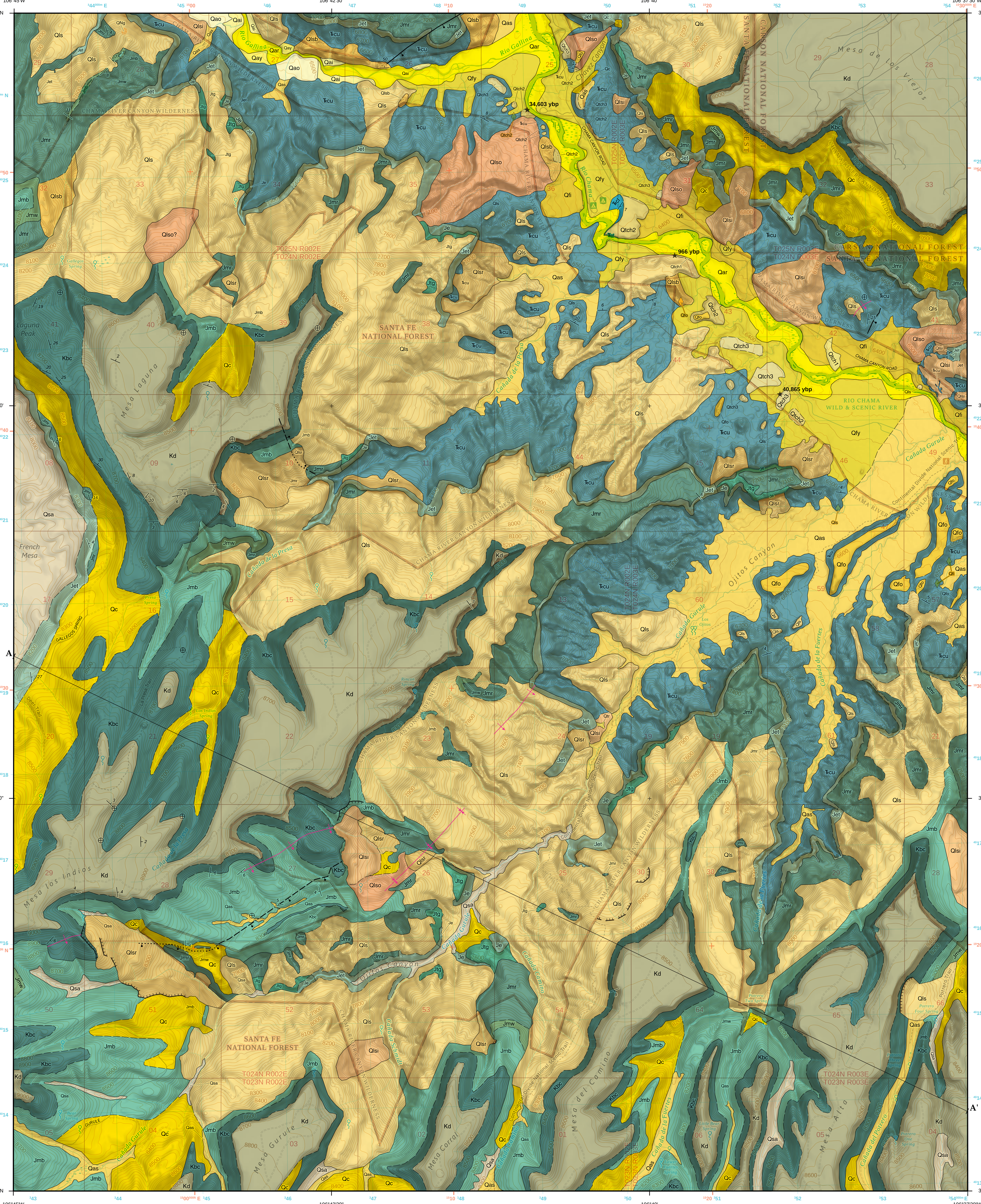


North American Datum of 1983 (NAD83)
Projection and 1,000-meter grid: Universal Transverse Mercator, Zone 13S, shown in blue.
10,000-foot ticks: New Mexico Coordinate System of 1983 (Central Zone), shown in red.

Digital base map data.......U.S. Geological Survey, 2019
Contours and hillshade.......IFSAR 4.5 m Digital Terrain Model, 2007

1:24,000

1 0.5 0 1 Mile

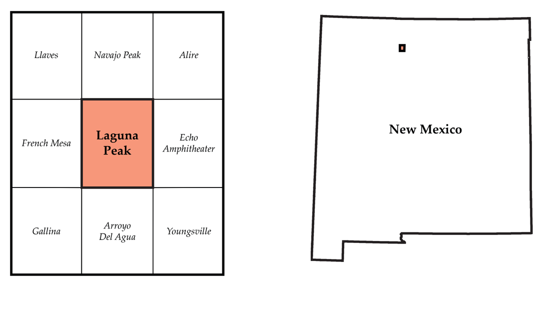
1,000 0 1,000 2,000 3,000 4,000 5,000 6,000 7,000 Feet

1 0.5 0 1 Kilometer

Contour Interval 20 Feet

North American Vertical Datum of 1988

Magnetic Declination
September 2024
8° 0' East
At Map Center



Quadrangle Location

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

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New Mexico Bureau of Geology and Mineral Resources
Geologic Map 85

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Geologic Map of the Laguna Peak 7.5-Minute Quadrangle, Rio Arriba County, New Mexico

April 2026

by

Shari A. Kelley[1], Rebecca L. Goughnour[1], Scott B. Aby[2], and Jon M. Krupnick[1]

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Comments to Map Users

A geologic map displays information on the distribution, nature, orientation, and age relationships of rocks and deposits, and the occurrence of structural features. Lithologic and fault contacts are irregular surfaces that form boundaries between different ages or types of units. Data depicted on this geologic map may be based on any of the following: field geologic mapping, a compilation of published and unpublished work, and/or photogeologic interpretation. Locations of contacts are not surveyed but are plotted by relative position on a topographic or orthophotographic base map; therefore, the accuracy of contact locations depends on the scale of mapping and the geologist's interpretation.

Resizing this map would cause the details of the map to be misrepresented and result in erroneous interpretations. Using this product at a scale different than originally intended requires verification of site-specific conditions with detailed surface mapping or subsurface exploration. Topographic and cultural changes may not be shown due to recent development.

Cross sections are constructed based on the author's interpretations of geologic mapping and available geophysical and subsurface (drill hole) data. Cross sections should be used to understand the map area's general geologic framework and not be the sole source of information for locating or designing wells, buildings, roads, or other human-made structures.

Point symbols can be set to rotate around a point of observation using their azimuth values. The point of observation can be one of three possibilities: the trailing end—or tail—opposite the arrowhead or other ornamentation of the symbol; the midpoint—or center of the symbol; or the head of the symbol. See the symbol codes described in the GIS data (FGDC_Symbols nonspatial table) for attributes that describe the azimuth measurement convention and the location of the point of observation for each symbol.

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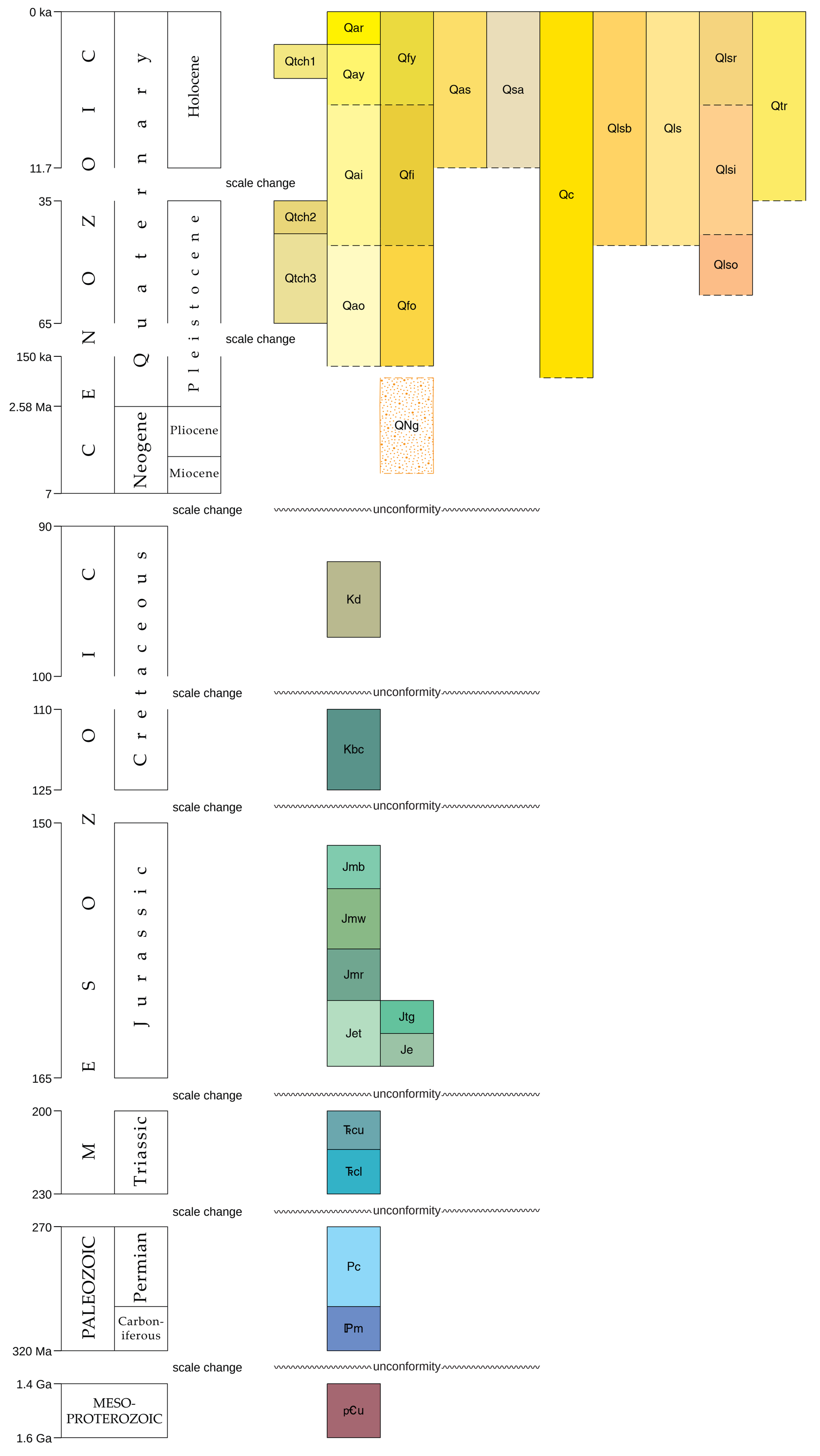
The views and conclusions in these map documents are those of the authors and should not be interpreted as necessarily representing the official policies, expressed or implied, of the State of New Mexico or the U.S. Government.

Correlation of Map Units



Explanation of Map Symbols

Contact—The identity and existence are certain. The location is accurate where solid or approximate where dashed.

Normal fault—The identity and existence are certain. The location is accurate where solid, approximate where dashed, or concealed where dotted. The ball and bar are shown on downthrown block.

Head or main scarp of landslide—Active, sharp, distinct, and location is accurate. Hachures point down scarp.

Head or main scarp of landslide—Inactive, subdued, indistinct, and (or) location is approximate. Hachures point down scarp.

Syncline—The identity and existence are certain. The location is accurate.

Monocline—The identity and existence are certain. The location is accurate. Arrows shows direction of dip.

Je — Key bed—The identity and existence are certain. The location is accurate. Beds are shown in the color of, and labeled with, the map unit identifier.

A A' — Cross section line and label.

74,519 ybp — Radiometric sample locality—Showing age.

Horizontal bedding.

23 — Inclined bedding—Showing strike and dip.

Qtch2 — Outcrop point too small to map as an area at map scale. The points are shown in the color of, and labeled with, the map unit identifier.

Surface alteration found on map units **Kbc** and **Kd**.

Description of Map Units

CENOZOIC
Quaternary–Neogene
Spring Deposit

Qtr — **Travertine (Holocene?)**—White to tan calcium carbonate deposited by a paleospring (?) on a landslide composed of Mesozoic sandstone blocks on the north side of Ojitos Canyon. The travertine encases plant fossils, including twigs, sticks, and possible flower buds. Thickness varies from 0.3–1 m.

Alluvial Deposits

Qar — **Recent alluvium (0 to 150 years old)**—Unconsolidated clays, silts, sands, gravels, and cobbles including active channel and floodplain deposits. Also includes lowest terraces, which are found 1–5 meters above modern channel grade. Approximately 1–2 m thick.

Qay — **Younger alluvium (late to middle Holocene)**—Unconsolidated clays, silts, sands, gravels, and cobbles deposited by the Rio Gallina. Deposit forms an inactive alluvial terrace with a tread 3–6 m above modern channel grade. Approximately 1–6 m thick.

Qai — **Intermediate alluvium (middle Holocene to late Pleistocene)**—Unconsolidated clays, silts, sands, gravels, and cobbles deposited by the Rio Gallina. Deposit forms an inactive alluvial terrace surface with a tread 6–9 m above modern channel grade. Approximately 1–9 m thick.

Qao — **Older alluvium (late Pleistocene)**—Unconsolidated clays, silts, sands, gravels, and cobbles deposited by the Rio Gallina. Deposit forms an inactive alluvial terrace surface with a tread greater than 15 m above modern channel grade. Unit is less than 15 m thick.

Fan Deposits

Qfy — **Younger fan deposits (Holocene)**—Unconsolidated clays, silts, sands, pebbles, cobbles, and boulders deposited by debris flow events and sheetwash. Commonly reddish in color, but brown and tan deposits are also present. Unit forms fan shapes at the bases of steep channels. Gravels are subangular to subrounded and include locally derived, Mesozoic sandstone clasts and Todilto Formation gypsum and limestone clasts. Deposits grade into and interfinger with adjacent Quaternary deposits. Occasionally incised by active channels. Unit is 1–10 m thick.

Qfi — **Intermediate fan deposits (Holocene to late Pleistocene)**—Unconsolidated clays, silts, sands, pebbles, cobbles, and boulders deposited by debris flow events and sheetwash. Commonly reddish in color. Unit forms fan shapes at the bases of steep channels. This unit contains moderately cemented to well-cemented intermediate-age fan deposits, as well as unconsolidated gravels deposited by younger fans. Gravels are subangular to subrounded and include locally derived Mesozoic sandstone clasts and Todilto Formation gypsum and limestone clasts. Deposits grade into and interfinger with adjacent Quaternary deposits. Occasionally incised by active channels. Unit is 1–10 m thick.

Qfo — **Older fan deposits (late Pleistocene)**—Unconsolidated clays, silts, sands, pebbles, cobbles, and boulders deposited by debris flow events and sheetwash. Commonly reddish in color. Gravels are subangular to subrounded and include locally derived, Mesozoic sandstone and Todilto Formation gypsum and limestone clasts. Unit forms gently sloping surfaces up to ~90 m above river grade. Unit is 1–10 m thick.

Terrace Deposits

QNg — **Lag gravels (late Pleistocene to late Miocene?)**—Unconsolidated lag deposit of pebble- to cobble-gravel preserved on a surface above the Entrada Sandstone on the south side of the Rio Gallina. Clasts include rounded Proterozoic quartzite, metaconglomerate, and granite and rounded yellow Mesozoic sandstone. The clasts are 1–5 cm in diameter. The locality is about 280 m above the modern elevation of the Rio Gallina.

Qtch1 — **Rio Chama terrace 1 (late Holocene)**—An allostratigraphic fluvial deposit below **Qtch2**. The unit consists of unconsolidated sand, pebbles, cobbles, and minor boulders. The unit is clast-supported, with subrounded to well-rounded clasts. Gravel lithologies include quartzite, volcanics, and subordinate Mesozoic sandstone (Chestnutt et al., 2019). Sand is fine- to very coarse-grained. The unit contains minor tabular beds of reddish gravelly sand. Tread height is 5–12 m above modern river grade. The unit is 1–9 m thick. The unit yielded a calibrated ^{14}C age of 939–1,017 years before present (Chestnutt et al., 2019).

Qtch2 — **Rio Chama terrace 2 (late Pleistocene)**—An allostratigraphic fluvial deposit above **Qtch1** and below **Qtch3**. The unit consists of unconsolidated sand, pebbles, cobbles, and minor boulders. The unit is clast-supported, with subrounded to well-rounded clasts. Gravel lithologies include quartzite, volcanics, and subordinate Mesozoic sandstone (Chestnutt et al., 2019). Sand is fine- to very coarse-grained. The unit contains minor tabular beds of reddish gravelly sand. Tread height is 6–38 m above modern river grade. The unit is 1–9 m thick. The unit yielded a calibrated ^{14}C age of 34,003–35,513 years before present (Chestnutt et al., 2019).

Qtch3 — **Rio Chama terrace 3 (late Pleistocene)**—An allostratigraphic fluvial deposit above **Qtch2**. The unit consists of unconsolidated sand, pebbles, cobbles, and minor boulders. The unit is clast-supported, with subrounded to well-rounded clasts. Gravel lithologies include quartzite, volcanics, and subordinate Mesozoic sandstone (Chestnutt et al., 2019). Sand is fine- to very coarse-grained. The unit contains minor tabular beds of reddish gravelly sand. Tread height is 27–38 m above modern river grade. The unit is 1–9 m thick. The unit yielded a calibrated ^{14}C age of 40,339–41,408 years before present (Chestnutt et al., 2019).

Slope Wash, Alluvial, and Eolian deposits

Qas — **Alluvium and slope wash (Holocene)**—Unconsolidated clay, silt, sand, and gravel deposited by alluvial channels and minor slope wash into valley bottoms. Sometimes includes eolian and colluvial deposits. Commonly adjacent to and interfingering with **Qsa**. Estimated thickness is 1–5 m.

Qsa — **Slope wash and alluvium (Holocene)**—Unconsolidated clay, silt, sand, and gravel deposited by slope wash and minor alluvial channels into small basins and hillslopes. Sometimes includes eolian and colluvial deposits. Forms smooth, sloped topography with nonexistent to shallowly incised channels. Estimated thickness is 1–5 m.

Mass-wasting deposits

Qc — **Colluvium (Holocene to middle Pleistocene)**—Unconsolidated boulders, cobbles, pebbles, sand, silt, and clay forming thick, poorly sorted deposits from undivided mass wasting events, including topples, slides, earth and debris flows, and sheet-flow. Gravel lithologies include a variety of locally derived rocks. The unit is mapped where colluvial deposits obscure the underlying bedrock. Approximately 1–20 meters thick.

Qlsb — **Landslide slump blocks (Holocene to late Pleistocene)**—Generally coherent, down-dropped, and back-tilted linear blocks of Jurassic Entrada Sandstone and Todilto Formation that have been displaced from the canyon rim by shear failure, rotation, and lateral displacement of weak underlying rock (Chestnutt et al., 2019). Slump blocks are 220 m to more than 2.5 km from the modern canyon rim. Slump blocks that are further from the canyon rim may have been "rafted" by later landslide events (Chestnutt et al., 2019). Thickness of the deposits is 40-90 m.

Qls — **Landslides, undivided (Holocene to late Pleistocene)**—Unconsolidated sand, silt, clay, pebbles, cobbles, and boulders deposited by rock falls, earth and debris flows, and rotational and translational landslides. Commonly displays landslide scarps, lateral margins, and toes. Contains jumbled, locally-derived rock types. The unit was mapped where landslide deposits lack obvious relative-age relationships, and where multiple landslides create larger complexes that are best mapped as a single unit. Thickness is up to 60 m and highly variable. Absence of a mapped landslide does not indicate the absence of a landslide hazard.

Qlsr — **Recent landslides (late Holocene)**—Unconsolidated sand, silt, clay, pebbles, cobbles, and boulders deposited by rock falls, earth and debris flows, and rotational and translational landslides. Deposits contain jumbled, locally-derived rock types. The unit displays fresh morphological features including flow banding, hummocks, lateral side-shear furrows and levees, and lobate toe deposits that over-thrust and spread over the preexisting ground surface (Chestnutt et al., 2019). **Qlsr** commonly crosscuts **Qlsi** and **Qlso**. Topography is moderately to very hummocky. Deposits are commonly unincised to minorly incised, with minor reworking by alluvial and colluvial processes. Thickness is up to 60 m and highly variable. Absence of a mapped landslide does not indicate the absence of a landslide hazard.

Qlsi — **Intermediate-age landslides (early Holocene to late Pleistocene)**—Unconsolidated sand, silt, clay, pebbles, cobbles, and boulders deposited by rock falls, earth and debris flows, and rotational and translational landslides. Deposits contain jumbled, locally-derived rock types. The unit displays muted landslide morphological features, including scarps, lateral margins, and landslide toes. **Qlsi** commonly crosscuts **Qlso**, but is crosscut by **Qlsr**. Deposits are characterized by overall smoothing of ground morphology by weathering and erosion, and development of drainage networks into the deposit (Chestnutt et al., 2019). These older deposits may be susceptible to creep during periods of high precipitation (Chestnutt et al., 2019). Thickness is up to 60 m and highly variable. Absence of a mapped landslide does not indicate the absence of a landslide hazard.

Qlso — **Older landslides (late Pleistocene)**—Unconsolidated sand, silt, clay, pebbles, cobbles, and boulders deposited by rock falls, earth and debris flows, and rotational and translational landslides. Deposits contain jumbled, locally-derived rock types, with angular boulders often commonly exposed on the surface of the deposit (Chestnutt et al., 2019). The unit displays subtle morphological features, with poorly-defined scarps and gradational lateral margins. **Qlso** is commonly crosscut by **Qlsr** and **Qlsi**. Topography is smooth to moderately hummocky and commonly reworked by alluvial and colluvial processes. The unit is commonly disconnected from the landslide source area. Thickness is up to 60 m and highly variable. Absence of a mapped landslide does not indicate the absence of a landslide hazard.

MESOZOIC SEDIMENTARY ROCKS
Cretaceous

Kd — **Dakota Sandstone (and Mancos Shale), undivided (Late Cretaceous)**—(includes the Encinal Canyon Member, Oak Canyon Member, Cubero Tongue, and Paguate Tongue of the Dakota Sandstone, and the Clay Mesa Tongue of the Mancos Shale; Owen et al., 2005). The oldest unit, the Encinal Canyon Member, is a tan fine- to medium-grained, moderately to well-sorted quartz sandstone with thin- to medium-tabular bedding that is locally cross-bedded. The grains are subround to subangular. Asymmetric ripple marks are common. This sandstone contains fossil wood and carbonaceous plant impressions are common near the base. The Cubero Tongue is fine- to medium-grained and well sorted. This sandstone has thin to medium tabular bedding and is usually bioturbated. The Paguate Tongue is fine- to medium-grained and well sorted. This sandstone has thin- to medium-tabular bedding, common bioturbation, and occasional symmetrical ripple marks. Abundant 0.5–1 mm brown-orange iron oxidation spots. Occasional herringbone cross-bedding and CaCO3 cement. Intervening beds within the unit are variably carbonaceous and form either finely laminated gray sandstone or black shale intervals. Total unit thickness is up to 50 m in the map area.

Kbc — **Burro Canyon Formation (Early Cretaceous)**—White, light-yellow, orange, and buff, conglomeratic sandstone with thin lenses of green or, more rarely, red mudstone (Saucier, 1974). The sandstone is fine- to medium-grained, quartzose, and kaolinitic. Small-scale trough cross-bedding is associated with the conglomeratic channels. Conglomerate clasts are mostly chalky, white chert and varicolored quartzite. Clasts are up to 2.5 cm in diameter and subangular to subrounded. The base of the unit is typically more conglomeratic, while the top of the unit is more sandy. In Ojitos Canyon, lower beds within this unit contain angular clasts up to 20–30 cm in diameter of greenish-white well-sorted fine- to medium-grained sandstone likely derived from scouring of the underlying Brushy Basin Member of the Morrison Formation. Laminar low-angle wedge and high-angle planar wedge cross-bedding is common in the sandier portions of the formation. Some sandstone beds are massive. Occasional asymmetrical ripples, pitted texture, wood casts, and 0.5 cm iron cemented sandstone concretions are present. Slope forming mudstone horizons are 0.5–3 m thick, gray-green, black, or brown-orange, and $CaCO_3$ cemented. Basal contact is disconformable and locally displays significant paleotopography. The unit is 30–40 m thick.

Jurassic
Morrison Formation

Jmb — **Brushy Basin Member (Late Jurassic)**—The Brushy Basin Member is the youngest member of the Morrison Formation and consists of variegated light-greenish-gray, light-gray, grayish-yellow-green, light-olive-gray, yellowish-brown, and drab-reddish-brown mudstones with discontinuous beds of cross-bedded to massive white, yellow, tan or grayish-tan sandstone. Mudstones have moderate silt and minor, very fine sand content. Sandstone interbeds are poorly to moderately sorted, fine- to coarse-grained, and subangular to well-rounded. The iron-bearing minerals in these sandstones are commonly altered to 2–4 mm oxidation spots, giving the sandstones a speckled appearance on weathered surfaces. Sandstones are typically moderately to well-indurated, and occasionally contain green rip-up clasts, burrows, and large (2–4 m), spherical, iron-cemented concretions. The basal contact is conformable, but abrupt, with the underlying Westwater Canyon Member of the Morrison Formation. On the north side of Ojitos Canyon, the upper part of the Brushy Basin Member of the Morrison Formation contains stacked cross-bedded sandstone beds that form continuous cliffs that are 6–10 m high. Upper contact with the overlying Burro Canyon Formation is sharp and disconformable with significant paleotopography. The unit is up to 68 m thick.

Jmw — **Westwater Canyon Member (Late Jurassic)**—The Westwater Canyon Member is the middle member of the Morrison Formation. This unit consists of white to buff, ledge-forming, laminated to trough cross-bedded sandstone with occasional conglomeratic sandstone, and characteristic horizons of mudstone rip-up clasts. Channel forms are common. The sandstone is fine- to coarse-grained and poorly sorted; sand grains are subangular to well-rounded. Feldspar is usually altered to clay, forming either white clay clots, or weathered out to form a pitted texture. Common 0.5–1.0 cm light-green to yellowish oxidation spots. Intervals of red and green silty mudstone rip-up horizons reach 6–8 m above base while isolated rip-ups are found throughout; commonly scoured by sandstone channels. Variable thickness throughout the quadrangle, thin or locally absent except in middle Cañada de la Presa, middle Ojitos Canyon, and upper Cañada de los Fuertes, where it is present. Upper contact is abrupt but conformable with overlying Brushy Basin Member of the Morrison Formation. Unit thickness ranges from 0–50 m.

Jmr — **Recapture Member (Middle to Late Jurassic)**—The Recapture Member is the basal member of the Morrison Formation. This unit consists of drab maroon to grayish-red or white to gray sandstone, siltstone, and sandy siltstone. Sandstones are light-maroon to whitish, very fine- to medium-grained, poorly to moderately indurated, and are occasionally $CaCO_3$ cemented. Sandstones are found in 5–10 cm thick beds with 0.25–1 cm laminae, and commonly display platy or flaggy bedding. Occasional intervals containing limestone nodules and/or mud rip-up clasts are present throughout the unit. Siltstones are red, green, and white with variable clay and sand content. Siltstones are occasionally scoured by sandstones. The unit is 75–125 m thick.

Jtg — **Todilto Formation, where gypsum is present (Middle Jurassic)**—The Todilto Formation consists of a lower, limestone-dominated interval (Luciano Mesa Member), which is locally overlain by a gypsum interval (Tonque Arroyo Member; Lucas et al., 1985, 1995; Kirkland et al., 1995). The Luciano Mesa Member is 2–5 m thick and consists mostly of thinly laminated (0.25–1 cm), dark-gray or yellowish-gray, kerogenic limestone, and calcareous shale. The overlying Tonque Arroyo Member is up to 60 m of white to light-gray, finely crystalline to megacrystalline gypsum interbedded with carbonate. A limestone microbreccia left by dissolution of the gypsum of the Tonque Arroyo Member is present at several places above the Luciano Mesa Member. Where the Tonque Arroyo Member is missing, the Luciana Mesa Member is too thin to map and is grouped into unit **Jet**. Total Todilto Formation thickness is up to 65 m, where the Tonque Arroyo Member is present.

Je — **Entrada Sandstone (Middle Jurassic)**—The Entrada Sandstone is a white, yellow, grayish-orange and red, cross-bedded, ripple-laminated, cliff-forming sandstone. The Entrada Sandstone is a very fine- to medium-grained, moderately well-sorted sandstone that forms bold cliffs along escarpments and mesa tops. Cross-beds are meters-high or "meter-scale" and formed from eolian dune-forming processes. Top of unit is conformable with the Luciano Mesa Member of the Todilto Formation, and the base of the Entrada Sandstone is unconformable with the Rock Point Formation of the Chinle Group. The unit is 55–75 m thick (Fitter, 1958; Crouse et al., 1992).

Jet — **Todilto Formation and Entrada Sandstone (Middle Jurassic)**—A combined unit containing both the Entrada Sandstone and lower, limestone-dominated Luciano Mesa Member of the Todilto Formation, which caps the Entrada Sandstone. Luciano Mesa Member consists of gray, laminated, kerogenic limestone and calcareous shale. Entrada Sandstone consists of yellow, grayish-orange, and red, cross-bedded and ripple-laminated, cliff-forming eolian sandstone. The unit is 55–75 m thick.

Triassic

Tcu — **Upper Chinle Group (Late Triassic)**—An informal upper unit that includes mudstones, siltstones, and sandstones of the Rock Point and Petrified Forest Formations. The Rock Point Formation consists of 5–10 m of reddish-brown, and grayish-red beds of siltstone and fine-grained sandstone. The top of the Rock Point Formation is marked by a sharp, unconformable contact with the Entrada Sandstone (the J-2 unconformity of Lucas, 1993), whereas the bottom of the unit is conformable with the underlying Petrified Forest Formation. The Petrified Forest Formation is approximately 170 m thick and contains two members, the Painted Desert Member and the Mesa Montosa Member. The overlying Painted Desert Member is a reddish-brown, bentonitic mudstone with thin ledges and lenses of ripple-laminated or cross-bedded sandstone; petrified wood is common. The base of the Painted Desert Member is a thick mudstone bed above the highest sandstone ledge of the Mesa Montosa Member. The underlying Mesa Montosa Member is primarily sandstone, with lesser amounts of mudstone and siltstone that range in color from reddish-brown to green; sandstone beds are very fine- to fine-grained, lightly $CaCO_3$ cemented, micaceous, and ripple-laminated to thinly-laminated; ripples are asymmetric. The Mesa Montosa Member is conformable with the underlying Poleo Formation.

Tcl — **Lower Chinle Group (Late Triassic)**—The lower Chinle Group primarily consists of the Poleo Formation. This unit is dominantly sandstone with subordinate conglomeratic sandstone, conglomerate, silty-sandstone, and mudstone. Sandstones are yellow-brown and yellow-gray, quartzose, fine- to medium-grained, angular to subangular, characteristically micaceous, and cross-bedded. Sandstones contain occasional rip-up clasts, potassium feldspar, mica, and rare plant impressions. The matrix includes abundant potassium feldspar and exotic lithics including fine-grained sedimentary, low-grade metamorphic, and felsic igneous clasts; commonly $CaCO_3$ cemented. Conglomerate is interbedded with horizons of very coarse sandstone. Silty sandstones are gray to blue with abundant silt and minor very fine sands; thinly laminated and micaceous. This unit is exposed along the banks of the Rio Chama below the confluence of the Rio Chama and the Rio Gallina. The upper contact is gradational into the overlying Mesa Montosa Member of the Petrified Forest Formation. Only the top few meters are exposed on the Laguna Peak quadrangle.

CROSS SECTION ONLY

Pc — **Cutler Formation (Early Permian)**—Red, maroon, and white granitic siltstones, sandstones, and conglomerates.

Pm — **Madera Formation (Pennsylvanian)**—Arkosic sandstone and limestone.

pCu — **Proterozoic rocks (Proterozoic)**—Igneous and metamorphic rocks ranging from 1.7 to 1.4 Ga.

Geologic Cross Section A–A'
(no vertical exaggeration)