojected to UTM projection — zone 13.
1000-meter Universal Transverse Mercator grid, zone 13, shown in blue.



QUADRANGLE LOCATION

Magnetic Declination
August, 2012
9:12132° East
At Map Center

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 1929

New Mexico Bureau of Geology and Mineral Resources
Open-file Geologic Map 239

Mapping of this quadrangle was funded by a matching-funds grant from the STATEMAP program of the National Cooperative Geologic Mapping Act, 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, *Associate Director for Mapping Programs*).

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

http://geoinfo.nmt.edu

Geologic map of the Cienega Ranch quadrangle, Socorro County, New Mexico

June, 2013

by
Colin T. Cikoski [1], Susan J. Roth [2], and G. Robert Osburn [3]

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DESCRIPTION OF MAP UNITS

Anthropogenic Deposits

af — **Artificial fill** — Compacted sediments, mainly of earthen dams. 0-4 m thick.

Quaternary Colluvium and Slopewash

Qsa — **Slopewash and alluvium, undivided (Holocene)** — Fine sand and silt with lesser medium-coarse sand and rare pebbles occupying shallow, low gradient channels. Minimal to no soil development. 0-1(?) m thick.

Qca — **Colluvium and alluvium, undivided (upper Pleistocene to Holocene)** — Proximal deposits of silt to boulders. Only mapped where concealing underlying geologic relationships, or where thought to be particularly thick. 0-4(?) m thick.

Quaternary Alluvial Deposits

Note: All alluvial units typically fine to the south (away from the Magdalena and Chupadera Mountain sources), and soils typically grade from more carbonate/less clay in the southern, lower elevation areas to more clay/less carbonate in the northern, higher elevation areas.

Historic alluvium (subject to annual deposition) — Boulders to fine sand along active stream channels exhibiting evidence of historic transport, including no soil development, little vegetation cover, and surfaces with high small-scale relief. 0-3(?) m thick.

Qah — **Younger alluvium, undivided (upper Pleistocene to Holocene)** — Used to designate narrow, typically shallow drainages where Qay_1 and Qay_2 cannot be distinguished reliably, and cannot be mapped separately from Qah at the given map scale. Up to 2 m thick.

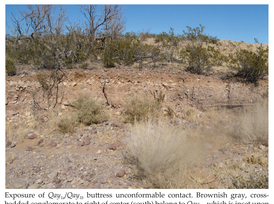
Qay — **Younger alluvium, younger subunit and historic alluvium, undivided (upper Holocene to Historic)** — Used where the two cannot be mapped separately at the given map scale.

Qay_{hy} — **Younger alluvium, younger subunit (Holocene)** — Pebbly sand to silt and sandy gravel with weak soil development. Gravel beds are typically poorly sorted pebbles with a few percent cobbles in massive matrix-rich beds. Fines are very fine to medium sands and silts, with colors of 7.5 YR 5/3-6/4 and 10 YR 6/4 measured. Carbonate horizon development up to Stage I+. Bar-and-swale topography typically apparent on terrace treads. 1-3 m thick.

Qay_1 — **Younger alluvium, older subunit (upper Pleistocene to Holocene)** — Used where Qay_{1y} and Qay_{1o} cannot be distinguished reliably, either due to the given map scale or to weak map unit indicators.

Qay_{1o} — **Younger alluvium, younger older subunit (upper Pleistocene to early Holocene)** — Cross-bedded conglomerate with fine to medium pebbles with lesser coarse pebbles and a few percent cobbles with moderately well developed soils. Poorly to moderately sorted gravels, with clayey to silty fine-medium sand matrices; clay as rare very fine to medium-sized films on gravels and bridging sand grains. Matrix colors of 5 YR 5/4-6/4 measured in clay-rich horizons, and 7.5 YR 6/3 measured outside these horizons. Carbonate horizon development as strong as Stage II. 1-2 m thick.

Qay_{1m} — **Younger alluvium, older older subunit (early to middle Holocene)** — Massive sand, pebbles, and cobbles. Poorly to very poorly sorted deposits, up to 10% cobbles with common coarse pebbles and abundant medium to fine pebbles. Matrices of poorly sorted silty very fine to fine sand with up to 15% medium-coarse grains, with clay as rare fine films on gravels. Moderately well-developed soils. Colors of 7.5 YR 4/2-6/2 and 5 YR 5/6 measured. Carbonate horizon development up to Stage II, with local Stage III horizons occurring where directly overlying less permeable units. 0.5-1 m thick.



Exposure of Qay_{1y}/Qay_{1o} buttress unconformable contact. Brownish gray, cross-bedded conglomerate to right of center (south) belong to Qay_{1o}, which is inset upon Qay_{1o} and $QTsf$ sediments to the left of center. The $Qay_{1o}/QTsf$ contact lay at the base of the white carbonate horizon, which here has Stage III morphology, a level of development likely enhanced by the presence of less permeable $QTsf$ sediments immediately below the horizon.

Qay_{1ss} — **Younger alluvium, older older subunit, sandy silt facies (early to middle Holocene)** — Silty sands grading up-section to sandy muds and forming a fine-grained cap on pebbles and cobbles of unit Qay_{1o}. Fines are moderately thinly planar bedded (beds up to 6 cm thick), with sparse fine pebbles up to 2 cm across. Colors of 10 YR 8/1 and 2.5 Y 8/2 measured. Clay films found toward the top, as common fine-sized gravel, ped face, and pore linings. 0.5-1.5 m thick.

Exposure of Qay_{1ss} sediments. Cobbly gravels at base belong to $QTsf$. Fines above are silty sands grading up-section to muds, which grade laterally into cobbly Qay_{1o} sediments.

Qai — **Intermediate-aged alluvium, undivided (upper Pleistocene)** — No exposure observed. Used to designate terraces with treads between those of Qao_1 and Qay_{1y}, which only occur locally. Surface examinations indicate a gravel-rich unit, with poorly sorted pebbles to boulders. Soil development evident as reddening of surface gravels. Thickness unknown, but probably <1-2 m thick.

Qao — **Older alluvium, undivided (upper Pleistocene)** — Used where Qao_1 and Qao_2 cannot be distinguished reliably. Deposits are similar to Qao_1 and Qao_2, as described below.

Qao_2 — **Older alluvium, younger subunit (upper Pleistocene)** — Matrix-rich conglomerate with pebbles and rare cobbles and strongly developed soils. Deposits are dominantly fine pebbles with up to 20% medium pebbles and rare coarse pebbles to sparse boulders. Matrices are up to 40% of deposits, consisting of poorly sorted silty to clayey fine to coarse sand, with colors of 5 YR 5/4-5/6 and 6/4, and 7.5 YR 5/3 and 4/4 measured. Carbonate horizon development up to Stage III, with common fine to medium clay films as gravel coats and bridges outside of the carbonate horizon. 1.5 to 4(?) m thick.

Streamcut exposure of Qao_2 over $QTsf$ clayey sand. Brownish gray gravel at the top of the outcrop belongs to map unit Qao_2. Note Stage III carbonate horizon at the top of this unit. Light brown to pale reddish brown fine-grained sediment beneath is clay-rich and belong to $QTsf$; this almost exclusively fine-grained facies of $QTsf$ is only.

Qao_1 — **Older alluvium, older subunit (upper Pleistocene)** — Matrix-rich conglomerate with pebbles and cobbles and strongly developed soils. Gravels are subequal fine and medium pebbles to weakly fine pebble-dominated, with up to 30% coarse pebbles and 5% cobbles. Matrices are poorly sorted silty fine to coarse sand, with colors of 5 YR 4-5/6 measured. Carbonate horizon development up to Stage III+, with rare fine bridging clay films outside of the carbonate horizon. 2 to 4(?) m thick.

Quaternary Piedmont Alluvial Deposits

Qpy — **Younger piedmont alluvium, undivided (upper Pleistocene to Holocene)** — Used where map units Qpy_1 and Qpy_2 cannot be reliably subdivided.

Qpyh — **Younger piedmont alluvium, younger subunit and historic alluvium, undivided (Holocene to Historic)** — Used where map units Qpy_1 and Qph cannot be separated at the given map scale.

Qpy_1 — **Younger piedmont alluvium, younger subunit (Holocene to Historic)** — Typically matrix-rich conglomerate with pebbles and cobbles and weakly developed soils. Dominantly fine pebbles, with up to 20% each of medium and coarse pebbles and a few percent cobbles, in weak planar tabular beds and paleochannel lenses. Fines are silty fine to coarse sand, with poorly sorted angular to subrounded grains. Carbonate horizon development typically Stage I. Matrix colors of 7.5 YR 6/3-4 and 4/4 measured. Up to 1.5 m thick.

Qpy_2 — **Younger piedmont alluvium, older subunit (upper Pleistocene to Holocene)** — Matrix-rich conglomerate with pebbles and cobbles and moderately well-developed soils. Dominantly fine to medium pebbles, with up to 30% coarse pebbles and 10% cobbles. Weakly planar tabular bedding with local paleochannels. Matrix is poorly sorted silty fine to coarse sand, with colors of 7.5 YR 4/4 and 7/3 measured. Carbonate horizon development typically Stage II. Up to 2 m thick.

Qpo — **Older piedmont alluvium (upper Pleistocene)** — Matrix-rich conglomerate with pebbles and cobbles and strongly developed soils. Deposits are dominantly fine pebbles and lesser medium pebbles, with coarse pebbles, cobbles, and sparse boulders concentrated in rare paleochannels. Matrices are muddy fine to coarse sands to fine sandy muds, with colors of 5 YR 5/3-4 and 7.5 YR 6-7/4 measured. Carbonate horizon development typically Stage III+, with local well-indurated pockets within an otherwise poorly indurated horizon. Clay films highly variable; locally abundant as fine to coarse pore linings, but commonly rare and fine as gravel coats. 1-3 m thick.

Quaternary Alluvial Fan Deposits

Qafu — **Undifferentiated fan alluvium (upper Pleistocene to Holocene)** — Used where multiple distributary networks overlap. May contain alluvial elements from Torreon Arroyo, Ryan Hill Canyon, Cienega Springs, Sawmill Canyon, and smaller drainages. No exposures observed, and age uncertain, but appears to be correlative with younger alluvial elements such as Qay_{1y}, Qay_1, and Qay.

Qafo — **Older undifferentiated fan alluvium (upper Pleistocene)** — Used where multiple distributary networks overlap. May contain alluvial elements from Torreon Arroyo, Ryan Hill Canyon, Cienega Springs, Sawmill Canyon, Copper Canyon, and smaller drainages. No exposures observed, but surface characteristics suggest correlation to older alluvial elements (Qao_1, $Qaro$, Qpo, etc.).

Roadcut exposure of $QTsf$ gravels along the Ryan Hill Canyon drainage. Note the well-developed carbonate horizon at shallow depth; laminae can be found at the top of this horizon, indicating a Stage IV morphology. Underlying gravels bear a clay-rich matrix.

Sawmill Canyon fan

Qasy — **Younger Sawmill Canyon fan alluvium (Holocene)** — Interbedded pebble beds, sand beds, and cobbly fills of paleochannels with weakly developed soils. Pebble beds are planar bedded and dominantly fine pebble-sized, while paleochannels bear common coarse pebbles and rare cobbles. Sand beds are discontinuous, muddy fine to coarse sand, with colors of 5 YR to 7.5 YR 5/4 and 7.5 YR 6/3 measured. Carbonate horizon development as strong as Stage I, with locally common clay films as fine gravel coats. 1-3 m thick.

Qasu — **Undivided Sawmill Canyon fan alluvium (upper Pleistocene to Holocene)** — Interbedded pebble to cobble conglomerate and silty sand. Gravels are dominantly matrix-poor fine pebbles with common medium pebbles, up to 20% coarse pebbles, and up to 5% cobbles. Sands are discontinuous lenses that are poorly sorted, variably clayey and silty fine to coarse sand. Clay as rare to common fine to coarse films on gravels and bridging grains. Matrix colors of 5 YR 4/4-6 and 6/3, and 7.5 YR 5-6/4 measured. Carbonate horizon development up to Stage I in buried soils. 2-5(?) m thick.

Ryan Hill Canyon fan

Qarh — **Historic Ryan Canyon fan alluvium (Holocene)** — No exposures observed, but surface examinations indicate a sand- and gravel-rich unit, with poorly sorted pebbles to rare boulders. High small-scale relief as bar-and-swale topography and pool-and-riffle stream channel morphology. Surfaces have poor grass cover, but common to dense shrub cover. No evidence of soil development. 0-2(?) m thick.

Qary — **Younger Ryan Canyon fan alluvium, univided (upper Pleistocene to Holocene)** — Used where map units $Qary_y$ and $Qary_o$ cannot be reliably distinguished.

$Qary_y$ — **Younger Ryan Canyon fan alluvium , younger subunit (Holocene)** — No exposures observed, but surface examinations indicate a sand- and gravel-rich unit, with poorly sorted pebbles to cobbles. Some small-scale relief as bar-and-swale topography is preserved, but smoothed relative to $Qarh$. Surface vegetation is a mix of shrubs and grasses, with grass cover increasing down-gradient. 0-2(?) m thick.

$Qary_o$ — **Younger Ryan Canyon fan alluvium , older subunit (upper Pleistocene)** — No exposures observed, but surface examinations indicate a gravel-rich unit, with poorly sorted pebbles to cobbles. Small scale relief is subdued, with some relict bars distinguishable. Surface vegetation is dominantly of grasses, with lesser shrubs. Soil development evident in common reddening on surface gravels, particularly cobbles. 0-3(?) m thick.

Qaro — **Older Ryan Canyon fan alluvium (upper Pleistocene)** — Sandy pebbles with age marked by red color and clay accumulation in the matrix. Gravels are poorly sorted pebbles, mostly fine pebbles with 15-25% medium-coarse pebbles, <1-1% cobbles, and sparse boulders. 15-30% matrix of clayey fine to coarse sands. Clay occurs as uncommon medium to coarse films coating gravels and bridging grains. Matrix color of 5YR 5/8 measured. 0-3(?) m thick.

Miocene to Lower Pleistocene

Santa Fe Group

Sedimentary fill of Miocene to Pleistocene rift basins associated with the Rio Grande rift (Baldwin, 1963; Hawley *et al.*, 1969). Subdivided based on age inferred from cementation, bedding attitude, and stratigraphic location.

QTsf — **Upper Santa Fe Group (Pliocene to lower Pleistocene)** — Clay-rich gravel and silty sand to sandy silt. Gravel beds dominate, and consist of poorly sorted fine to medium pebbles with up to 40% coarse pebbles and up to 15% cobbles and rare boulders. Matrices are rich in pale to medium red clays, both as aggregated chips and as medium to coarse films on gravel faces and bridging sand grains. Clay-rich fine to coarse sand beds are discontinuous and thin, increasing in abundance to the south. Matrix colors of 2.5 YR 5-6/6 and 5 YR 5-6/4-6 measured away from carbonate horizons; colors of carbonate horizons include 5 YR 8/3, 7.5 YR 9/2, and 10 YR 9.5/1. Carbonate horizon development in buried soils up to Stage III; active soil typically bears a Stage IV horizon.

Tsfl — **Lower Santa Fe Group (Miocene to Pliocene)** — Pale to medium brown conglomerate, pebbly sandstone, and sandstone. Conglomerates are poorly sorted and subangular to subrounded, dominantly of pebbles with rare cobbles and sparse boulders up to 30 cm across. Gravel compositions are dominated by rhyolites of various textures, reflecting the textures of the various major ignimbrite units. Rare (up to 3%) andesitic material and sparse (up to 1%) aphyric basaltic material is also present, as are trace recycled volcaniclastic sedimentary gravels. Sandstones and matrices are poorly sorted silty fine to coarse sand. Locally interbeds with white ash fall and reworked ashy material. Likely correlative to the Popotosa Formation.

Lower Santa Fe Group (*Tsfl*) conglomerates. Dips this steep (here, 16° to S30E) have not been observed in any overlying strata.

Tsfb — **Basal Santa Fe Group (Miocene)** — Reddish brown to red, matrix-rich conglomerate. Conglomerate grades up-section from matrix-supported, massive, unsorted mudflow deposits to stratified, matrix-rich, poorly sorted conglomerates. Beds are typically well-indurated, and dominated by clasts of the Lemitar Tuff (*Tl*).

Eocene to Oligocene Volcanic and Volcaniclastic Rocks

Mogollon Group (*sensu* Cather *et al.*, 1994)

Tsc — **South Canyon Tuff** — Light gray to tan, crystal-poor to moderately crystal-rich, pumiceous, moderately to densely welded rhyolitic ignimbrite. Phenocryst abundance increases sharply up-section from 2-4% to 20-25%, and consists throughout of subequal quartz and sanidine, 1-3 mm across and subhedral, with minor plagioclase and biotite.

Tlp — **La Jara Peak basaltic andesite lavas** — Medium to dark gray to purplish gray, fine-grained lavas. Phenocrysts are up to 8% of flows, principally of matic crystals reduced to reddish brown to orange iron oxides, with sparse white, chalky plagioclase crystals. Both are <1 mm across.

Tl — **Lemitar Tuff** — Light gray to medium red, generally crystal-rich, pumice-poor, lithic-poor, moderately to densely welded rhyolitic ignimbrite. Phenocryst content increases up-section from 5 to 40%, though in this study area the tuff is more often than not crystal-rich (25-40%). Phenocryst composition is variable, but commonly consists of abundant sanidine, rare to common quartz, rare plagioclase, and sparse biotite, with phenocrysts 1-3 mm across.

Tcu — **Tuff of Caronita Canyon** — Divided into lower and upper members based on phenocryst abundance and composition:

Tcu — **Tuff of Caronita Canyon, upper member** — White to medium gray and locally pale red, crystal-rich, pumiceous, poorly to densely welded tuff. Phenocryst content is 30-40%, and dominated by subequal amounts of subhedral sanidine and coarse, commonly bipyramidal quartz, with lesser biotite and sparse plagioclase.

Tcl — **Tuff of Caronita Canyon, lower member** — Light gray to medium red, crystal-poor to moderately crystal-rich, pumiceous, poorly to densely welded tuff. Phenocrysts are 3-20%, increasing up-section, and dominantly of plagioclase, with lesser biotite and magnetite, and sparse sanidine, quartz, pyroxene, and amphiboles.

Tvp — **Vicks Peak Tuff** — White to tan, crystal-poor, lithic-poor, pumice-rich, moderately to densely welded rhyolitic ignimbrite. Phenocrysts are up to 5% of the rock, dominantly of subhedral, clear, tabular sanidine, with sparse quartz. Pumices are locally coarse, up to 20 cm across observed, and commonly replaced by vapor-phase quartz and sanidine, imparting a sugary texture surrounded by a light-colored, fine-grained rim. Generally poorly exposed on this quadrangle.

Tlj — **La Jencia Tuff** — Light gray to reddish gray, crystal-poor, lithic-poor, densely welded rhyolitic ignimbrite. Phenocrysts are typically <2% of the rock, though locally up to 5% low in the unit, and are dominantly clear, tabular sanidine up to 2 mm across. Sparse quartz and biotite also present. Lithics are 0-2%, typically of andesitic material, with sparse crystal-rich rhyolites. Middle portion of the unit is diagnostically strongly flow-foliated, imparting a red-and-gray striping to outcrops. Lithophysae are locally abundant near the base.

Tlp — **Lower La Jencia Tuff** — White to tan, lithic-rich, crystal-poor, variably welded tuff. Up to 50% lithic fragments, principally of aphyric andesitic material, with sparse crystal-rich, quartz-bearing rhyolites. Rare phenocrysts (up to 5%) of fine (up to 2 mm across) clear tabular sanidine. Where well-exposed, grades upsection into unit *Tlj*. May be in part or entirely correlative to unit *Tzt*, with the gradational contact resulting from inter-tuff welding.

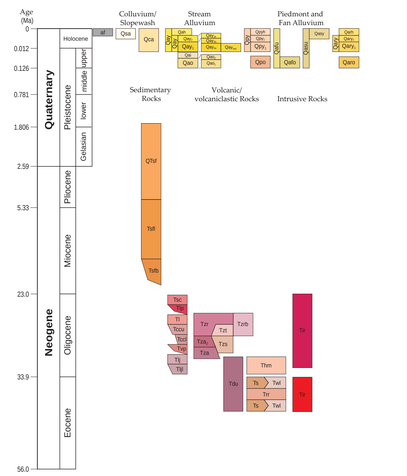
Exposure of the Socorro caldera wall at the time of the eruption of the La Jencia Tuff. Backpack lies on the contact, with the La Jencia Tuff lying to the left (northeast) and pre-caldera porphyritic andesite lavas of Willow Springs lying to the right. Attitude of contact is 60° to N36E (dip, dip direction). Foliations in the basal La Jencia Tuff parallel this contact, grading up-section to a gentler eastward tip.

Luis Lopez Formation

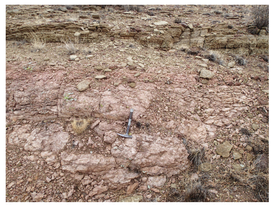
Volcanic and clastic fill of the Socorro caldera

Tzr — **Rhyolite lavas** — White to pink to tan to brown, variably spherulitic, crystal-poor, flow-banded rhyolite flows. Phenocrysts are sparse (<1-2%) and fine (up to 1 mm across), and dominantly of sanidine, with local biotite and plagioclase. Spherulitic textures occur throughout, generally concentrated along certain flow bands but locally dominating flows. Locally (auto)brecciated, locally vitrophyric.

CORRELATION OF MAP UNITS



Tzt — **Tuff of the Luis Lopez Formation** — White to tan, very lithic-rich, moderately pumice-rich, crystal-poor, variably welded tuff. Tuff is 20-50% lithic fragments, principally of aphyric basaltic to andesitic material, with lesser andesite porphyry, and sparse crystal-rich, quartz-bearing rhyolite. Lithics are up to 5 cm across. Sparse phenocrysts of fine (up to 1 mm across) sanidine and lesser quartz. Small (up to 2 cm across) flattened pumices are variably rare to common. Where directly underlying unit *Tlj*, may be in part or entirely correlative to unit *Tlj*.



Upper portion of the tuff of the Luis Lopez Formation. Mottled white and pink rock under hammer is pumice-rich and moderately lithic-rich tuff, while overlying thinly bedded material is tuffaceous sandstone. Here, the tuff underlies ring-fracture rhyolite domes (map unit *Tzr*), which in turn underlies the La Jencia Tuff.

Tzrh — **Rhyolitic breccia** — Light gray to light pink to light reddish brown breccia of flow-banded, phenocryst-poor rhyolite. Clasts contain 1-2% phenocrysts of sanidine up to 1 mm across. Individual breccia blocks are 1 to 20 cm across, angular, and densely packed with local "jigsaw" textures. Rare xenoliths of andesitic material and white rhyolites.

Tzs — **Volcaniclastic sedimentary rocks** — Conglomerate and sandstone bearing common andesitic material and rare rhyolitic material. Beds are poorly to very poorly sorted, with angular to subrounded gravel comprised predominantly of pebbles but with rare cobbles and sparse boulders. 0-40% rhyolitic material, commonly of sandine-rich porphyries, but with rare aphyric, strongly flow-banded rhyolites. Sandstones and conglomerate matrices are very poorly sorted wackes, with clay to coarse sand grains, angular to subangular. Individual beds are 20-50 cm thick.

Tza — **Andesitic lavas** — Pale brown to light brownish gray, with variable greenish colors from alteration, plagioclase-pyroxene andesite porphyries. *Tza* is up to 10% phenocrysts of subequal plagioclase and pyroxene, up to 0.5 mm across, with rare biotite. *Tza*, is 15-20% phenocrysts of plagioclase up to 1 cm across, with rare (up to 5%) pyroxene up to 1 mm across. Sparse biotite and amphibole crystals.

Datil Group (*sensu* Cather *et al.*, 1994)

Tdu — **Datil Group, undivided** — Used in cross-section only. May include any combination of the below units, and possibly others not exposed at the surface.

Thm — **Hells Mesa Tuff** — White to light brown to light gray, poorly to densely welded, crystal-rich, quartz-rich, pumice-poor ignimbrite. Phenocrysts are abundant (20-40%), with common quartz up to 5 mm across, lesser tabular sanidine and plagioclase, and rare biotite. Generally lithic-poor, but locally lithic-rich. Not separated into inter- and intracaulderon facies here as diagnostic criteria were not observed in the field.

Tcr — **Tuff of Rocque Ramos Canyon** — Light gray to light brownish gray, phenocryst-rich, moderately lithic-rich, pumice-poor, moderately to densely welded ignimbrite. Contains 15-20% phenocrysts principally of clear to white, tabular sanidine <1-5 mm across, with local, subordinate, black to coppery biotite crystals up to 2 mm across. Lithics occupy up to 5% of the rock and are of andesitic material up to 2 cm across. Rare pumice fragments are moderately to strongly flattened and up to 5 mm long. Correlation based on similarity to an ignimbrite on the Indian Well Wilderness quadrangle. $^{40}Ar/^{39}Ar$ date is 35.32 ± 0.14 Ma (Chamberlin and Cikoski, 2010).

Twl — **Andesite lavas of Willow Springs** — Medium to dark gray, reddish gray, and dusky red, plagioclase ± pyroxene andesite porphyry lavas. Lavas contain 20-40% phenocrysts, dominantly of white, often chalky, tabular plagioclase 3-7 mm across, with subordinate, but locally abundant, prismatic black pyroxene crystals 1-7 mm across. Individual flows are 3-20 m thick. Map unit contains small, unmappable areas of unit *Ts*.

Spears Group (*sensu* Cather *et al.*, 1994)

Ts — **Spears Group, undivided** — Interbedded conglomerate and sandstone with abundant andesitic material and no rhyolitic material. Beds are poorly to very poorly sorted with angular to subrounded clasts, and dominantly pebble to cobble in size but locally bouldery. Clasts are of plagioclase-pyroxene porphyry lavas, similar to the lavas of Willow Springs, with subordinate aphyric lavas and rare to locally abundant white amphibole porphyry lavas. Generally very poorly exposed.

Eocene to Oligocene Intrusive Igneous Rocks

Ti — **Rhyolitic intrusions** — Fine-grained, flow-banded cliff-forming rhyolitic plugs. Phenocrysts of subhedral quartz occupy up to 2% of the rock masses, with trace biotite and magnetite. Flow foliations pronounced and commonly contorted.

Td — **Intermediate dikes** — Plagioclase ± pyroxene porphyry dikes, 0.25 to 1 m thick.

MAP SYMBOLS

A — A' Location of geologic cross section.

Geologic contact. Solid where exposed or known, dashed where approximately known, dotted where concealed; queried where uncertain.

Normal fault, ball-and-bar on downthrown side. Solid where exposed, dashed where approximately known, dotted where concealed. Tick gives attitude of fault plane, showing dip magnitude, arrow gives trend of fault plane lineations, showing plunge magnitude.

Reverse fault, teeth on upthrown side. Solid where exposed, dashed where approximately known, dotted where concealed.

Caldera margins, well located, approximately located, concealed. Single tick - exhumed caldera topographic wall circa eruption of Hells Mesa Tuff (32.3 Ma). Double tic - exhumed caldera wall.

67 Andesite dike, unit Tid, tick showing dip.

85 / 63 Minor fault, tick gives attitude of fault plane, showing dip magnitude, arrow gives trend of fault plane lineations, showing plunge magnitude.

Strike and dip of inclined bedding.

80 Strike and dip of igneous foliation.

40 Strike and dip of igneous foliations for multiple observations at a single locality.

Paleocurrent sediment direction determined by clast imbrication.

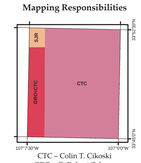
COMMENTS TO MAP USERS

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 are based on 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.

The map has not been reviewed according to New Mexico Bureau of Geology and Mineral Resources standards. Revision of the map is likely because of the on-going nature of work in the region. The contents of the report and map should not be considered final and complete until reviewed and published by the New Mexico Bureau of Mines 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. Cross-sections are constructed based upon the interpretations of the authors made from geologic mapping, and available geophysical (regional gravity and aeromagnetic surveys), and subsurface (drillhole) data.

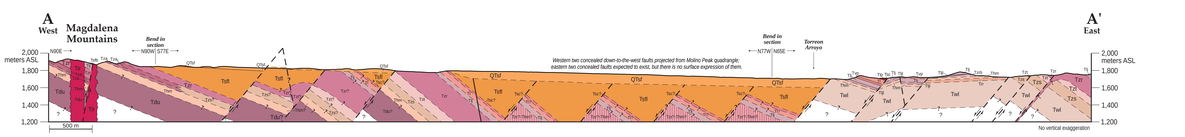
Cross-sections should be used as an aid to understanding the general geologic framework of the map area, and not be the sole source of information for use in locating or designing wells, buildings, roads, or other man-made structures.

Mapping Responsibilities



CTC – Colin T. Cikoski
GRO – G. Robert Osburn
SJR – Susan J. Roth

GEOLOGIC CROSS SECTION



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