

Geology of the Cerro Conejo 7.5-Minute Quadrangle, Sandoval County, New Mexico

EDMAP PROJECT Map Unit Descriptions

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MAP UNIT DESCRIPTIONS

Quaternary

- af Artificial Fill (anthropogenic).**
- Qal Alluvium undivided (Holocene to late Pleistocene(?)).** Predominantly stratified sand and silt with local gravelly, clay-rich, and silt-rich eolian beds. Locally composed of several aggradational packages separated by soils. Deposits underlie floodplains and reflect the bedrock composition in adjacent hillslopes. From < 1 m to 10 m thick.
- Qac Alluvium and colluvium, undivided (Late Pleistocene and Holocene).** Valley wall and low-order drainage valley bottom deposit of stratified alluvium and poorly-stratified and sorted colluvium.
- Qae Alluvium and eolian sand, undivided (Late Pleistocene and Holocene).** Deposit of mixed stratified, locally pebbly alluvium with massive, eolian fine to medium sand. Found predominantly in interfluvial areas in proximity to major drainages.
- Qs Sand and sand dunes (Late Pleistocene and Holocene).** Sand and sand dunes found primarily on the Llano de Albuquerque. Deposits are 1 to 12 m thick.
- Qg5 Gravel terrace deposits (Late Pleistocene).** Sand and gravel underlying fluvial terraces along major arroyos and washes. The deposit is derived largely from local Tertiary basin-fill units. Deposit is 1 to 5 m thick and may be correlative to Qt5 of the Jemez valley.
- Qg4 Gravel terrace deposits (Middle-Late Pleistocene).** Sand and gravel underlying fluvial terraces along major arroyos and washes. The deposit is derived largely from local Tertiary basin-fill units. Deposit represents a major paleovalley fill 3-10 m thick and may be correlative to Qt4 of the Jemez valley.

- Qs4 Sandy terrace deposits (Middle-Late Pleistocene).** Sand and minor gravel underlying fluvial terraces along major arroyos and washes. The deposit is derived largely from local Tertiary basin-fill units and contains a significant amount of wind-derived material. Deposit represents a major paleovalley fill 3-10 m thick and may be correlative to Qt4 of the Jemez valley.
- Qs4p Sandy pediment deposits (Middle-Late Pleistocene).** Sand and minor gravel underlying alluvial slopes and piedmonts tributary to major arroyos and washes. The deposit is derived largely from local Tertiary basin-fill units and contains a significant amount of wind-derived material. Deposit represents a major paleovalley fill 3-10 m thick and may be correlative to Qp4 of the Jemez valley.
- Qg3 Gravel terrace deposits (Middle Pleistocene).** Sand and gravel underlying fluvial terraces along major arroyos and washes. The deposit is derived largely from local Tertiary basin-fill units. Deposit may be correlative to Qt3 of the Jemez valley. Deposit is 1-3 m thick.
- Qs3 Sandy terrace deposits (Middle Pleistocene).** Sand and minor gravel underlying fluvial terraces along major arroyos and washes. The deposit is derived largely from local Tertiary basin-fill units and contains a significant amount of wind-derived material. Deposit may be correlative to Qp3 of the Jemez valley. Deposit is 1-3 m thick.
- QTp Pantadeleon Formation (Pliocene-early Pleistocene).** Interbedded gray gravels, tannish yellow to tan muddy sands, and sandy muds typically preserved as colluvium, alluvium and eolian material proximal to fault scarps in down dropped hanging wall blocks. Gravel clasts include ripped-ups from an eroded petrocalcic horizon (5%), red granite, which is more angular – subangular than granite found in older strata (30-40%), and ~ 10% sandstone and ~5% basalt. A lens of white fine-grained volcanic ash near the top of the Pantadeleon Formation has been geochemically correlated to the 3.28 Ma Nomlaki Tuff of the Tuscan and Tehama Formations in eastern California (A. Sarna-Wojciki, written commun., 1998). Deposit ranges from 3-5 m on footwall blocks to 5-10 m on hanging wall blocks.

Tertiary

Santa Fe Group

This quadrangle represents a outstanding locality to define the stratigraphy of the Santa Fe Group in the northwestern portion of the Albuquerque basin. A tripartite subdivision of the group, first proposed by Bryan and McCann (1937) is retained because this division represents clearly mappable, easily distinguishable lithostratigraphic units with distinct hydrostratigraphic implications. The three formations of the Santa Fe Group are, from the base, the Zia Formation, Cerro Conejo Formation, and the Arroyo Ojito Formation, the latter named for exposures in this quadrangle. The source of Santa Fe Group sedimentation in the Sky Village NE quadrangle begins in the early Miocene with predominantly gray to light-pink colored quarto-feldspathic

eolian sand (Zia Formation) sourced from the north and west. These eolianites contain minor lacustrine and fluvial facies. In the middle Miocene, a large through-going, SE-flowing sandy fluvial system was established through the region resulting in the deposition of pink to red, locally pebbly quartzo-feldspathic to litharenite sandstone of the Cerro Conejo Formation. This formation is characterized by both fluvial and eolian facies. The origin of the fluvial system is unknown, but might represent some paleo-Rio Puerco system. The overlying Arroyo Ojito Formation represents a distinct break in sediment composition and depositional environment from the Cerro Conejo Formation. The yellow-colored Navajo Draw Member at the base of the Arroyo Ojito Formation represents an ancestral Rio Puerco that sourced Oligocene volcanoclastics and Mesozoic rocks along the eastern Colorado Plateau. The Arroyo Ojito Formation is decidedly coarser grained than the older deposits, and coarsens upwards to the purplish-colored sandy gravel of the Ceja Member.

Toc Ceja member of the Arroyo Ojito Formation (Pliocene, Blancan (?)). Interbedded, lenticular, purplish-red to light reddish-brown gravels/cobbles/**boulders**, reddish-yellow to brownish-yellow muddy sands (sand grain size is very fine to medium-grained), and grayish sandy gravels and cobbles. The lower contact of Toc is defined at either the first appearance of a discontinuous 0-1 m-thick buried soil with a Stage III Bk **or** the first appearance of purplish red to light reddish brown gravels/cobbles/boulders. Clast composition shows > 5% basalt, > 5% Pedernal chert, and > 10% granite. The upper contact of Tsfu3 is defined at, or stratigraphically correlates to, a prominent soil with a Stage IV to Stage V calcic horizon. The deposit is up to 25 m thick.

Tob Loma Barbon Member of the Arroyo Ojito Formation (late Miocene, Hemphillian(?)). Brown, reddish brown, and buff/tan, resistant, cliff-forming, lenticular clay, sandy muds, clayey to silty sands, and brown feldspathic sands, intercalated with minor sandy gravel/cobble/boulder beds. The muddy sands and sands occur in lenticular beds which extend a few decameters laterally on the hanging wall proximal to faults. Gravel clasts are composed of >10% granite, 1-2% Pedernal chert and <0.5% red siltstones and shales. The lower contact is defined by a red, muddy gravelly sand with distinct, subangular, coarse granite clasts composing up to 50% of the unit. Generally, there is more clay and mud at the base of Tsfu2. Silty sand and gravel/cobble/boulder beds become more common than muddy beds in the middle portion of the unit. Deposit is approximately 100 m thick.

Ton Navajo Draw Member of the Arroyo Ojito Formation (late Miocene, Hemphillian (?)). Greenish to yellowish, friable, slope-forming tan silty to muddy feldspathic sand (silty sand being the dominant texture of the member), sand, and gravel with minor sandy mud beds. Bedding is usually lenticular and less than 1 meter thick. The gravels often fill channels that are <1 meter deep. The muds tend to be about 0.1 m thick. Boulder-size petrified wood locally occurs in the gravelly facies which contain < 10% granite, ~0.5% red siltstone and shale, and <5% basalt, but are dominated by gray intermediate to felsic volcanic rock and brown Mesozoic chert. The intermediate volcanic clasts are likely reworked Abiquiu Formation, reworked and mixed with Mesozoic rocks stripped

off of the western Colorado Plateau by the ancestral Rio Puerco. Deposit thickness is approximately 80 m.

- Tcc Cerro Conejo Formation (middle Miocene, Barstovian-early Clarendonian)** A generally pinkish to orangish buff-tan, ash-rich, resistant, cliff-forming, poorly-sorted lithic to feldspathic sandstone with variable proportions of silt, and reddish-brown mud 0.1-0.5 m thick. The sand and muddy sand beds are tabular, thin to very thickly-bedded. These tabular beds contrast with the overlying lenticular beds of Ton. Gravels and granular-rich beds occur in Tcc but are rare. Cemented sand beds are common in Tcc, especially near its top. The formation is subdivided into a basal eolian sandstone facies (~20 m thick), a middle ash-rich facies (~ 100 m thick) and an upper eolian sandstone facies (~20 m thick). The thicker ash bed has been geochemically correlated (A. Sarna-Wojcicki, unpublished data) in similar Tcc deposits east of the Sky Village NE quadrangle to match two Snake River Plain/Yellowstone hotspot tephra from the Trapper Creek section of southern Idaho. Age estimate of the best match is 11.2 ± 0.1 Ma (Perkins et al., 1998) or 11.1 ± 0.1 Ma if U.S. Geological Survey Menlo Park hornblende standards are used. A weaker match to a higher tephra in the same section is dated at 10.94 ± 0.03 Ma (all dates are feldspar laser-fusion $^{40}\text{Ar}/^{39}\text{Ar}$). The 11 Ma age of this ash agrees well with biostratigraphic data obtained from the Cerro Conejo Formation here and elsewhere which place this body of rock in the latest Barstovian-Clarendonian land mammal age (cf. Tedford, 1981). The lower contact of Tcc was placed at the first appearance of sets of reddish-brown mudstone beds ~0.1 m thick. Previous detailed biostratigraphic work by Gawne (1981) concluded that these particular red mudstones do not correlate to the Canyada Pilares member of the Zia Formation as they have yielded Barstovian-aged fauna. Gawne's (1981) biostratigraphic contact occurs at the foot of the 15 m-high cliff of sandstone above an unconformity (please refer to her Figure 2B). However, this unconformity did not prove to be mappable so the contact shown on the map was placed at the first appearance of the reddish-brown mudstone. The mapped contact corresponds better to a lithostratigraphic definition of Tsfm and was laterally continuous across the quadrangle. Tcc is likely correlative to Tedford and Barghoorn's (1997) "Unnamed Member". This formation represents a transition from the dominantly eolian facies of the Zia formation to the dominantly fluvial facies of the middle Santa Fe Group.
- Tzc Chamisa Mesa Member of the Zia Formation (early Miocene, Hemmingfordian;** Galusha, 1966). Red, yellow, and buff, friable, slope-forming sandstone interbedded with greenish silty sands. Locally, the sandstone has a whitish gray color similar to the underlying Piedra Parada Member. It either occurs as a thickly-bedded massive facies or as medium-bedded cross-stratified facies. The deposit is approximately 200 m thick.
- Tzp Piedra Parada Member of the Zia Formation (early Miocene, Hemmingfordian;** Galusha, 1966). Fine to coarse-grained, whitish-gray to pinkish-gray to tan, subarkosic to quartzose, locally cemented, resistant, cliff-forming sandstone. The deposit commonly exhibits large-scale cross-stratification (generally >1 m-high foresets). The deposit is approximately 100-120 m thick.

Tg Galisteo Formation (Eocene; Lucas, 1982). Red, reddish brown, and yellow arkosic sandstone, mudstone, siltstone and conglomerate. Thickness approximately 175 m.

Marker Beds

Green Siltstone – shown as a line with tics. This green siltstone is found near the top of Tsfm and should not be confused with a green silt/sand that is located near the bottom of Tsfm. Texturally, this marker bed varies between a mudstone (at the west end of its mapped trace) to a ashy sandy silt (at the east end of its mapped trace). The thickness of the marker bed ranges from 0.3 m (at the west end of its mapped trace) to 0.8 m (at the east end of its mapped trace).

Upper Ash – shown as a line with x's. Generally, a very fine white ash which lacks biotite (visible primary mafic minerals are < 1% in volume and <0.5 mm in diameter). West of the Jemez fault, this ash is about 1 m thick and generally not altered. East of the Jemez fault, the ash is altered and contains 1-2% black minerals, which have a dendritic form and are interpreted to be secondary Mn-oxides. In addition, the ash east of the Jemez fault has a talc-like texture. West of the Jemez fault, another ash, being similar to the “Upper Ash,” is located 20-30 feet above the “Upper Ash.” This ash is not as laterally continuous as the “Upper Ash” and was not mapped.

Lower Ash – shown as a line with filled circles. This ash contains ~3% biotite phenocrysts, which have a long diameter of ~ 1 mm. It is located about 20-30 feet below a green silt/sand. West of the Jemez fault, the ash has been slightly altered. Primary biotite grains are present along with interpreted secondary black minerals (probably Mn). These black minerals compose about 2% of the ash. East of the Jemez fault, the primary biotite grains are more corroded than what is observed west of the Jemez fault.

Cretaceous

Mesaverde Group

Carbonaceous shale and sandstone, local coals.

Kmm Menefee Formation. Tan, brown, and yellow sandstones interbedded with dark-colored shales and coal. Brightly-colored (red) klinker(?) locally present.

Kmpl Point Lookout Sandstone. Tan, fine-grained, flaggy quartzose marine sandstone. Thickness ranges from 0 to 5 m.

Mancos Shale

Dark-gray, calcareous marine shale and siltstone with zones of calcareous concretions, few thin limestone beds. Shale facies occurring between mappable sand and limestone bodies.

Km Mancos Shale (undivided). Dark-gray, marine shale and intercalated sandstones.

Kmhd Hasta-Dalton Sandstone. Fine to medium grained, bioturbated and fossiliferous gray marine sandstone.

C,B,A El Vado Sandstone(?). At least three (A, B, and C, in ascending order) fine to medium-grained, cross-stratified, locally bioturbated and fossiliferous marine sandstone.

Kmt Tocito Sandstone. Fine-grained, hummocky and plane-parallel cross-stratified marine sandstone.

Kmg Gallup Sandstone. Yellow, sugary-textured, bioturbated, coarse marine sandstone.

Kmjl Juana Lopez Member. Orange-brown and olive to purplish gray, fossiliferous calcarenite interbedded with fissile, medium to dark-gray noncalcarenitic clay shale with local, abundant calcareous concretions. Fossils consist mostly of abraded fish bones, pelecypods, and ammonites. The ribbed oyster (*Lopha lugubris*) is a distinctive and abundant marker fossil. Thickness ranges from 1 to 3 m.

Kms Semilla Sandstone Member (?). Dark-gray shale and tan to yellow, planar laminated siltstone overlain by well-sorted, well-rounded, fine-grained and horizontally bedded sandstone. Locally, planar cross-beds and bioturbated with abundant worm traces. Well-exposed as a ridge-former in the southwestern quarter of the quadrangle. In the northwestern portion of the quadrangle, the Semilla Sandstone is poorly exposed and outcrops as a low hill held up by discontinuous sandstone and pervasive concretions. Locally absent.

Kmgr Graneros Shale Member. Dark-gray, marine shale with local, thin limy sandstone beds and thin limestone beds. A pervasive zone of calcareous concretions that underlies low hills may be equivalent to the Greenhorn Limestone Member. From 1 m to 3 m thick.

Dakota Formation

In the map area the Dakota Formation consists of intertonguing sandstones and shales. Following from Landis et al., (1973) and Dane et al., (1971), from oldest to youngest these units are an unnamed carbonaceous basal sandstone (mapped as the top of the Jackpile Sandstone), the Oak Canyon Member of the Mancos Shale, and the Cubero Tongue of the Dakota Formation, both of which comprise **Kd1**; the Clay Mesa Tongue of the Mancos Shale, and the Paguate Tongue of the Dakota Formation, both of which comprise **Kd2**; the Whitewater Arroyo Shale Tongue of the Mancos Shale and the Two Wells Sandstone Tongue of the Dakota Formation which comprise **Kd3**. The **Kd3** sandstone/shale couplet is poorly exposed and only occurs a narrow belt in the northwestern portion of the map area.

Kd3 Two Wells Sandstone Tongue of the Dakota Sandstone. Light gray, to yellow-gray, fine-grained, distinctly fine-bedded sandstone. Forms dip slope on back of cuesta ridges. Distinguished from lower Mancos Shale (Graneros Shale Member and local Greenhorn Limestone Member) in the map area by the last occurrence of slightly calcareous to non-calcareous sandstone. Thickness unknown.

Whitewater Arroyo Shale Member of the Mancos Shale. Dark-gray to olive-gray, shale. Thickness unknown.

- Kd2 Paguate Tongue of Dakota Formation.** Tan to yellow siltstone capped by sugary, calcareous, feldspathic sandstone. Planar bedded with local cross-beds and concretions. Thickness ranges from 5 m to 10 m.
Clay Mesa Member of the Mancos Shale. Dark-gray, carbonaceous shale. It is the first shale unit overlying resistant Cubero sandstone. Thickness ranges from 10 m to 18 m thick.
- Kd1 Cubero Member of Dakota Formation.** Gray, platy, bioturbated, calcareous, moderately well to poorly indurated, fine-grained feldspathic sandstone intercalated with thin shale and siltstone beds. Ridge-former of variable thickness, ranges from 5 m to 10 m thick.
Oak Canyon Member of Dakota Formation. Dark-gray, carbonaceous shale that increases in silt and fine-grained sand up section. It is the first shale unit that lies unconformably upon the Jackpile Sandstone. Thickness varies throughout map area but typically ranges from 10 m to 20 m thick.

Jurassic

Morrison Formation (Anderson and Lucas, 1995)

Buff-colored sandstone and variegated-colored siltstone and shale.

- Jmj Jackpile Sandstone.** Yellow to white-gray subarkosic arenites, with minor conglomerate seams, clay galls and iron nodules, interbedded with gray-green claystone (Flesch, 1974). Medium to large scale, moderately dipping trough cross-beds, planar cross-beds, and scour and fill structures. This map unit includes a local, 0-5 m thick, distinctive, white, carbonaceous sandstone at its base. The basal sandstone is tentatively correlated with the Burro Canyon or Cedar Mesa Formations (Cretaceous). The Jackpile Sandstone ranges from 6 m to 25 m thick.
- Jmbb Brushy Basin Shale Member.** Variegated gray-green and red-brown, montmorillonitic claystone, yellow to tan, iron oxide stained, well-indurated arkosic arenites with conglomeratic seams and clay galls (Flesch, 1974). Discontinuous, resistant sandstone units typically cap mesas and the shale is topographically expressed as a broad slope. From 60 m to 90 m thick.
- Jmsw Salt Wash Member** (formerly mapped as Westwater Canyon, Flesch, 1974). Light gray, yellowish to tan, iron oxide stained, fine- to medium-grained, well-sorted, well-rounded, arkosic to subarkosic arenites, interbedded with grayish-red, silty mudstones. Sandstone interbeds vary in thickness with a main continuous, lower unit and a main, upper, discontinuous unit in the northern half of the map area. Occasionally, highly discontinuous sandstone units are present in the main lower unit in the northern half of the map area. Medium and large scale trough cross-bedding and wedge sets, with local scour and fill, ripples and parting lineations. From 35 m to 50 m thick.

San Rafael Group (Anderson and Lucas, 1996)

Gypsum and gypsiferous siltstone interbedded with shales and minor limestone.

Js **Summerville Formation** (includes previously differentiated Recapture Member).
Variegated maroon and gray, thinly bedded sandstone interbedded with gypsiferous siltstone, sandy siltstone, or mudstone (Anderson and Lucas, 1992). Generally a slope former, but can occur as a steep cliff with well-indurated horizontal bedding. Sandstone beds are lenticular and as thick as 15 m. A 0.1 to 0.2-m thick, grayish pink carbonate bed with vertical striations occurs at the top of the formation. The carbonate bed is interpreted to be a pedogenic carbonate, and therefore, marks a diastem or unconformity at the top of the San Rafael Group sequence (Anderson and Lucas, 1996). Maximum of 80 m thick.

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