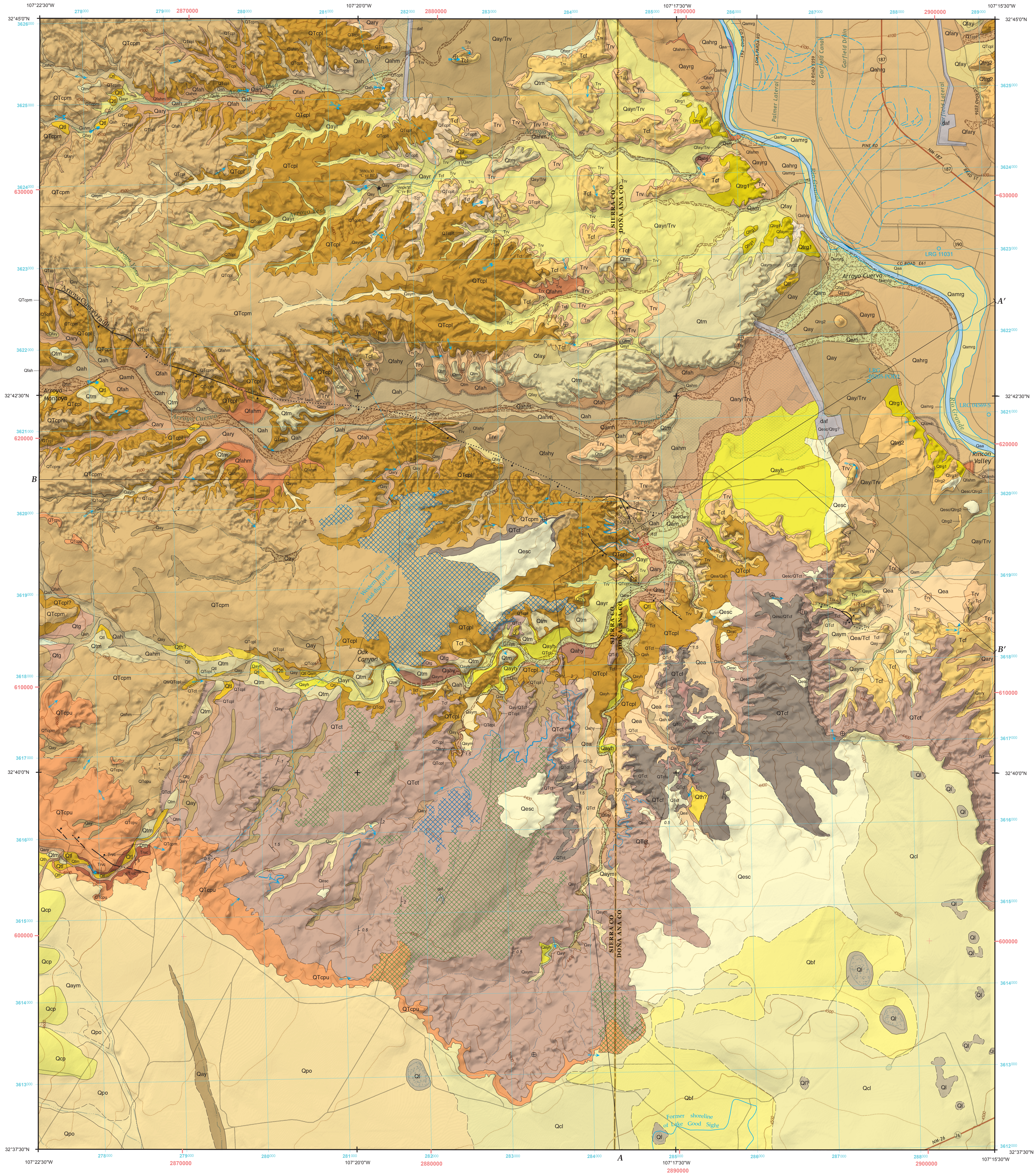
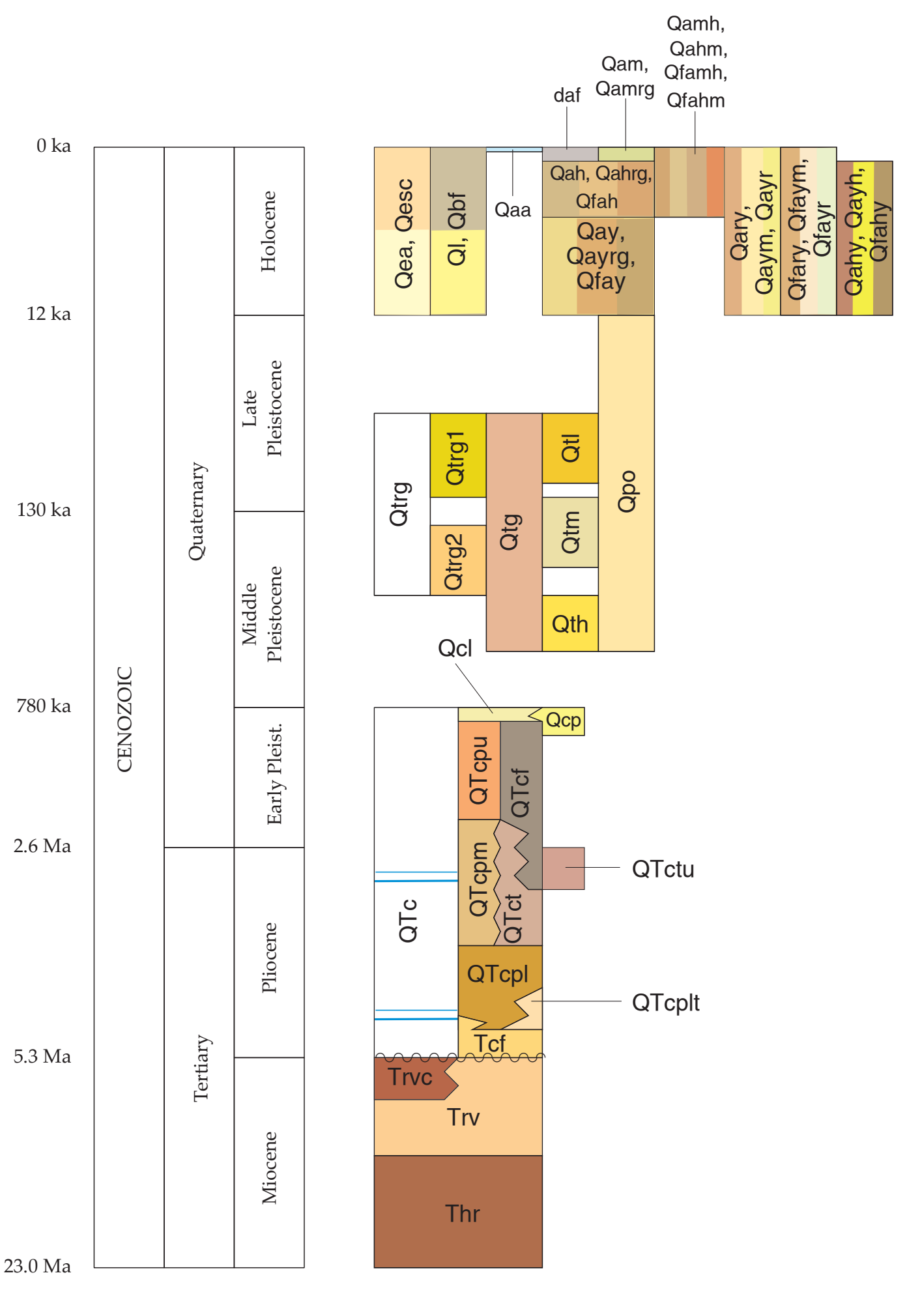
NEW MEXICO BUREAU OF GEOLOGY AND MINERAL RESOURCES A DIVISION OF NEW MEXICO INSTITUTE OF MINING AND TECHNOLOGY



Correlation of Map Units



Explanation of Map Symbols

- A ├──┤ A′ Cross-section line and label
- Geologic contact—Identity and existance 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.
- Normal fault—Identity and existence certain; questionable where queried. Location accurate where solid, approximate where dashed, and dotted where concealed.
- Monocline—Identity and existence certain, location accurate where solid, dotted where concealed.
- Former shoreline or marine limit—Identity and existence certain, location accurate
- Lower axial-fluvial facies of the Camp Rice Formation—Identity and existence certain; questionable where queried. Location accurate where solid, dashed where approximate.
- Western extent of axial-fluvial facies of the Camp Rice Formation
- Former shoreline of Lake Good Sight—Identity and existence certain, location accurate.
- Former shoreline or marine limit—Identity and existence certain, location approximate.
- 6 Inclined fault—Showing dip value and direction
- 6 Vertical or near-vertical fault
- ⊕ Horizontal bedding
- 6 Inclined bedding—Showing strike and dip
- 6 Apparent dip—Showing approximate 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
- ○ Select water wells with lithologic logs and NM Office of State Engineer permit number
- ▨ Upper Capilla geomorphic surface
- ▨ Lower Capilla geomorphic surface
- ——? Bentonite bed in cross section. Identity and existence certain; questionable where queried. Location solid where certain, queried where questionable

Description of Map Units

NMBGMR Open-File Geologic Map 261
Last Modified February 2017

Quaternary

Eolian and Hillslope Units

Qea **Eolian and alluvial sand, undivided**—Light-brown (7.5YR 6/3-4) to light-yellowish-brown (10YR 6/4) silt-sand in thickly laminated to medium (0.8-25cm), tabular to lenticular beds. Loose, very weakly calcareous, and horizontal-planar laminated to planar cross-stratified (foresets up to 15 cm thick). Sand is moderately well-sorted, subangular to rounded, fU grains composed of 65–70% quartz, 15–20% lithics (volcanic, chert, mafic), and 15–20% feldspar with little or no interstitial clay. Approximately 35% of beds contain stringers of fine pebbles consisting of moderately sorted, subrounded to rounded calcite nodules, volcanics, quartzite, and granite. No soil or clast varnish observed at surface. Surface is commonly rippled. Deposit forms coppice dunes and occasional blow-outs less than 50 cm deep. >1.2 m thick.

Qesc **Eolian sand, slopewash, and hillslope colluvium, undivided**—Yellowish-red (5YR 5/6-8), clayey to pebbly silt–sand and pebble gravel deposited by eolian and hillslope processes. Loose, weakly calcareous, and massive to ripple or planar cross-stratified. Sand is quartzose and consists of vfL-fU grains. Contains 5–10% exotic pebbles such as quartzite and granite. Cumulic soil development indicated by stronger chroma and vague blocky peds is common in the upper 0.5–1.0 m of the deposit, which may form coppice dunes and blow-outs. Commonly mantles Camp Rice Formation or middle Pleistocene terraces in the central and southern parts of the quadrangle. 1.2–2 m thick.

Closed-Basin Units

Ql **Playa deposits**—Loose clay and silt deposited in small playas. Likely under 5 m thick [description from Seager et al., 1982]. Loose, undissected loam, silt, or clay that may be slightly gravelly in places. No more than 15 m thick [description from Seager et al., 1982].

Qbf **Basin-floor deposits**—Loose, undissected loam, silt, or clay that may be slightly gravelly in places. No more than 15 m thick [description from Seager et al., 1982]. Combined in cross section with Qcl, colored the same as Qbf.

Valley-Floor Units

daf **Disturbed or artificial fill**—Sand and gravel that has been moved by humans to form berms and dams, or has been reworked/remobilized for construction of infrastructure or buildings.

Qaa **Active alluvium of the Rio Grande**—Sandy pebble-cobble gravel in the axial channel of the Rio Grande, commonly in longitudinal or transverse bars. Loose. Clasts consist of poorly to moderately sorted, subrounded to rounded pebbles and cobbles. Boulders may be present, transported from local tributaries to the active channel during larger flood events. Clast lithologies are diverse, reflecting bedrock exposed throughout the Rio Grande catchment. Sand is moderately to very well sorted, subrounded to rounded, fine- to coarse-grained, and quartzose. Total thickness unknown but likely 1–3 m.

Qam **Modern alluvium**—Gray (7.5-10YR 5/1) to brown (7.5YR 5/2) pebbly sand and sandy pebble–cobble and pebble-cobble-boulder gravel in modern channels, troughs, and bars. Loose, non-calcareous, and cross-stratified. Gravel is imbricated, poorly sorted, subangular to well rounded (mostly subrounded to rounded), and consists of pebbles (55–90%), cobbles (10–40%), and boulders (5–15%) of >80% volcanic lithologies with minor Paleozoic carbonates and chert. Sand consists of fU-cL grains composed of 60–65% lithics (volcanics>chert>carbonate), 25–30% quartz, and 5–15% feldspar; no clay present. Occasionally, channel margins feature light-brown (7.5YR 6/3), thin (<3–4 cm) veneers of mud (65–70% silt, 30–35% clay). Maximum thickness approximately 3 m.

Qamrg **Modern alluvium of the Rio Grande**—Similar to Qam but with overall grayer colors (10YR hue). Deposit identified from active channel observed in 1937 aerial photographs. Clast lithologies are diverse, reflecting bedrock exposed throughout Rio Grande catchment. Total thickness unknown but likely 1–3 m.

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

Qah **Historical alluvium**—Brown (7.5YR 4-5/3-4) sand and sandy pebble and pebble-cobble-boulder gravel in tabular to lenticular beds. Loose and commonly trough cross-stratified. Gravel is clast-supported, imbricated, very poorly to poorly sorted, subrounded to well-rounded and consists of pebbles (60–100%), cobbles (0–30%), and boulders (0–10%) of ~80% felsic to intermediate volcanics and ~20% Paleozoic carbonate and chert. Matrix consists of very poorly sorted, subangular to rounded, very fine to medium sand composed of 60–70% lithics (volcanic), 20–30% quartz, and 10–20% feldspar with minor to subordinate clay flakes. Deposit is inset into younger alluvium (Qay). Tread heights <1.5 m above modern grade. <2–2.5 m thick.

Qahrg **Historical alluvium of the Rio Grande**—Similar to Qah but with overall grayer colors (10YR hue). Deposit identified outside of active channel observed in 1937 aerial photographs. Clast lithologies are diverse, reflecting bedrock exposed throughout Rio Grande catchment. Low-relief (typically <1 m) furrows and berms on the surface of this deposit represent banks, scroll-bars, and oxbow lakes of the historical Rio Grande. Maximum tread heights 2.3–2.5 m above modern grade. Well data suggest a typical thickness of 4–5 m.

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.

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

Qay **Younger alluvium**—Yellowish-brown (10YR 5/4) to strong-brown, brown, or light-brown (7.5YR 4-5/3-6; 6/3-4), gravelly to silty sand in thin to thick (6–80 cm), tabular beds. Loose, moderately to strongly calcareous, internally massive to weakly planar cross-stratified (foresets up to 10 cm thick), and vaguely normally graded. Sand consists of moderately to moderately well-sorted, subangular to rounded, silty vfL-fL (15% fU-cU) grains composed of 55–75% lithics (volcanic), 15–25% quartz, and 10–25% feldspar with 0–5% clay chips. Sandy beds contain 10% scattered fine to medium pebbles and rare charcoal fragments. Deposit contains rare to subordinate (1–35%) pebble to cobble gravel lags and lenses up to 75 cm thick. Gravel consists of moderately to strongly calcareous, clast-supported, trough cross-stratified to well imbricated, fine to very coarse pebbles and fine to medium cobbles. Clasts are poorly to moderately sorted, subrounded to rounded, and consist of ~2/3 felsites and ~1/3 intermediate volcanics with 3–5% Paleozoic carbonate and chert. Gravel matrix consists of poorly sorted, subangular to rounded, fL-cU sand grains of similar composition to sandy beds but with 10% tannish to reddish free-grain argillans. Deposit features buried soils including 15–20 cm thick cumulic (Bw) horizons, ~30 cm thick Bt horizons with prismatic peds and ped argillans, and 45–60 cm thick Btk horizons with ped argillans and stage I+ carbonate morphology (carbonate masses). Deposit is capped by a 20–25 cm thick A horizon that is eroded in places. Strongly bioturbated by fine to coarse roots. Radiocarbon samples from an exposure in section 23, T18S, R5W returned conventional ages of 3880+/-30 and 3860+/-30 ^{14}C yr BP. Correlative fan deposits (Qfay) exposed in the southernmost Garfield 7.5-minute quadrangle returned a conventional radiocarbon age of 9360+/-150 ^{14}C yr BP (Metcalf, 1969). Deposit is inset into older terraces (Qtg) and inset by historical alluvium (Qah). Includes sediment correlative to both Leasburg and Fillmore alluvium described by Gile et al. (1981). Tread height 2.1–2.8 m above modern grade. >2–3 m thick.

Qayrg **Younger alluvium of the Rio Grande**—Similar to Qay but with both redder and grayer colors (5YR, 10YR hues). Clast sizes may be bimodal between pea-sized pebbles and boulders. Clast lithologies are diverse, reflecting bedrock exposed throughout Rio Grande catchment. Includes sediment correlative to both Leasburg and Fillmore alluvium described by Gile et al. (1981). Tread heights 3.5–7 m above modern grade. Well data suggest a maximum thickness of 19–25 m.

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

Alluvial Fan and Piedmont Units

Qfamh **Modern and historical fan alluvium, undivided**—Modern fan alluvium (Qfam) and subordinate historical fan alluvium (Qfah). Modern fan alluvium is typically sandy pebble–cobble gravel graded to modern stream courses; see description for Qfah.

Qfah **Historical fan alluvium**—Loose deposits of gravel graded to low-lying terraces formed on historical alluvium (Qah). 1.5–3 m thick.

Qfahm **Historical and modern fan alluvium, undivided**—Historical fan alluvium (Qfah) and subordinate modern fan alluvium (Qfam). Modern fan alluvium is typically sandy pebble–cobble gravel graded to modern stream courses; see description for Qfah.

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

Qfary **Recent and younger fan alluvium, undivded**—Recent and younger fan alluvium, undivided—Recent fan alluvium (Qfah and Qfam, undivided) and subordinate younger fan alluvium (Qfay). See detailed descriptions of each individual unit.

Qfay **Younger fan alluivum**—Dark-brown (10YR 3/3) clayey silt in massive to medium (20–30 cm), mostly tabular beds. Loose, weakly to moderately calcareous, and internally massive. Silt contains 10–15% vfU-fU sand grains and up to 5% scattered fine to coarse pebbles. Subordinate (25–35%) beds consist of brown to dark-brown or dark-yellowish-brown (10YR 4/3 to 3/3–4), loose, moderately calcareous, mostly clast-supported, medium- to thick-bedded (12–50 cm), broadly lenticular, imbricated, very poorly sorted, subangular to rounded pebble-cobble-boulder gravel. Clasts consist of pebbles (50–100%), cobbles (0–25%), and boulders (0–30%) up to 40 cm in diameter of volcanic lithologies reworked from QTc. Gravel matrix consists of very poorly to poorly sorted, subangular to subrounded, silt-cL sand composed of 70–75% lithics (volcanic), 15–20% quartz, and 10–15% feldspar with up to 35% brownish clay bridges. Deposit may feature a stage I+ soil below the surface (carbonate nodules, filaments, and masses); elsewhere, this soil has been erosionally stripped. Heavily bioturbated by medium to very coarse roots and burrows. A deposit exposed in the southernmost part of the Garfield 7.5–minute quadrangle returned a conventional radiocarbon age of 9360+/-150 ^{14}C yr BP (Metcalf, 1969). Deposit is graded to low-lying terraces formed on younger alluvium (Qay). 1.8 to >4 m thick.

Qfaym **Younger and modern fan alluvium, undivded**—Younger fan alluvium (Qfay) and subordinate modern fan alluvium (Qfam). Modern fan alluvium is typically sandy pebble–cobble gravel graded to modern stream courses; see detailed description for Qfay.

Qfayr **Younger and recent fan alluvium, undivded**—Younger fan alluvium (Qfay) and subordinate recent fan alluvium (Qfah and Qfam, undivided). See detailed descriptions of each individual unit.

Qpo **Piedmont alluvium**—Piedmont alluvium—Pebble gravel and sandy pebble gravel that is weakly consolidated to cemented in upper part by soil carbonate or clay. Gravel may be matrix- or clast-supported and consists of poorly sorted, subangular to rounded clasts. Stage II to IV carbonate morphology (carbonate nodules, laminar carbonate) is common in upper 1 m. Underlies fan and terrace deposits and erosion-surface veneers graded to closed-basin floors. 1.2–8 m thick [description modified from Seager et al., 1982].

Terrace Deposits of the Rio Grande

Qtrg1 Qtrg2 **Rio Grande terrace deposits,**—Loose deposits of sandy gravel and pebbly sand lenses with common extra-basin clasts. Locally subdivided into 2 deposits:
Lowest Rio Grande terrace deposit—Light-brownish-gray (10YR 6/2) to brown or strong brown (7.5YR 5/4 or 4/6), sandy pebble and pebble-cobble gravel and subordinate pebbly sand in thin to very thick (6–120 cm), tabular to lenticular or wedge-shaped beds. Loose, weakly calcareous, and well imbricated to vaguely cross-stratified to (rarely) massive. Gravel beds comprise 65-95% of deposit and consist of poorly sorted, rounded to well-rounded pebbles (75–90%) and cobbles (10–25%) of volcanic lithologies (40–55%), Paleozoic sedimentary lithologies and chert (15–25%), quartzite (10–15%), granite (5–10%), and Cretaceous sedimentary lithologies (3–5%). Gravel matrix consists of poorly to moderately sorted, subangular to well rounded (mostly rounded), vfU-mL sand composed of 65–70% quartz, 15–20% feldspar, and 10–20% lithics (volcanic>chert + granite). Matrix sand contains 10–20% outsized coarse sand grains to granules. Sandy beds comprise 5–35% of deposit and consist of moderately sorted, subangular to rounded, silt to fU sand composed of 50–60% quartz, 25–30% feldspar, and 15–20% lithics, and may contain stringers and small lenses of fine to medium pebble gravel. Deposit may be slightly to moderately bioturbated by fine to medium roots and medium to very coarse burrows. Stage II calcic horizons are common with 70–80% of clasts covered by carbonate coats or rinds. Deposit is likely correlative to the Picacho alluvium of Hawley (1965), Ruhe (1967), Hawley and Kottlowski (1969), Metcalf (1969), and Gile et al. (1981). Tread height 15–21 m above modern grade. 1–12 m thick. **Lower-middle Rio Grande terrace deposit**—Dark-yellowish-brown (moist; 10YR 4/4) to pale-brown (dry; 10YR 6/3), sandy pebble-cobble gravel and sand in thick (35–90 cm), broadly lenticular beds. Loose, weakly calcareous, and well imbricated to vaguely cross-stratified (foresets up to 40 cm thick). Gravel beds comprise 65–80% of deposit and consist of poorly to moderately sorted, rounded to well rounded pebbles (55–65%) and cobbles (35–45%) ofi ntermediate volcanics (45–60%), felsites (30–40%), Paleozoic sedimentary lithologies (5–15%), granite and amphibolite (5–10%), quartzite (3–5%), and miscellaneous lithologies (trace to 2%). Gravel matrix consists of very poorly to poorly sorted, subrounded to well rounded, fU-vcL sand (10–20% vcU sand to granules) composed of 65–70% quartz, 15–20% feldspar, and 10–20% lithics (volcanics, chert) with no clay. Sand lenses constitute 20–35% of deposit and are planar cross-stratified. Surface of deposit may be erosionally stripped; elsewhere, clasts at surface feature 15–20% weak varnish. Deposit may be correlative to the Tortugas alluvium of Hawley (1965), Ruhe (1967), Hawley and Kottlowski (1969), Metcalf (1969), and Gile et al. (1981). Tread height 21–25 m above modern grade. 15–18 m thick.

Terrace Deposits of Rio Grande Tributaries

Qtg **Terrace deposits of Rio Grande tributaries, undivided**—Loose to weakly consolidated deposits of sandy gravel and pebbly sand found along Rio Grande tributaries in the central, southern, and western parts of the quadrangle. Locally subdivided into 3 deposits:

Qtl **Lower tributary terrace deposit**—Dark-reddish-brown to light-reddish-brown (5YR 3-6/3), sandy pebble-cobble gravel in thin to thick (7–85 cm), tabular to broadly lenticular beds. Loose to weakly consolidated, weakly calcareous, and well-imbricated to vaguely trough cross-stratified or massive. Gravel is poorly to moderately sorted, subrounded to well rounded, and consists of pebbles (70–95%) and cobbles (5–30%) of felsites (55–60%), intermediate volcanics including diorite and dacite (35–40%), and Paleozoic carbonates, chert, and basalt (5–10% total). Matrix consists of poorly sorted, subangular to rounded, fL-cU sand (up to 2% vcL-vcU grains) composed of 60–70% lithics (volcanic>chert), 20–30% quartz, and 5–10% feldspar with 5–10% reddish clay chips and free-grain argillans. Well-sorted pebbly beds comprise 50–60% of deposit. Poorly sorted pebble–cobble gravel beds that are occasionally matrix-supported comprise 40–50% of deposit. Packages of A and Bt horizons may be up to 55 cm thick on slopes of deposit. Weak varnish observed on 5–15% of clasts at surface. Strath forms up to 30 cm of scour on underlying units. Tread height 3–6 m above modern grade. 5.1–5.5 m thick.

Qtm **Middle tributary terrace deposit**—Reddish brown to brown (5-7.5YR 4/3-4), sandy pebble-cobble gravel in medium to thick (15–100 cm), tabular to broadly lenticular beds. Loose, weakly to strongly calcareous, and well-imbricated to vaguely trough or planar cross-stratified (foresets 15–20 cm thick). Gravel is clast-supported, very poorly to poorly sorted, subrounded to well-rounded, and consists of pebbles (60–90%), cobbles (5–30%), and boulders (0–10%) up to 60 cm in diameter of subequal proportions of felsites and intermediate volcanics with subordinate amounts of chert (up to 5%) and Paleozoic carbonates (up to 4%). Matrix consists of poorly sorted, subangular to rounded, fL-vcL sand comprised of 45–75% lithics (volcanic>>chert), 10–40% quartz, and 5–20% feldspar with 10–15% reddish free-grain argillans. Deposit contains minor (5–10%) thin-lenses of brown (7.5YR 5/3), loose, weakly calcareous, internally massive to horizontal-planar laminated, moderately sorted, subangular to rounded, pebbly (fine to medium, <10%), fU-cL sand comprised of 65–75% lithics (volcanic>>chert), 20–25% quartz, and 10–15% feldspar. Deposit features stage I+ carbonate morphology (clast coatings) in upper 1–1.5 m as well as occasional manganese oxide staining of clasts, particularly just above its basal strath. Weak to moderate varnish observed on 10–30% of clasts at surface. Tread height 8–21 m above modern grade. 3–6.4 m thick.

Qth **Higher tributary terrace deposit**—Yellowish-red (moist; 5YR 4/6) to reddish-brown or brown (dry; 5-7.5YR 5/3), sandy pebble–cobble gravel in very thin to thick (3–60 cm), mostly lenticular beds. Loose, non- to very weakly calcareous, and well-imbricated to trough or planar cross-stratified (foresets 3–15 cm thick) with rare lateral accretion sets. Gravel is clast-supported, poorly to moderately sorted, subrounded to rounded, and consists of pebbles (75–95%), cobbles (5–25%), and small boulders (<2%) of volcanics (85–95%) and Paleozoic carbonates and chert/jasperoid (5-10%). Matrix consists of poorly to moderately well sorted, subangular to rounded, fU-cL sand (5–10% cU-vcU) comprised of 45–55% lithics (volcanic>>chert), 40–45% quartz, and 10–15% feldspar with 5–8% reddish free-grain argillans. Subordinate (15–25%) beds consist of ripple laminated to massive sand similar to gravel matrix. Moderate varnish observed on 55–65% of clasts at surface. Stage I+ to II carbonate morphology (coated clasts, tubules) observed in upper 1.2–1.4 m of deposit. Rarely, thin (less than 6 cm) sandy beds in body of deposit feature pervasive iron oxide staining. Tread height 17–33 m above modern grade. No more than 5 m thick in most places.

Quaternary-Tertiary

Basin-fill units

QTc **Camp Rice Formation**—Gravel, sand, silt, and clay deposited by coalesced fan complexes and the ancestral Rio Grande in the Palomas and Hatch–Rincon basins. Fossil data (summarized by Morgan and Lucas, 2012), basalt radiometric ages (Bachman and Mehnert, 1978; Seager et al., 1984; Jochems, 2015; Koning et al., 2015, 2016), and magnetostratigraphic data (Repenning and May, 1986; Mack et al., 1993, 1998; Leeder et al., 1996), indicate an age range of ~5.0–0.8 Ma for the Camp Rice Formation and the correlative Palomas Formation to the north. Where not significantly eroded, the surface soil may be marked by a petrocalcic horizon that is 1–2 m thick and generally exhibits stage IV carbonate morphology. Total thickness of 25–77 m in quadrangle. Includes 10 sub units:

Qcp **Piedmont-slope facies**—Pinkish-gray to light-brown (7.5YR 6/2-3), sandy pebble-cobble-boulder gravel that is poorly exposed. Clasts include pebbles (60–70%), cobbles (25–30%), and boulders (5–15%) of intermediate volcanic lithologies derived from the Good Sight Mountains with occasional (5–10%) rhyolite containing sparse quartz and sanidine phenocrysts. Unit contains subordinate sandy silt. Stage I+ to II calcic horizons at surface are indicated by numerous (50–80%) clasts with thin calcite coats. Surface appears to grade below that on QTcpu to north. <15 m thick (Seager et al., 1982).

Qcl **Sediments underlying La Mesa surface**—Yellowish-red to light-reddish-brown (5YR 5/6 to 6/4), sandy clay in thick (35–80 cm), tabular beds. Loose to weakly consolidated, strongly calcareous, and internally massive. Contains 8–12% subangular to rounded, mL-vcL sand grains composed of >70% lithics (volcanic) and no more than 30% quartz + feldspar. Unit is capped by a 30 cm thick petrocalcic soil featuring stage III+ to IV carbonate morphology. 1–3 m thick. Combined in cross section with Qbf.

QTcpu **Upper piedmont facies**—Reddish-brown to light-reddish-brown (5YR 5-6/4), sandy pebble–cobble gravel in medium to thick (20–55 cm) beds. Loose and weakly calcareous. Gravel is clast-supported, imbricated, poorly sorted, subangular to rounded (mostly subrounded to rounded), and consists of pebbles (80–90%) and cobbles (10–20%) comprised of volcanics (85–95%) and Paleozoic carbonate and chert (up to 10%). Gravel matrix consists of poorly sorted, subangular to rounded, silty mL-vcL sand comprised of 60–75% lithics (volcanic), 20–30% quartz, and 5–20% feldspar with common dark-reddish-brown free-grain argillans. To the east, the unit more commonly features buried soils and becomes dominated by finer-grained beds, including: (1) reddish-brown (5YR4/3-4), moderately calcareous mud in medium (30 cm), internally massive beds; and (2) reddish brown (5YR 4/4), weakly calcareous, moderately well-sorted to well-sorted, silty vfL-fL sand (10–15% fU-cL) of similar composition to gravel matrix but lacking clay. Sand is massive and contains up to 3% scattered subrounded, fine-pebbles of volcanic lithologies. Paleosols are typically Btk horizons with stage II carbonate morphology (calcic nodules). Overall distribution of gravel to sand + mud in unit is 60–70% to 30–40%, respectively. 5–27 m thick.

QTctu **Upper transitional facies**—Similar to the transitional facies (QTct) of the Camp Rice Formation. This unit is found above a tongue of axial-fluvial facies (QTcf) that is traceable over 2–3 km in section 7, T19S, R4W. It contains a higher percentage (up to 35–40%) of sandy and sandy-pebble beds than does QTct. 3–6 m thick.

QTct **Transitional facies**—Slightly sandy mud, silt, and sand in medium to thick (20–80 cm), tabular beds (rare lenses). Loose and non- to moderately calcareous or carbonate-cemented. Sandy mud is the most common lithology (50–65% of unit) and consists of yellowish-red to strong-brown (5-7.5YR 4/6), internally massive mud that contains disseminated gypsum as veinlets and blades, particularly in the upper 10–15 m of the unit. The next most common lithology (30–45% of unit) is light-brown (7.5YR 6/3-4), internally massive, well-sorted silt with 5–10% very fine sand grains. Approximately 25–30% of the unit consists of strong-brown (7.5YR 4-5/6), internally massive to thickly horizontal-planar laminated to ripple cross-stratified, moderately to moderately well-sorted, subangular to rounded, vfL-mL sand comprised of 55–65% quartz, 20–25% lithics (dark-mafic minerals, volcanics, chert), and 10–25% feldspar with no more than 3–5% clay. All three lithologies (mud, silt, and sand) may feature rare calcic paleosols that are likely hydromorphic as indicated by a lack of well-developed Bt horizons. Very rarely, unit contains lenses of light-yellowish-brown (2.5Y 6/4) to pale olive (5Y 6/4), loose, moderately calcareous, thickly laminated to thick-bedded (0.5–50 cm), internally massive to horizontal-planar laminated to (rarely) ripple cross-laminated, well-sorted, subrounded to well-rounded, silty fU-mU sand comprised of 75-80% frosted quartz, 10–15% lithics (volcanic, amphibolite, chert), and 5–10% feldspar with no clay. This sand contains 3–5% scattered, subrounded to well-rounded, fine to medium pebbles of volcanics, chert, quartzite, and granite. It has yielded fossils of camel (*Camelops*), peccary (*Platygonus*), desert tortoise (*Gopherus*), and mud turtle (*Kinosternon*) (G. Morgan, pers. comm., 2017). Another rare lithology found in the upper ~15 m of the unit includes mottled reddish-brown to light-reddish-brown (5YR 5-6/3-4) to light-brownish-gray (2.5Y 6/2), fissile shale with reduced zones concentrated around small (<0.8 cm) clusters of organic material and 0.3–0.5 cm partings/laminations of very fine sand. Unit is laterally gradational with QTcf to east and QTcpm to west. Overall, unit is up to 65 m thick, though thin intervals of 2–7 m may be bound by QTcf tongues.

QTcf **Axial-fluvial facies**—Tongues of light-brownish-gray to pale-brown (10YR 6/2-3) sand and pebbly sand in very thin to medium (2–30 cm), stacked, mostly lenticular beds. Loose to weakly calcite-cemented and planar cross-stratified (foresets up to 10 cm thick) to occasionally massive. Sand consists of poorly to moderately sorted, subangular to well-rounded, mL-cL grains of 45–50% quartz, 30–35% lithics (volcanics, granite, quartzite), and 10–20% feldspar; no clay observed. Contains subrounded to well rounded granules and fine to coarse pebbles of volcanics (50–55%), granite (15–20%), Paleozoic sedimentary lithologies (~10%), and lesser amounts of chert, quartzite, and basalt. Subordinate (<20%) beds include yellowish red (5YR 4-5/6), loose, weakly calcareous, massive mud with occasional calcic or manganese oxide masses. Carbonate rhizoliths up to 2 cm in diameter are commonly found in float but calcic soil horizons are not observed. Vertebrate fossils are common in this unit, including the Blancan horses *Equus simplicidens* and *E. scotti*(?) as well as the small camel *Hemiauchenia* (G. Morgan, pers. comm., 2017). Forms scoured contacts on transitional (QTct) and middle piedmont facies (QTcpm). One relatively thick (18 m) tongue in the southeastern part of the quadrangle exhibits a laterally gradational contact with QTct. 0–18 m thick.

QTcpm **Middle piedmont facies**—Silty clay, sandy silt, and sandy gravel in thin to very thick (7–110 cm), tabular to lenticular beds. Loose to moderately consolidated and non- to moderately calcareous. Gravel constitutes 30-45% of unit by volume and is clast-supported, imbricated to weakly horizontally laminated (where sandy), poorly sorted, subrounded to rounded, and consists of mostly pebbles with <10 to 45% cobbles of felsites (45–55%), intermediate volcanics including diorite and dacite (20–30%), and Paleozoic carbonates, chert/jasperoid, and basalt (total 15–35%). Gravel matrix consists of dark-grayish-brown to grayish-brown (10YR 4-5/2), poorly to moderately sorted, subangular to rounded, fL-cL sand composed of 75–80% lithics (volcanic>>chert), 10–15% quartz, and 5–15% feldspar grains with trace clay particles. Silt and clay beds are strong to light brown (7.5YR 4/6 to 6/3) and internally massive. Silt beds may contain 5–10% grains of subangular to subrounded, mU-cU sand composed of >85% lithic (volcanic) grains as well as 10–12% clay and 3–5% angular to subrounded, fine- to medium-pebbles. Sandy beds are somewhat common in the central part of the quadrangle and consist of brown to pinkish gray (7.5YR4/3 to 6-7/2), weakly consolidated, moderately calcareous, thin-bedded (6–10 cm), lenticular, internally massive to vaguely trough cross-stratified, moderately sorted, rounded, fL-mU grains of 55–65% lithics (mostly volcanic), 10–20% quartz, and 10–15% feldspar; no clay observed. Buried soils observed in unit include stage I to II calcic (Btk) horizons with carbonate masses and filaments in finer-grained beds to stage IV horizons (K) with laminar carbonate in gravels; better developed soils occur in the western part of the quadrangle. Unit conformably overlies the lower-piedmont facies (QTcpl) and is laterally gradational with the transitional facies (QTct). 9–31 m thick. Shown as dark-green line in select locations of cross-section ***B-B′***.

QTcpl **Lower piedmont facies**—Sandy to clayey silt, pebble gravel/conglomerate, and sandy pebble-cobble-boulder gravel/conglomerate in thin to thick (5–70 cm), tabular to broadly lenticular beds. Loose to well-consolidated and weakly to moderately calcareous. Silt beds constitute 50–60% of unit by volume and are yellowish-red to light-reddish-brown (5YR 5/6 to 6/4), blocky weathering/massive, and contain 5–8% poorly sorted, subrounded granules to fine-pebbles of mostly volcanic lithologies. Silt beds also have rare (3–5%) 10–20 cm-thick lenses of clast-supported pebble-cobble gravel. Gravel/conglomerate constitutes 40–50% of unit by volume and is clast- to matrix-supported, imbricated to vaguely trough cross-stratified, very poorly to moderately sorted, subangular to rounded, and consists of pebbles (70–90%), cobbles (10–30%), and boulders (10–15%) of felsites (35–60%), intermediate volcanics (20–60%), and lesser proportions of Paleozoic carbonate and chert. However, in the northeast corner of the quadrangle (section 16, T18S, R4W), clasts are dominated by Paleozoic sedimentary lithologies derived from fault blocks to the north (e.g., Nakaye Mountain). Gravel matrix consists of reddish-brown to yellowish-red (5YR 4/3-6) to brown or light-brown (7.5YR 5-6/3-4), very poorly sorted, angular to subrounded, vfU-cU sand composed of 70–80% lithics (volcanic), 10–20% quartz, and 5–15% feldspar with 0–15% reddish clay chips and free-grain argillans. Occasionally, unit features ledges of pinkish-white (7.5YR 8/2), moderately consolidated, thin- to medium-bedded (8–20 cm), tabular, massive calcrete containing 15–20% scattered, angular to subrounded, mostly lithic (>60%), vfU-vcL sand grains. Such beds are commonly found in central and eastern parts of quadrangle. Stage I to II calcic (Bk) horizons observed in upper 15–35 cm of many beds. Cumulic (Bw) horizons observed elsewhere are up to 45 cm thick. Unit shares mostly conformable contacts with QTcplt below and QTcpm above; in places, unit lies on Trv with angular disconformity. 7–45 m thick.

QTcplt **Lower transitional piedmont facies**—Silt, sand, and pebble gravel/conglomerate that are generally reddish to reddish-brown in color. Gravel/conglomerate beds are subordinate, lack clay in matrix, and consist of mostly pebbles comprised of felsites (40-45%), intermediate volcanics (35-40%), and Paleozoic carbonate and chert (15–20%). Silt and fine-sand beds contain 5–15% pebbles of similar lithologies. May contain stage II calcic horizons with carbonate nodules in places. Conformably underlies QTcpl; disconformably underlain by Tcf or Trv. 0–15 m thick.

Tcf **Lower axial-fluvial facies**—Dark-yellowish-brown to yellowish-brown (moist; 10YR 4-5/4) to pale-brown (dry; 10YR 6/3) sand and subordinate pebble gravel in thin to medium (5–30 cm), mostly lenticular beds. Loose, non-calcareous, and internally massive to planar cross-stratified (foresets up to 20 cm thick). Sand is poorly to moderately sorted, rounded to well-rounded, fU-cL grains composed of 70–80% quartz, 10–15% feldspar, and 10–15% lithics (dark mafic minerals, volcanics) with no clay. Contains mud rip-ups up to 40–45 cm in diameter. Fine to coarse pebble gravel constitutes 10-15% of unit by volume and is clast-supported, imbricated, poorly sorted, and subrounded to rounded; clasts include abundant granite. The matrix of gravel lenses is similar to the sand described above. These lenses are occasionally bound by layers of carbonate nodules up to 5 cm thick. Fossilized wood specimens including the family *Cupressaceae* (S. Manchester, pers. comm., 2017) are common in unit; vertebrate fossil fragments are also observed. Overlies angular disconformity with Trv. 4–15 m thick. Shown as light-green line in slect locations of cross sections ***A-A′*** and ***B-B′***.

Tertiary

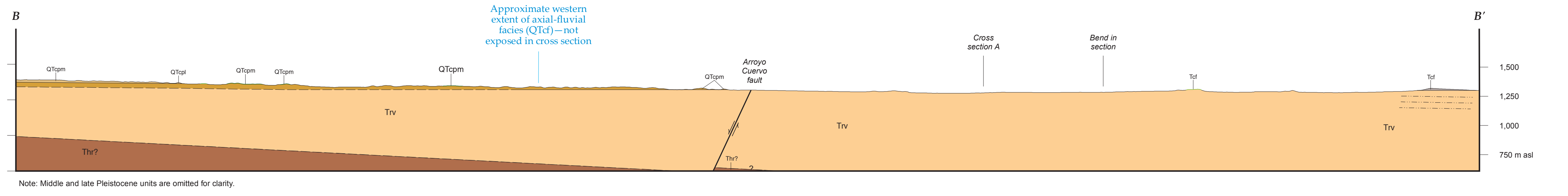
Santa Fe Group Basin-Fill Units Predating the Camp Rice Formation

Trv **Rincon Valley Formation**—Dark-reddish-brown to red (2.5-5YR 3/4 to 4/6) mudstone and clayey silt with minor silty sandstone in thin to very thick (4–110 cm), tabular beds. Mudstone is internally massive and commonly contains gypsum in the form of prismatic crystals, shards, and amalgamated masses. Gypsum also occurs in tabular horizons up to 10 cm thick as well as secondary coatings on fractures. Silty sandstone is light reddish brown to light brown (5-7.5YR 6/3-4), massive to ripple cross-laminated, and very fine-grained (10-15% fL-mL grains). Thin laminations of red mud occur in sandstone beds, which may also contain up to 5% outsized granules of volcanic lithologies. Underlies angular disconformity with QTcpl or Tcf. >430 m thick based on projection from Hatch quadrangle to east (Seager, 1995).

Trvc **Fanglomerate facies**—Light-reddish-brown (2.5-5YR 6/3-4) to reddish yellow (5YR 6/6) pebble-cobble-boulder conglomerate and subordinate sandstone in thin to thick (8–85 cm), tabular to occasionally lenticular beds. Indurated/moderately to strongly clay-cemented, non-calcareous, and reverse graded. Clasts are moderately imbricated, very poorly to poorly sorted, subrounded to rounded, and consist of pebbles (50–95%), cobbles (5–40%), and boulders (0–10%) dominated by intermediate volcanic lithologies (80–85%). Where not replaced by clay, matrix consists of poorly to moderately sorted, subrounded to rounded, fU-cU (mostly mL-cL) sand comprised of 70–80% lithics (volcanic), 10–20% quartz, and 10–15% feldspar. Subordinate (5–15%) beds consist of very weakly calcareous, weakly to moderately consolidated, internally massive to trough cross-stratified, poorly sorted, subrounded to rounded, pebbly (fine to medium), fU-cU sandstone. Sand and pebble compositions in sandstone are similar to those in conglomerate but with 40–50% reddish clay bridges. Unit also contains rare (<5%) beds of matrix-supported pebble–cobble gravel. Total thickness unknown but greater than 9 m.

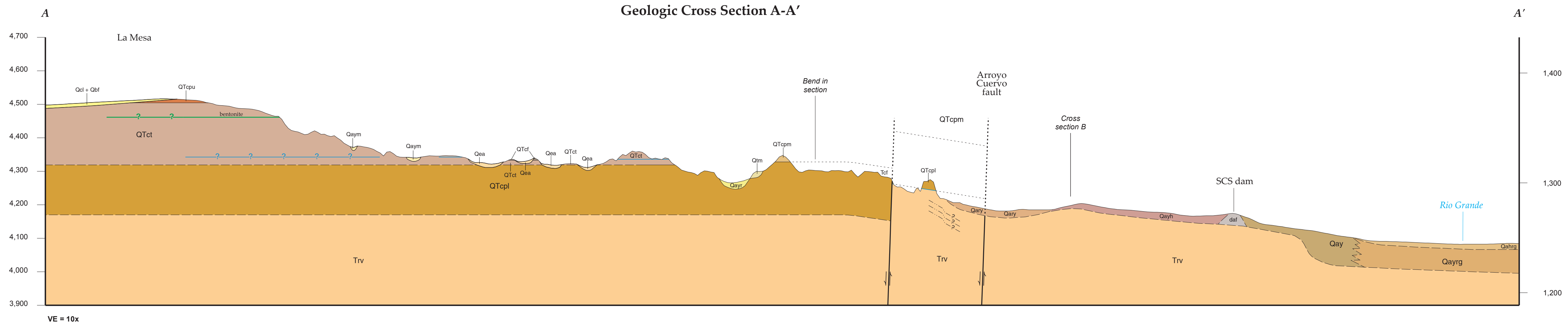
Thr **Hayner Ranch Formation**—Dark-gray to tan conglomerate, conglomeritic sandstone, and mudstone with clasts of Uvas basaltic andesite and Bell Top ash-flow tuff. Unit is both conformably and unconformably overlain by Trv in different areas. At least 427 m thick [description from Seager, 1995]. Cross section only.

Geologic Cross Section B-B′



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

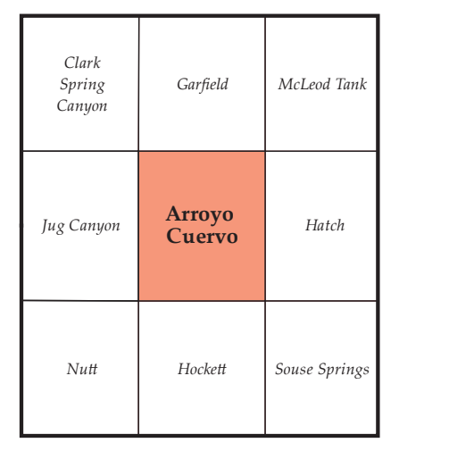
Geologic Cross Section A-A′



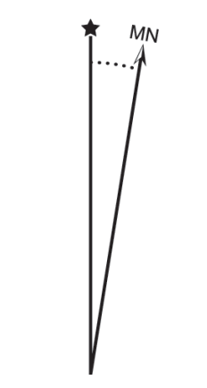
VE = 10x

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 blue.

Roads..........©2006-2010 Tele Atlas
Names..........GNIS, 2008
Hydrography..........National Hydrography Dataset, 2005
Contours..........National Elevation Dataset, 2000

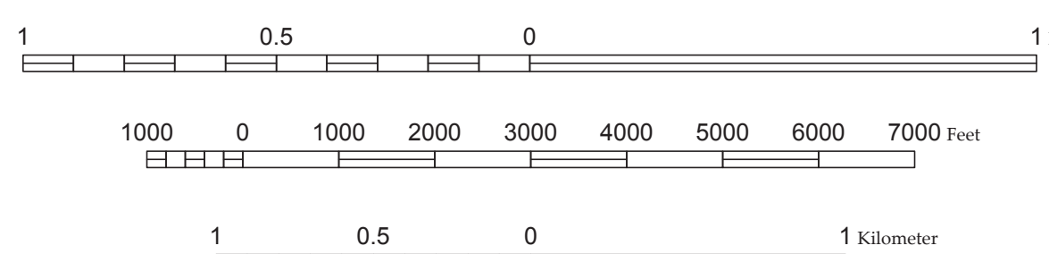


Quadrangle Location



Magnetic Declination
July, 2015
8° 81' East
At Map Center

1:24,000



Contour Interval 20 Feet

North American Vertical Datum of 1988

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Comments to Map Users

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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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Open-File Geologic Map 261

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Geologic Map of the Arroyo Cuervo 7.5-Minute Quadrangle, Doña Ana and Sierra Counties, New Mexico

June, 2017

by
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