

Geologic Map of the Cienega Ranch Quadrangle, Socorro County, New Mexico

By

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Open-file Digital Geologic Map OF-GM 239

Scale 1:24,000

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Unit descriptions for the Cienega Ranch quadrangle

Note: Carbonate horizon morphologies are after Gile et al. (1966), colors are after Munsell Color (1994), clay film terminology is after Birkeland (1999), and all proportions are visual estimates.

Artificial deposits

af Compacted sediments, mainly of earthen dams. 0-4 m thick.

Colluvium and slopewash

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

Qsa Slopewash and alluvium, undivided. 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.

Alluvium (Qa_)

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.

Qah Historic alluvium. 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.

Qay Younger alluvium, undivided. Includes areas of both Qay1 and Qay2. See individual descriptions for more detail.

Qayh Younger alluvium, younger subunit, and historic alluvium, undivided. Used where the two cannot be mapped separately at the given map scale.

Qay2 Younger alluvium, younger subunit. 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.

Qay1 Younger alluvium, older subunit, undivided. Used where Qay1a and Qay1b cannot be distinguished reliably, either due to the given map scale or to weak map unit indicators.

Qay1b Younger alluvium, younger older subunit. 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.
Qay1a	Younger alluvium, older older subunit. 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.
Qay1as	Younger alluvium, older older subunit, sandy silt facies. Silty sands grading up-section to sandy muds and forming a fine-grained cap on pebbles and cobbles of unit Qay1a. 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.
Qayu	Younger alluvium, undivided. Used to designate narrow, typically shallow drainages where Qay1 and Qay2 cannot be distinguished reliably, and cannot be mapped separately from Qah at the given map scale. Up to 2 m thick.
Qai	Intermediate-aged alluvium. No exposure observed. Used to designate terraces with treads between those of Qao2 and Qay1a, 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. Used where Qao1 and Qao2 cannot be distinguished reliably. Deposits are similar to Qao1 and Qao2, as described below.
Qao2	Older alluvium, younger subunit. 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.
Qao1	Older alluvium, older subunit. 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.

Undifferentiated fan alluvium (Qaf_)

- Qafu Undifferentiated fan alluvium. 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_, Qary_, and Qasfy.
- Qafo Older undifferentiated fan alluvium. 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, Qaro, Qpo, etc.).

Alluvium of the Sawmill Canyon fan (Qasf_)

- Qasy Younger Sawmill Canyon fan alluvium. 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. 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.

Alluvium of the Ryan Hill Canyon fan (Qar_)

- Qarh Historic alluvium of the Ryan Hill Canyon fan. 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 alluvium of the Ryan Hill Canyon fan. Used where map units Qary2 and Qary1 cannot be reliably distinguished.
- Qary2 Younger alluvium of the Ryan Hill Canyon fan, younger subunit. 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.

- Qary1 Younger alluvium of the Ryan Hill Canyon fan, older subunit. 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 alluvium of the Ryan Hill Canyon fan. 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.

Piedmont alluvium (Qp_)

- Qpy Younger piedmont alluvium, undivided. Used where map units Qpy1 and Qpy2 cannot be reliably subdivided.
- Qpy2 Younger piedmont alluvium, younger subunit. 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.
- Qpyh Younger piedmont alluvium, younger subunit and historic alluvium, undivided. Used where map units Qpy2 and Qah cannot be separated at the given map scale.
- Qpy1 Younger piedmont alluvium, older subunit. 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. 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.

Santa Fe Group

- QTsf, Tsf_ 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. 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. Pale to medium brown conglomerate, pebbly sandstone, and sandstone. Conglomerate is 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 volcanoclastic 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.
- Tsfb Basal Santa Fe Group. 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.

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 mafic 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.
Tcc_	Tuff of Caronita Canyon. Divided into lower and upper members based on phenocryst abundance and composition.
Tccu	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.
Tccl	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.
Tljl	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.

Luis Lopez Formation

Tz_	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.

- 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.
- Tzrb 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, Tza2 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. Tza2 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 intracauldron facies here as diagnostic criteria were not observed in the field.
- Trr Tuff of Roque 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. $^{40}\text{Ar}/^{39}\text{Ar}$ 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 \pm 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.
- Ts Spears Group (sensu Cather et al., 1994). 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.

Intrusive rocks

- Tir 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.
- Tid Intermediate dikes. Plagioclase \pm pyroxene porphyry dikes, 0.25 to 1 m thick.

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Table 1: Summary of geochronologic data for the Cienega Ranch quadrangle volcanic units

Unit	Age ¹ (Ma)	±2σ	Ref ²	Comments
Tsc	27.55	0.14	M91	Erupted from the Mt Withington caldera ³
Tl	28.18	0.16	M91	Erupted from the Hardy Ridge caldera ³
Tcc	28.14	0.14	M91	Possibly a precursor to the eruption of the Lemitar Tuff (McIntosh et al., 1991).
Tvp	28.70	0.06	M91	Erupted from the Nogal Canyon caldera ³
Tlj	29.04	0.08	M91	Erupted from the Sawmill Canyon caldera ³
	28.88	0.06	C04	
Tzt	30.24	0.05	C04	
Thm	32.27	0.20	M91	Erupted from the Socorro caldera ³
Trr	35.19	0.08	M91	
	35.32	0.14	CC10	

¹: All ages are single-crystal sanidine ⁴⁰Ar/³⁹Ar ages, scaled from original sources to reflect the Fish Canyon Tuff sanidine monitor assigned age of 28.02 from Renne et al. (1998).

²: References: C04 – Chamberlin et al., 2004; CC10 – Chamberlin and Cikoski, 2010; M91 – McIntosh et al., 1991.

³: Source calderas after Chapin et al. (2004).