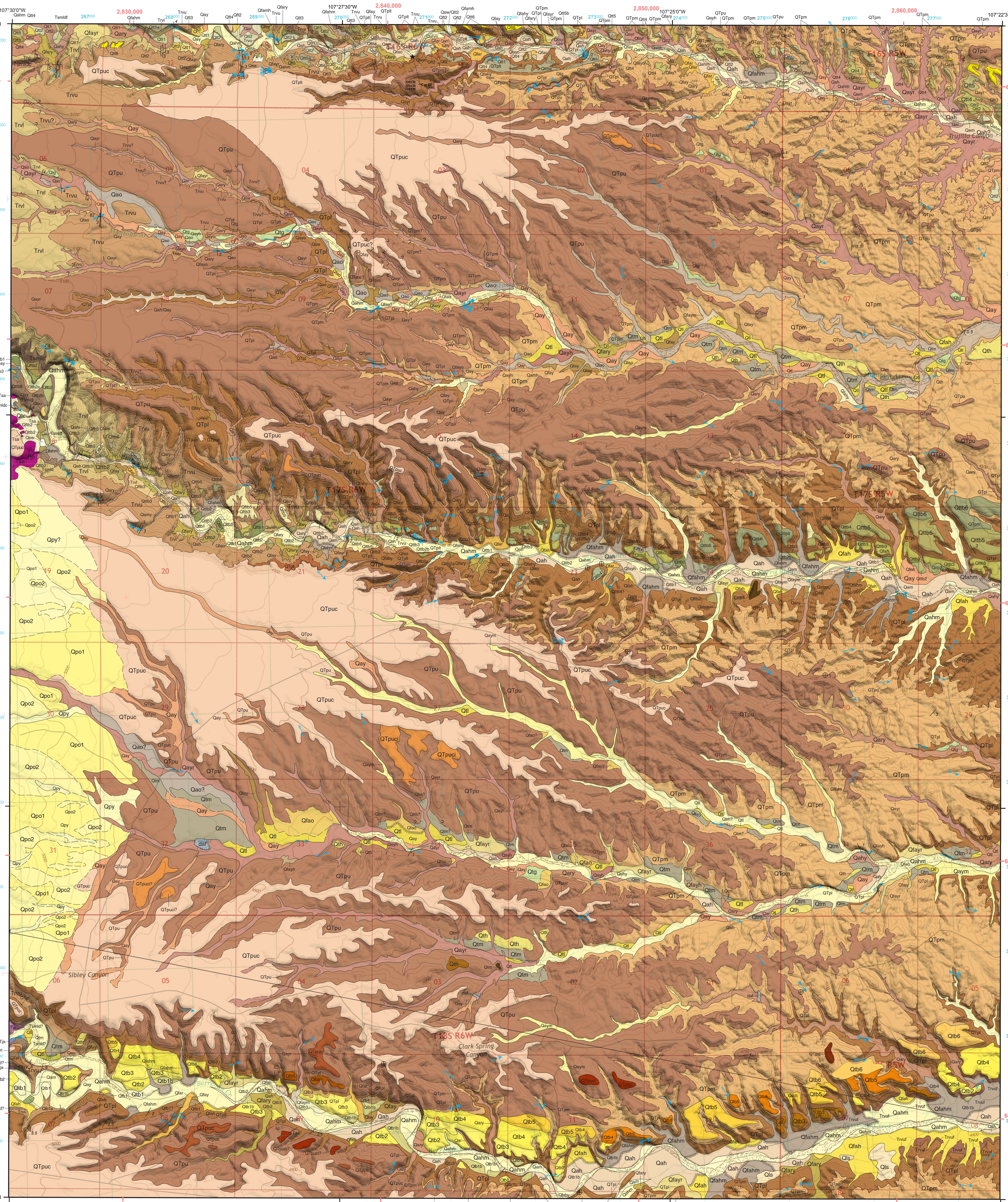
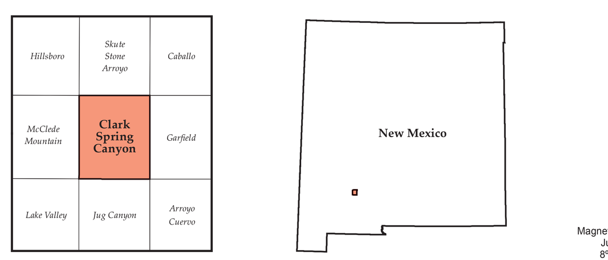


Base map from U.S. Geological Survey 2013
North American Datum of 1983 (NAD83); World Geodetic System of 1984 (WGS84).
Projection and 1000-meter grid: Universal Transverse Mercator, Zone 13S
10,000-foot ticks: New Mexico Coordinate System of 1983 (west zone), shown in red.

1:24,000

Contour Interval 20 Feet
North American Vertical Datum of 1988



Magnetic Declination July, 2016 8° 52' East At Map Center

Quadrangle Location

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

[575] 835-5490

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

http://geoinfo.nmt.edu

Digital layout and cartography by the NMBGMR Map Production Group:
Phil Miller
David J. McCraw
Elizabeth H. Roybal

New Mexico Bureau of Geology and Mineral Resources
Open-File Geologic Map 263

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Geologic Map of the Clark Spring Canyon 7.5-Minute Quadrangle, Sierra County, New Mexico

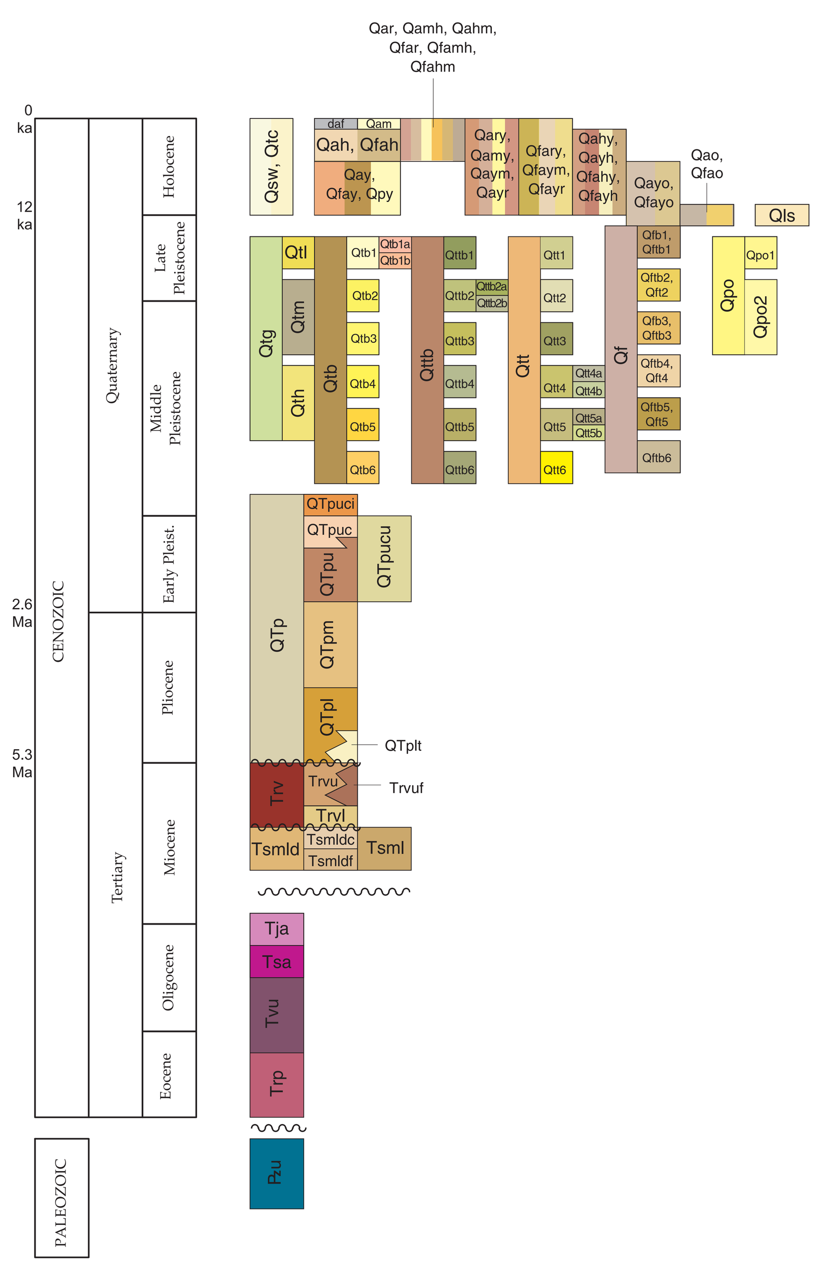
June, 2017

by
Andrew P. Jochems [1] and Daniel J. Koning [1]

[1] New Mexico Bureau of Geology and Mineral Resources, 801 Leroy Place, Socorro, NM 87801

FIGURE 1—Exposure of contact between units QTpu (above) and QTpm (below). Contact occurs at abrupt, slightly wavy scour at base of gray gravel in center-right of photo. Gravel beds in unit QTpu are typically stacked, clast-supported, and well imbricated, and are interpreted as fluvial in origin. Below, unit QTpm is comprised of reddish to light brownish extra-channel fine sand, silt, and mud that may be overprinted by buried soils featuring cambic and/or stage I-III calcic horizons. UTM coordinates 276951 m E, 3637651 m N (NAD 83).

Correlation of Map Units



Explanation of Map Symbols

- A —— A′ Cross-section line and label
- Geologic contact—Identity and existence certain; questionable where queried. Location accurate where solid, approximate where dashed, and concealed where dotted.
- Gradational contact—Identity and existence certain, location accurate where continuous, location approximate where discontinuous.
- Fault—Identity and existence certain, location concealed.
- Small, minor inclined fault—Showing strike and dip.
- Horizontal bedding
- Inclined bedding—Showing strike and dip.
- Apparent dip—Showing approximate strike and dip.
- Gently inclined (between 0° and 30°) bedding, as determined remotely or from aerial photographs—Showing approximate strike and direction of dip.
- Inclined flow banding, lamination, layering, or foliation in igneous rock—Showing strike and dip.
- Fluvial transport direction
- Sediment transport direction determined from imbrication.
- Sediment transport direction determined from crossbeds.
- ★ Radiometric sample locality—Location of radiometrically dated sample.

Comments to Map Users

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

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

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Description of Map Units

Quaternary

Qsw **Slopewash**—Clay, very fine sand, and minor silt and fine to coarse sand in very thin, poorly stratified, lenticular beds. Loose and massive. Sand may contain ~5% scattered pebbles. Commonly exhibits cumulic soil development with medium to coarse, sub-blocky peds, illuviated clay, and stage I carbonate morphology. May interfinger with upper Pleistocene fan deposits; otherwise, deposit onlaps fan gravels in most places. 1–2 m thick.

Qtc **Talus and colluvium**—Cobbles and boulders (minor pebbles) lying at the base of steep escarpments or forming aprons flanking upland areas on Trvld and Tsa in section 18, T17S, R6W. Deposit may exhibit massive or slope-parallel textures. Gravel is very poorly sorted and angular to subangular. Where present, matrix is also very poorly sorted. Thickness unknown but inferred to be <3 m in most places.

Qls **Landslide deposit**—Light-brownish to light-reddish, sandy pebble-cobble-boulder gravel underlying hummocky topography along Berrenda Creek in section 7, T18S, R5W and section 12, T18S, R6W. Loose with random or massive fabric. No soils observed. Deposit forms toreva blocks that overlie Trvuf and are elongate parallel to the modern stream course. Up to ~15 m thick.

daf **Disturbed or artificial fill**—Sand and gravel that has been moved by humans to form berms and dams.

Qam **Modern alluvium**—Light-brownish-gray (10YR 6/2) sand and pebble-cobble-boulder gravel in modern channels, troughs, and bars. Loose, non-calcareous, and moderately well imbricated to rippled to (rarely) fluted. Gravel is clast-supported, very poorly to poorly sorted, subrounded to well-rounded, and consists of pebbles (60–90%), cobbles (10–30%), and boulders (up to 10%) of >80% volcanic lithologies and up to 10% Paleozoic sedimentary lithologies. Sand consists of poorly sorted, subrounded to rounded, fU-cU grains (5–8% very coarse grains) composed of 50–55% quartz, 30–40% lithics (volcanic>chert), and 10–20% feldspar with little or no clay. Veneers of brown (7.5YR 5/3) silt and clay are occasionally found at channel margins. Maximum thickness approximately 3 m.

Qamh **Modern and historical alluvium, undivided**—Modern alluvium (Qam) and subordinate historical alluvium (Qah). See detailed descriptions of each individual unit.

Qamy **Modern and younger alluvium, undivided**—Modern alluvium (Qam) and subordinate younger alluvium (Qay). See detailed descriptions of each individual unit.

Qah **Historical alluvium** —Well-defined, interbedded sandy silt, pebbly sand, and sandy gravel in very thin to medium, tabular to lenticular beds. Loose. Sand and pebbly sand is commonly horizontal-planar or gently cross-stratified. Gravel is clast- to matrix-supported, commonly imbricated, poorly to moderately sorted, subrounded (minor subangular), and consists of very fine to very coarse pebbles (60-100%), cobbles (0–30%), and boulders (0–10%) of >80% volcanic lithologies. In sandy gravel beds, sand matrix consists of dark-brown to brown (10YR 3-5/3), very poorly to poorly sorted, subrounded to well-rounded (minor subangular), fL-cU grains (very fine to medium in floodplain facies) of 60–70% lithics (volcanic), 20–30% quartz, and 10–20% feldspar with no clay. In pebbly sand and sand intervals, sand consists of grayish-brown to brown (10YR 5/2-3), poorly to moderately sorted, subrounded (minor subangular), very fine to very coarse grains (very fine to medium in floodplain deposits). Along Berrenda Creek, deposit commonly features brown (10YR 4/3), loose, moderately calcareous, thin- to thick-bedded (6–40 cm), tabular, internally massive, well-sorted, sandy silt with 5-10% subrounded, lithic-rich, vfL-fU sand. Top soil characterized by weak to no soil development. Where present, soil is characterized by a weak stage I calcic horizon. Commonly bioturbated by fine to coarse roots and burrows. Surface has distinct bar-and-swale relief (10-30 cm) and very weak clast varnishing in places. These surface characteristics, in addition to relatively distinct bedding and color, distinguish deposit from Qay. Radiocarbon samples from an exposure in section 34, T16S, R6W returned conventional ages between 330+/-30 and 770+/-30 14C yr BP. Unit generally overlies a sharp contact with or is inset into Qay. Inferred to be 1.5–4 m thick.

Qahm **Historical and modern alluvium, undivided**—Historical alluvium (Qah) and subordinate modern alluvium (Qam). See detailed descriptions of each individual unit.

Qahy **Historical and younger alluvium, undivided**—Historical alluvium (Qah) and subordinate younger alluvium (Qay). See detailed descriptions of each individual unit.

Qar **Recent alluvium**—Historical alluvium (Qah) and modern alluvium (Qam) in approximately equal proportions. See detailed descriptions of each individual unit.

Qary **Recent and younger alluvium, undivided**—Recent alluvium (Qah + Qam) and subordinate younger alluvium (Qay). See detailed descriptions of each individual unit.

Qay **Younger alluvium**—Brown (10YR 4-5/3; 7.5YR 5/2-3), relatively fine sand to silty sand interbedded with subequal to minor gravelly beds in very thin to medium, tabular to lenticular beds. Weakly consolidated. Finer sediment is generally massive within beds but locally occurs in laminated to very thin beds that are horizontal-planar to low-angle cross-stratified. This sand is moderately sorted, subrounded (lesser subangular), and mainly very fine- to medium-grained, locally with minor coarse to very coarse sand and scattered pebbles. Its composition reflects the local source area. In small, steep canyons (drainage area of <1 mi²), sediment is generally a sandy gravel in very thin to thin, tabular to lenticular beds with <10% low-angle cross-bedding. Gravel is commonly clast-supported, poorly to moderately sorted, subrounded, and consists of pebbles and subordinate cobbles of compositions reflecting the local source area. Channel-fill sand consists of poorly sorted, subrounded (minor subangular), fine to very coarse grains composed mostly of lithics (volcanic). Finer sediment typically exhibits cumulic soil profiles characterized by moderate to strong, fine to coarse, subangular, blocky peds, locally with faint evidence of clay illuviation (especially clay bridges). Buried calcic horizons are not usually observed. Erosion typically results in poor top soil preservation and coarse lag gravel, but locally a stage I to stage II calcic horizon is found. Darkened A horizons ~10 cm thick (dark-grayish-brown, 10YR 4/2) are rare. Surface has very subdued bar-and-swale topography (<20 cm) and weak clast varnish. Compared to Qah, bedding is slightly less distinct and commonly internally massive due to infiltration offine-grained sediment, bioturbation, and weak cumulic soil development. The deposit also has more fine sand and silty-clayey sand beds and a surface with more subdued bar-and-swale relief than Qah. 1–4 m thick.

Qaym **Younger and modern alluvium, undivided**—Younger alluvium (Qay) and subordinate modern alluvium (Qam). See detailed descriptions of each individual unit.

Qayh **Younger and historical alluvium, undivided**—Younger alluvium (Qay) and subordinate historical alluvium (Qah). See detailed descriptions of each individual unit.

Qayr **Younger and recent alluvium, undivided**—Younger alluvium (Qay) and subordinate recent alluvium (Qah + Qam). See detailed descriptions of each individual unit.

Qayo **Younger and older alluvium, undivided**—Younger alluvium (Qay) and subordinate older alluvium (Qao). See detailed descriptions of each individual unit.

Qao **Older alluvium**—Sandy pebble-cobble and pebble-cobble-boulder gravel, pebbly sand, and clay-silt in laminations to very thin to medium, tabular to lenticular beds. Loose to consolidated and horizontal-planar laminated to planar cross-stratified (foresets 10-40 cm thick). Gravel is clast-supported to open-framework, poorly sorted, subrounded (minor subangular), and consists of pebbles (50–70%), cobbles (25 to >50%), and boulders (3–12%) of volcanic lithologies including up to 1% basalt. Sand consists of yellowish-to reddish-brown (5YR 4/6 to 5/4), moderately sorted, subangular to subrounded, fU-vcU (<7% vfl-fL) grains dominated by lithics (volcanic) with 1–2% partial clay films. Subordinate (up to 20%) beds in upper 1.2 m of deposit feature gleyed, light brownish gray or light gray (10YR 6/2; 10YR-2.5Y 7/1-2, N 7/) clay-silt with minor sand-pebble interbeds 5–15 cm thick. Surface is typically smooth and undissected. Tread height 2–2.5 m above modern grade. 1–2.2 m thick.

Qfamh **Modern and historical fan alluvium, undivided**—Modern fan alluvium and subordinate historical fan alluvium (Qfah). Modern fan alluvium is grayish or yellowish-brown (10YR 5/2 or 5/4), loose, sandy pebble-cobble gravel graded to Qam or Qah; see description for Qfah.

Qfah **Historical fan alluvium**—Brown (7.5-10YR 4-5/3) to pale-brown (10YR 6/3), sandy fine pebble gravel interbedded with pebble-cobble gravel in medium to thick (10–60 cm), tabular to lenticular beds. Loose, weakly to moderately calcareous, and massive to well-imbricated. Gravel is clast- to matrix-supported and consists of pebbles(50–100%) and cobbles (0–50%) of volcanic lithologies reworked from QTp. Matrix of pebbly gravel consists of very poorly to poorly sorted, subangular to rounded, vfL-cL sand (20–25% very coarse sand to granules) composed of 70–80% lithics (volcanic) and 20–30% quartz + feldspar with 5–15% brownish clay bridges. Matrix of pebble-cobble gravel consists of very poorly to poorly sorted, subangular to rounded, vfU-cL sand composed of 65–75% lithics(volcanic) and 25–35% quartz + feldspar with no clay. Weak A horizons may be observed in the upper 15–20 cm of the deposit. Deposit is bioturbated by very fine to coarse roots and burrows. Surface features bar-and-swale topography with <25 cm of relief. Deposit underlies fans graded to Qah. At least 1.7–2 m thick.

Qfahm **Historical and modern fan alluvium, undivided**—Historical fan alluvium (Qfah) and subordinate modern fan alluvium. Modern fan alluvium is grayish or yellowish-brown (10YR 5/2 or 5/4), loose, sandy pebble-cobble gravel graded to Qam or Qah; see description for Qfah.

Qfahy **Historical and younger fan alluvium, undivided**—Historical fan alluvium (Qfah) and subordinate younger fan alluvium (Qfay). See detailed descriptions of each individual unit.

Qfar **Recent fan alluvium**—Historical fan alluvium (Qfah) and modern fan alluvium in approximately equal proportions. See descriptions for Qfamh and Qfah.

Qfary **Recent and younger fan alluvium, undivided**—Recent fan alluvium (Qfar) and subordinate younger fan alluvium (Qfay). See descriptions for Qfamh, Qfah, and Qfay.

Qfay **Younger fan alluvium**—Interbedded silt, sand, and sandy gravel in thin to thick (6–33 cm), tabular to broadly lenticular or wedge-shaped beds. Loose to weakly consolidated and moderately to strongly calcareous. Sandy beds may be planar cross-stratified (foresets up to 5 cm thick) or horizontal-planar laminated. Granule-pebble and pebble-cobble gravel consists of clast-supported, imbricated, very poorly to poorly sorted, subangular to rounded clasts of volcanics reworked from QTp. Gravel matrix consists of brown to grayish-brown (7.5-10YR 5/2), poorly sorted, subangular to rounded, fU-cU sand composed of 60–70% lithics (volcanic), 20-30% quartz, and 10–20% feldspar with no clay. Finer-grained beds consist of brown to light-brown (7.5YR 5-6/3), very poorly to poorly sorted, subrounded to rounded, silt to mU or fL-cU sand composed of 60-90% lithics (volcanic) and 10–40% quartz + feldspar, occasionally with 10–20% floating granules and fine-to medium pebbles. Topsoil may feature weak overprinting of upper 8–10 cm by incipient A horizon. Elsewhere, surface overlies a stage I+ calcic horizon or is erosionally stripped. Deposit is bioturbated by fine to very coarse roots and burrows. Surface features subdued bar-and-swale topography with <10–15cm of relief. Deposit underlies fans graded to Qay. At least 1.5–1.7 m thick.

Qfaym **Younger and modern fan alluvium, undivided**—Younger fan alluvium (Qfay) and subordinate modern fan alluvium. Modern fan alluvium is grayish-or yellowish-brown (10YR 5/2 or 5/4), loose, sandy pebble-cobble gravel graded to Qam or Qah; see description for Qfay.

Qfayh **Younger and historical fan alluvium, undivided**—Younger fan alluvium (Qfay) and subordinate historical fan alluvium (Qfah). See detailed descriptions of each individual unit.

Qfayr **Younger and recent fan alluvium, undivided**—Younger fan alluvium (Qfay) and subordinate recent fan alluvium (Qfar). See descriptions for Qfamh, Qfah, and Qfay.

Qfayo **Younger and older fan alluvium, undivided**—Younger fan alluvium (Qfay) and subordinate older fan alluvium (Qfao). See detailed descriptions of each individual unit.

Qfao **Older fan alluvium**—Reddish-brown (5YR 4/4) to brown (7.5YR 4/3-4) or pale-brown (10YR 6/3), sandy pebble-cobble-boulder gravel and pebbly sand in medium to very thick (25–140 cm), tabular to lenticular beds. Loose and weakly to moderately calcareous. Gravel is clast- to matrix-supported (35–40 and 60–65%, respectively), massive to variably imbricated, very poorly to poorly sorted, subangular to rounded, and consists of pebbles (50–95%), cobbles(5–30%), and boulders (0–25%) of volcanic lithologies reworked from QTp. Matrix sand consists of poorly sorted, subangular to subrounded, silty, medium to coarse (minor vfL-mU) grains of 60–70% lithics (volcanic), 15–20%quartz, and 15–20% feldspar with up to 25% brownish free-grain argillans. Pebbly sand is similar to gravel matrix. Well-developed topsoil is locally preserved and characterized by a strong calcic horizon (stage II+ to III+) overlain by cambic or illuviated clay horizons. Up to 60–70% of clasts at surface clasts may be varnished. Basal gravels scour underlying units up to 70 cm. Deposit underlies fans graded to Qao, which is often eroded. 1–10 m thick.

Qfb1 **Alluvial fans prograding onto lowermost Berrenda Creek terraces**—Alluvium underlying fan surfaces graded to Qtb1.

Qfb3 **Alluvial fans prograding onto middle Berrenda Creek terraces**—Alluvium underlying fan surfaces graded to Qtb3.

Qftb1 **Alluvial fans prograding onto lowermost Tierra Blanca Creek terraces**—Alluvium underlying fan surfaces graded to Qttb1.

Qftb2 **Alluvial fans prograding onto lower Tierra Blanca Creek terraces**—Alluvium underlying fan surfaces graded to Qttb2.

Qftb3 **Alluvial fans prograding onto middle Tierra Blanca Creek terraces**—Alluvium underlying fan surfaces graded to Qttb3.

Qftb4 **Alluvial fans prograding onto upper-middle Tierra Blanca Creek terraces**—Alluvium underlying fan surfaces graded to Qttb4.

Qftb5 **Alluvial fans prograding onto upper Tierra Blanca Creek terraces**—Alluvium underlying fan surfaces graded to Qttb5.

Qftb6 **Alluvial fans prograding onto uppermost Tierra Blanca Creek terraces**—Alluvium underlying fan surfaces graded to Qttb6.

Qft2 **Alluvial fans prograding onto lower Trujillo Creek terraces**—Alluvium underlying fan surfaces graded to Qtt2.

Qft4 **Alluvial fans prograding onto upper-middle Trujillo Creek terraces**—Alluvium underlying fan surfaces graded to Qtt4.

Qft5 **Alluvial fans prograding onto upper Trujillo Creek terraces**—Alluvium underlying fan surfaces graded to Qtt5.

Qpy **Younger piedmont alluvium**—Reddish-brown to brown (5-7.5YR 4/4) sandy pebble-cobble-boulder gravel in thick (35 to >50 cm), tabular to lenticular beds. Loose, very weakly calcareous, well-imbricated to internally massive, and normally graded. Gravel is clast-supported, very poorly to poorly sorted, subangular to subrounded, and consists of pebbles (50–80%), cobbles (20–50%), and boulders (5–15%) of andesite derived from the Sibley Mountains. Matrix consists of very poorly sorted, angular to subrounded, fU-vcL sand composed of 85–90% lithics (volcanic) and 10–15% quartz + feldspar with 30–50% free-grain argillans and perhaps occasional clay bridges. Gravel interbeds with subordinate dark-brown (7.5YR 3/4), loose, weakly calcareous, thick-bedded (40-50 cm), tabular to wedge-shaped, internally massive, moderately well-sorted silt-clay with 5–10% vfL-mL sand. Surface gravels in sand matrix. Calcareous root traces are somewhat common but no soil development observed. Bar-and-swale topography at surface features less than 10 cm of relief. 1–2.5 m thick.

Qpo **Older piedmont alluvium**—Loose, calcareous, yellowish-red (5YR) pebble-cobble-boulder gravel. Gravel is mostly matrix-supported and dominated by andesite. Upper part of deposit contains soil profile with stage II calcic horizons. Surface features weakly to moderately varnished clasts and bar-and-swale topography with <30 cm relief. Up to 3.5 m thick. Subdivided into 2 deposits based on landscape position:

Qpo1 **Older piedmont alluvium, younger allostratigraphic unit**—Deposit surface is approximately 2–4 m above that of Qpy.

Qpo2 **Older piedmont alluvium, older allostratigraphic unit**—Deposit surface is approximately 8–9 m above that of Qpy and 4–7 m above that of Qpo1.

Qtg **Tributary terrace deposits, undivided**—Reddish-brown to brown (5-7.5YR 4/3-4), sandy pebble-cobble-boulder gravel in medium to very thick (10–110 cm), tabular to broadly lenticular beds. Loose to weakly consolidated, non- to moderately calcareous, and moderately or well-imbricated to vaguely planar cross-stratified (foresets up to 30 cm thick). Gravel is clast-supported (rarely matrix-supported), very poorly to poorly sorted, subangular to well-rounded (mostly subrounded to rounded), and consists of pebbles (50–90%), cobbles (10–45%), and boulders (5–15%) of mostly volcanic lithologies reworked from QTp (<5% each of Paleozoic carbonates, chert, and basalt). Matrix sand consists of very poorly to poorly sorted, subangular to rounded, mL-vcL (minor fU) grains composed of 55-80% lithics (volcanic), 10–35% quartz, and 5–20% feldspar with 5–30% dark-reddish free-grain argillans and clay bridges. Contains rare (5%), 15- to 70-cm-thick lenses of moderately calcareous, lenticular, planar cross-stratified (foresets up to 10 cm thick) to horizontal-planar laminated (rare), moderately well-sorted, subrounded to rounded, fU-cL sand composed of 60–70% quartz, 20–30% lithics (volcanic), and 10–15% feldspar with no clay. Individual terrace deposits are distinguished by surface characteristics and relative abundance of calcic soils related to age. Older deposits feature moderate to strong varnish on up to 85% of clasts at surface as well as calcic horizons with up to stage II+ carbonate accumulation. 1.2–7 m thick. Subdivided into 3 deposits based on landscape position:

Qtl **Lower tributary terrace deposit**—Terrace tread 3–6 m above valley floor.

Qtm **Middle tributary terrace deposit**—Terrace tread 5–13 m above valley floor.

Qth **Upper tributary terrace deposit**—Terrace tread 8–20 m above valley floor. Also includes high terrace near confluence of Jaralosa and Berrenda Creeks with tread 30–31 m above valley floor.

Qtb1 **Lowermost Berrenda Creek terrace deposit**—Terrace tread 3–9 m above valley floor. Subdivided into 2 deposits:

Qtb1a **Lowermost Berrenda Creek terrace deposit, younger allostratigraphic unit**—Terrace tread 3–4 m above valley floor.

Qtb1b **Lowermost Berrenda Creek terrace deposit, older allostratigraphic unit**—Terrace tread 5–9 m above valley floor.

Qtb2 **Lower Berrenda Creek terrace deposit**—Terrace tread 10–14 m above valley floor.

Qtb3 **Middle Berrenda Creek terrace deposit**—Terrace tread 15–22 m above valley floor.

Qtb4 **Upper-middle Berrenda Creek terrace deposit**—Terrace tread 27–33 m above valley floor.

Qtb5 **Upper Berrenda Creek terrace deposit**—Terrace tread 35–46 m above valley floor.

Qtb6 **Uppermost Berrenda Creek terrace deposit**—Terrace tread 47–51 m above valley floor.

Qttb1 **Lowermost Tierra Blanca Creek terrace deposit**—Terrace tread 3–5 m above valley floor.

Qttb2 **Lower Tierra Blanca Creek terrace deposit**—Terrace tread 4–11 m above valley floor. Subdivided into 2 deposits:

Qttb2a **Lower Tierra Blanca Creek terrace deposit, younger allostratigraphic unit**—Terrace tread 4–7 m above valley floor.

Qttb2b **Lower Tierra Blanca Creek terrace deposit, older allostratigraphic unit**—Terrace tread 7–11 m above valley floor.

Qttb3 **Middle Tierra Blanca Creek terrace deposit**—Terrace tread 10–19 m above valley floor.

Qttb4 **Upper-middle Tierra Blanca Creek terrace deposit**—Terrace tread 18–27 m above valley floor.

Qttb5 **Upper Tierra Blanca Creek terrace deposit**—Terrace tread 21–39 m above valley floor.

Qttb6 **Uppermost Tierra Blanca Creek terrace deposit**—Terrace tread 40–52 m above valley floor.

Qtt1 **Lowermost Trujillo Creek terrace deposit**—Terrace tread 2–7 m above valley floor.

Qtt2 **Lower Trujillo Creek terrace deposit**—Terrace tread 4–17 m above valley floor.

Qtt3 **Middle Trujillo Creek terrace deposit**—Terrace tread 10–23 m above valley floor.

Qtt4 **Upper-middle Trujillo Creek terrace deposit**—Terrace tread 13–26 m above valley floor. Subdivided into 2 deposits:

Qtt4a **Upper-middle Trujillo Creek terrace deposit, lower subunit**—Terrace tread 19–20 m above valley floor.

Qtt4b **Upper-middle Trujillo Creek terrace deposit, upper subunit**—Terrace tread 21–23 m above valley floor.

Qtt5 **Upper Trujillo Creek terrace deposit**—Terrace tread 19–34 m above valley floor. Subdivided into 2 deposits:

Qtt5a **Upper Trujillo Creek terrace deposit, lower subunit**—Terrace tread 23–25 m above valley floor.

Qtt5b **Upper Trujillo Creek terrace deposit, upper subunit**—Terrace tread 29–34 m above valley floor.

Qtt6 **Uppermost Trujillo Creek terrace deposit**—Terrace tread 35–47 m above valley floor.

Quaternary-Tertiary

Palomas Formation

QTpuc **Upper coarse piedmont facies**—Reddish-brown (5YR 4-5/4), sandy pebble, pebble-cobble, and pebble-cobble-boulder gravel in medium to thick (35–80 cm), tabular beds. Loose to somewhat consolidated, slightly calcareous to weakly clay-cemented, and internally massive to well-imbricated and/or vaguely planar cross-stratified (foresets up to 20 cm thick). Gravel is clast- to matrix-supported (85% versus 15%, respectively), very poorly to poorly sorted, subrounded to rounded, and consists of pebbles (55–95%), cobbles (5–45%), and boulders (trace to 5%). Median clast diameter is ~25 cm. Clast lithologies include intermediate volcanics (40–45%), Paleozoic sedimentary lithologies and chert (15–35%), Kneeling Nun tuff (10–15%), undivided felsic volcanics (2–30%), and trace to 2% each of basalt and volcaniclastic sandstone. Matrix consists of poorly sorted, subrounded, fine to coarse (10% very coarse) sand composed of 60–65% lithics (volcanic>>chert), 20–25% quartz, and 10–15% feldspar with up to 20–25% clay flakes and free-grain argillans. Unit may be capped by stage IV calcic horizon with laminar carbonate. Laterally gradational with upper part of QTpu south of Tierra Blanca Creek. 0–30 m thick.

QTpuci **Upper coarse piedmont facies, inset subunit**—Gravel bed(s) as in QTpuc but inset into Cuchillo surface by 3–7 m throughout quadrangle. Individual beds typically 3–5 m thick.

QTpu **Upper piedmont facies**—Dark-reddish-brown to reddish-brown (5YR 3-4/4), laterally extensive, occasionally stacked channel fills with subordinate yellowish-red (5YR 4-5/6) silt and mud interbeds. Pebbly to cobbly channel-fill gravel is in thick (40–70 cm), lenticular (minor tabular) beds. Loose to weakly consolidated, slightly to moderately calcareous, and weakly clay-cemented. Gravel is clast-supported, well-imbricated to occasionally planar cross-stratified (foresets 20–35 cm thick), very poorly to poorly sorted, subrounded to well-rounded, and consists of pebbles (60–95%), cobbles (5–35%), and boulders (0–5%). Median clast diameter is ~11 cm. Clast lithologies include intermediate volcanics (30-65%), undivided felsic volcanics (10–40%), Kneeling Nun tuff (10–20%), Paleozoic carbonate and chert (7–15%), and trace to 4% each of basalt, intermediate intrusive lithologies, and volcaniclastic sandstone. Channel-fill matrix consists of very poorly to poorly sorted, subangular to rounded, fine to very coarse sand composed of 70-80% lithics (volcanic>chert + carbonate), 15–20% quartz, and 5–10% feldspar with 1–20% red clay flakes and free-grain argillans. Silt and mud beds are massive/poorly stratified and contain up to 5% very fine to medium sand grains. These beds are commonly overprinted by illuviated clay and/or stage I to II calcic horizons with prismatic peds, ped argillans, root casts coated by manganese oxide, slickensides, and perhaps carbonate nodules and masses. Basal contact taken at base of lowest laterally extensive channel fill or stacked channel fills. Upper part is laterally gradational with QTpuc south of Tierra Blanca Creek. 0–35 m thick.

QTpm **Middle piedmont facies**—Reddish-brown to light-brown (5YR 5/4 to 7.5YR 6/3), extra-channel sediment with rare to minor gravel that increases in proportion westward. Loose to weakly consolidated and moderately to strongly calcareous. Silt-sand and sandy mud occur in massive/poorly stratified beds. These finer-grained deposits contain varying amounts of fine- to medium (lesser coarse) sand grains typically dominated by lithics (volcanic). Mudbeds may be overprinted by cambic and/or illuviated clay and stage I-III calcic horizons with very fine carbonate masses, root casts coated by manganese oxide, prismatic peds, and ped argillans. Gravel is clast-supported, thin- tomedium-bedded (8–20 cm), tabular, weakly imbricated, poorly sorted, subangular to rounded, and consists of pebbles (75–90%) and fine cobbles (10–15%). Median clast diameter is ~7 cm. Clast lithologies include intermediate volcanics(40–60%), undivided felsic volcanics (10–30%), Paleozoic carbonate and chert (10–15%), Kneeling Nun tuff (5–15%),and 0–2% each of basalt, intermediate intrusive lithologies, and volcaniclastic sandstone. Gravel matrix consists of brown (7.5YR 5/3-4), moderately sorted silt to very fine sand with 15–25% subrounded to rounded, fine to medium sand-grains composed of >90% lithics (volcanic) with no clay. Lower 3–10 m may be vertically gradational with QTpl, particularly along Tierra Blanca and Berrenda Creeks. 0 to >48 m thick.

QTpl **Lower piedmont facies**—Pinkish to light-brownish-gray or light-brown (7.5-10YR 6/2-3), sandy pebble gravel channel fills and minor sand in thin to medium (3–30 cm), tabular to broadly lenticular beds. Weakly to moderately consolidated, slightly to strongly calcareous and/or calcite-cemented, and moderately imbricated. Channel-fill gravel is clast-supported (rarely matrix-supported), poorly to moderately sorted, subangular to rounded (mostly subrounded), and consists of fine to coarse pebbles of intermediate volcanics (40–60%), undivided felsic volcanics (10–35%), Kneeling Nun tuff (10-20%), Paleozoic sedimentary lithologies and chert (10–15%), and 2–4% each of intermediate intrusive lithologies and volcaniclastic sandstone. Median clast diameter is ~5 cm. Where not replaced by calcite, gravel matrix consists of moderately sorted, subangular to subrounded, silt to very fine (15% fine to coarse) sand composed of 75–80% lithics (volcanic), 10–15% quartz, and 5–10% feldspar with no clay. Gravel coarsens slightly upsection. Subordinate sandy beds consist of internally massive to horizontal-planar laminated (very thin), moderately well-sorted, angular to rounded (mostly subangular to subrounded), very fine to fine grains with similar composition to gravel matrix. These beds may contain 1% granules and fine pebbles. Abundant stage II through III+ calcic paleosols, locally with illuviated clay or cambic horizons. Upper 3–10 m may be vertically gradational with QTpm, particularly along Tierra Blanca and Berrenda Creeks. 0–31 m thick.

QTplt **Transitional base of the lower piedmont facies**—Pinkish-gray to light-brown or reddish-yellow (7.5YR 6/2-6) to grayish-brown (10YR 5/2), pebbly sand and sandy gravel in very thin to thin, tabular beds or thin to medium, lenticular beds. Rarely, beds are light-reddish-brown to reddish-yellow (5YR 6/4-6). Weak to moderately calcite-cemented. Sandy sediment may exhibit low-angle cross-stratification. Sand is poorly to moderately sorted, subround (minor subangular), fine to very coarse (<10% silt and very fine to fine sand) and composed mostly of volcanic grains. Gravel beds constitute 30–50% of deposit and consist of poorly to moderately sorted, subrounded (minor subangular) pebbles (70–80%), cobbles (15–25%), and boulders (trace to 5%). Clast lithologies include intermediate volcanics (40–45%), Kneeling Nun tuff (20–25%), undivided felsic volcanics (15–20%), intermediate intrusive lithologies (<10%), chert (5–10%), and rare (0.5–2%) Paleozoic carbonates and reddish-brown, vesicular, altered basalt. Minor medium to thick, lenticular beds contain abundant matrix-supported, poorly sorted cobbles. 10–50% overprinting by calcic paleosols (stage I to III carbonate morphology), which increases upsection in Trujillo Creek. Calcic horizons are locally overlain by cambic or illuviated clay horizons. 0–14 m thick.

Rincon Valley Formation and Lower Santa Fe Group

Trvu **Upper unit of the Rincon Valley Formation**—Light-brown to brown or strong-brown (7.5YR 6/3-4; 5/4-6) or reddish-brown to reddish-yellow or light-reddish-brown (5YR 4-6/4; 6/3), pebbly sand with <5–40% sandy gravel interbeds. Mostly non- to weakly cemented with 5–20% moderate (0-10% strong) calcite cementation. Pebbly sandand sand are horizontal-planar laminated to thinly bedded (minor lenticular beds) with 1–20% cross-stratification as low-angle cross-laminations or in thin to very thin, planar foresets up to 30 cm tall. Sand is poorly to moderately sorted, subangular to subrounded, fine to very coarse (mostly medium to very coarse; <15% very fine to fine), and composed mostly of volcanic grains with very little interstitial clay (no more than 1%) except for deposits interpreted as debris flows where clay is up to 7%. Sandy pebbles are in thin to medium, lenticular beds or very thin to thin, tabular beds. Gravel is mostly clast-supported, imbricated, poorly to moderately sorted, subangular to subrounded, and comprised of pebbles with 5–15% cobbles and trace boulders (locally up to 20% cobbles and 1% boulders) that are relatively platy. Clast lithologies include subequal to slightly greater proportions of felsic volcanics (including 1–5% Kneeling Nun tuff and lesser Sugarlump tuff, the latter being noted only in Trujillo Creek) compared to intermediate volcanics. Trace to 0.5% Paleozoic carbonates appear in the upper part of the unit in Trujillo Creek and other lithologies include 0.5% Cretaceous(?) andesites and trace to 1% reddish brown, vesicular basalt. Unit contains ~3–25% poorly sorted, cobble- to coarse-pebble-rich debris flow deposits in medium, lenticular channel fills. Paleosols are very sparse compared with the overlying Palomas Formation; observed paleosols have calcic horizons with up to stage II carbonate morphology. Lower contact is gradational with Trvl and placed where there is an upsection decrease in reddening, clast-size (typically <15% cobbles), and cementation. 0–52 m thick.

Trvuf **Upper unit of the Rincon Valley Formation, fine lithofacies**—Reddish-brown (2.5YR 4/4) to yellowish-red or light-reddish-brown (5YR 5/6; 6/4), silty to slightly sandy clay in massive or very thick, tabular beds. Loose and non-to somewhat calcareous. May contain 2–10% scattered fine to medium pebbles that are poorly to moderately sorted, angular to subrounded, and consist of volcanic lithologies. In places, 5–10% scattered carbonate masses are present but soil horizonation is not observed. Found in the southeast part of the quadrangle along Berrenda Creek; likely interfingers with coarser Trvu facies to west in subsurface. >15 m thick.

Trvl **Lower unit of the Rincon Valley Formation**—Brown to light-brown or pinkish-gray (7.5YR 5/4 to 6/3; 7/2), well-bedded pebbly sandstone with subordinate (25–35%) sandy pebble-conglomerate interbeds. Well-cemented by calcite and opaline silica. Both pebbly sandstone and conglomerate beds are locally cross-stratified with planar foresets that dip at low angles (up to 15 cm tall); minor trough-cross-stratification also observed. Pebbly sandstone is horizontal-planar laminated to very thin-bedded, and consists of poorly to moderately sorted, subangular to subrounded, fine to very coarse (<10% finer) grains composed mostly of lithics (volcanic). Conglomerate is in very thin to medium, lenticular beds (minor tabular beds). Gravel is mostly clast-supported, poorly to moderately sorted, subrounded (minor subangular), and comprised of pebbles with 10% cobbles (in Tierra Blanca Creek) to 10–20% cobbles (in Trujillo Creek); 0–1% boulders. Clast lithologies include subequal (+/-20%) felsites and intermediate volcanic clasts, 5–10% Kneeling Nun tuff, and no Paleozoic carbonates or dark-colored basalts. Unit contains approximately 3–5% (Tierra Blanca Creek) to 10–30% (Trujillo Creek) matrix-supported, poorly sorted, cobbly debris flow deposits in thin to thick, lenticular beds. Paleosols are very sparse. 80 m thick.

Tsmld **Santa Fe Group, middle-lower debris flow facies**—Debris flow deposits of the middle to lower Santa Fe Group exposed along Tierra Blanca Creek. These deposits are separated from younger strata by a sharp, scoured disconformity (no angularity of bedding across contact; no paleosol observed). Perhaps correlative to the Hayner Ranch Formation of Seager (1971). At least 60 m thick. Two lithofacies are present that are typically merged for the purposes of 1:24,000-scale mapping:

Tsmldc **Santa Fe Group, middle-lower debris flow facies, upper coarse lithofacies**—Light-reddish-brown to light-brown (5-7.5YR 6/4) or pinkish-gray to pink (5-7.5 YR 7/2-4), sandy conglomerate and minor pebbly sandstone that are mostly massive. In Tierra Blanca Creek, bedding is more distinctive southwards where debris flows occur in medium to thick, lenticular beds. In Trujillo Creek, bedding is medium to thick and tabular. Within relatively massive conglomerate are minor intervals of very thin to medium, lenticular beds of pebbly sandstone and sandy clast-supported pebbles. Conglomerate is moderately to well-cemented by calcite and inferred silica. Gravel consists of matrix- to clast-supported, very poorly to poorly sorted, subangular to subrounded, well-graded pebbles through cobbles with lesser boulders. Clast lithologies include 20–35% platy, dark gray, aphanitic andesite correlated to the andesite of Sibley Mountain (Tsa), as well as 1% Cretaceous(?) andesites and trace to 3% aphanitic, reddish-brown, vesicular basalts. Largest clasts are up to 0.6 m across. Matrix consists of very poorly to poorly sorted, subangular (minor subrounded), clayey to silty, very fine- to very coarse-grained sand composed of volcanic grains. Occupies most of unit Tsmldc on the quadrangle. >50 m thick.

Tsmldf **Santa Fe Group, middle-lower debris flow facies, lower fine lithofacies**—Pinkish-gray to pink (5-7.5YR 7/2-4) clay, silt, and very fine-grained sand in medium to thick, tabular beds. Internally massive. Contains minor to abundant, scattered fine- to very coarse-gained sand and lesser pebbles that are poorly sorted and subangular to subrounded. Clast composition includes greater proportions of felsic volcanics than Trvldc (up to 50% including 3% Kneeling Nun and 5–10% other distinctive tuffs). This sediment onlaps paleotopographic relief developed on older volcanic rocks. Conformably underlies Tsmldc across an approximately 1-m-thick gradation. Up to 15 m thick.

Tsml **Santa Fe Group, middle-lower basin-fill units, undivided**—Basin-fill alluvium pre-dating the Palomas Formation and likely the Rincon Valley Formation as well. Likely correlative to the Hayner Ranch Formation of Seager (1971). 0 to >600 m thick.

Volcanic Rocks

Tja **Andesite of Jaralosa Creek**—Dark-gray (N 4/) weathering brown (7.5YR 5/3) to dark-reddish-brown (5YR 3/3), cliff-forming, massive to platy, porphyritic, fine-grained andesite. Phenocrysts include 13–15% plagioclase (up to 0.75 mm, subhedral; thin laths define pilotaxitic texture), 2–3% pyroxene (up to 1.5 mm, anhedral; typically weathered), and trace quartz (1–2 mm, anhedral). O'Neill and others (2002) suggest that this andesite intrudes Santa Fe Group basin-fill along Jaralosa Creek but this relationship was not conclusively established in the field. They identified this rock as an andesite based on geochemical analysis. 12–20 m thick.

Tsa **Andesite of Sibley Mountain**—Very dark-gray (7.5YR 3/1) weathering brown (7.5YR 5/3) to yellowish-red (5YR 4/6), ledge- to cliff-forming, massive to foliated, aphanitic-porphyritic, fine-grained andesite to trachyandesite flows. Phenocrysts include 3–4% plagioclase (up to 1 mm, subhedral to anhedral; commonly weathered to secondary mineral that is wintergreen in color), 1–2% hornblende (up to 0.75 mm, euhedral; occasionally features oxidation rims), and trace quartz (up to 1.25 mm, anhedral). O'Neill et al. (2002) identify this rock as bordering between andesite and trachyandesite based on geochemical analysis. Individual flows commonly 9–18 m thick.

Cross-Section Only Units

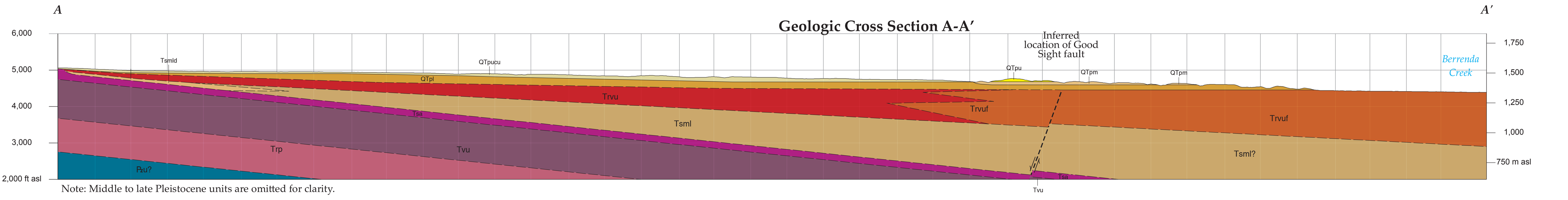
QTpucu **Upper coarse and upper piedmont facies, undivided**—Upper coarse piedmont (QTpuc) and upper piedmont (QTpu) alluvium. See detailed descriptions of each individual unit. 0–40 m thick.

Tvu **Volcanic rocks, undivided**—Includes Kneeling Nun and Sugarlump tuffs. See O'Neill et al. (2002) for descriptions. At least 320 m thick.

Trp **Rubio Peak Formation**—Volcaniclastic material and interbedded flows of intermediate volcanics. See O'Neill et al. (2002) for descriptions. Approximately 145-265 m thick.

Pzu **Paleozoic sedimentary rocks, undivded**—Limestone, dolostone, and minor beds of shale and sandstone. Includes lower (and perhaps upper) Paleozoic strata described by O'Neill et al. (2002). At least 230 m thick.

Geologic Cross Section A-A′



Note: Middle to late Pleistocene units are omitted for clarity.