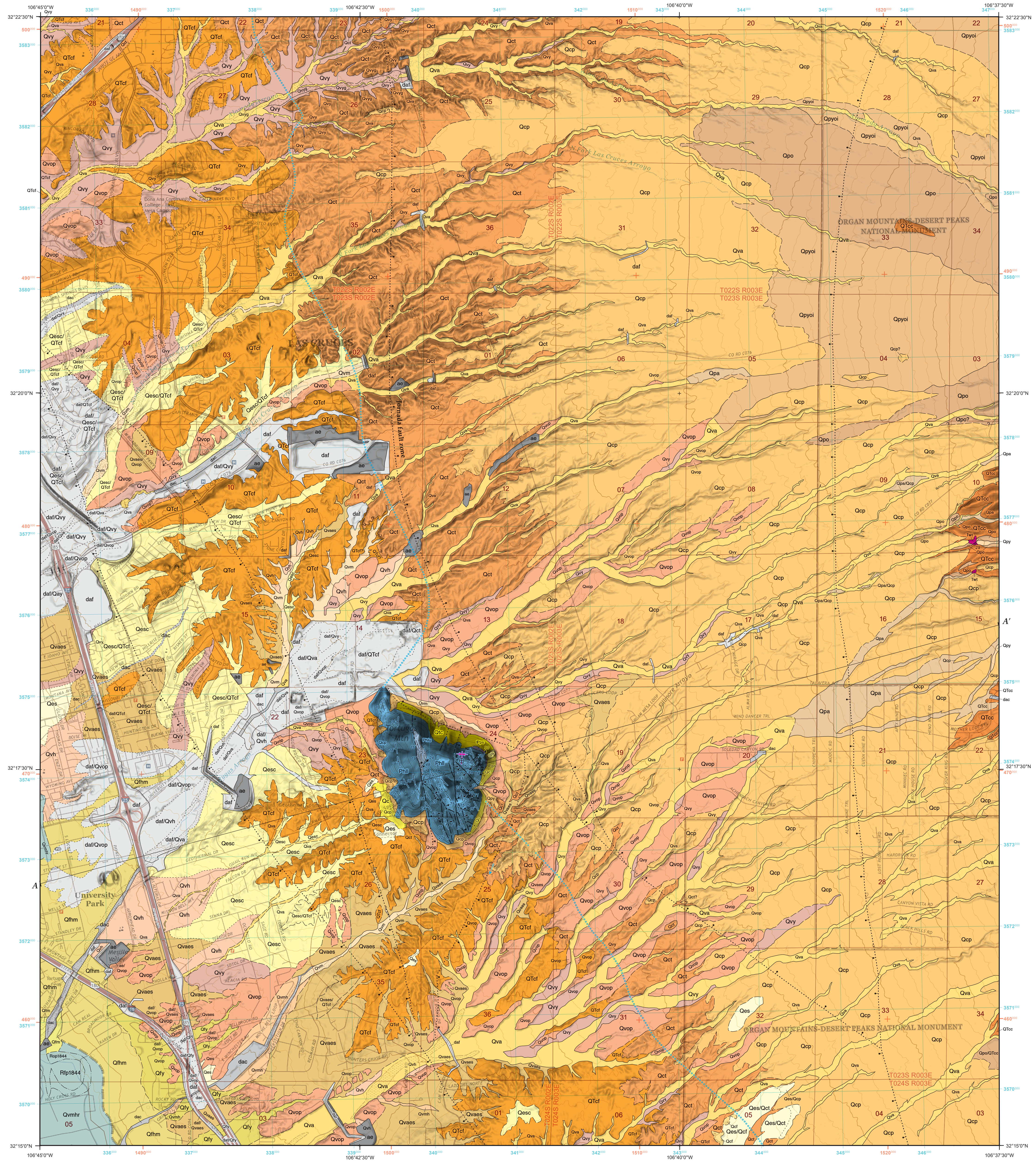
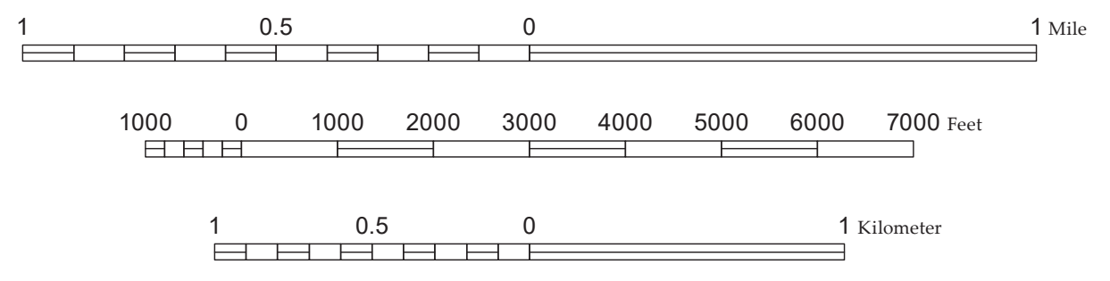
NMBGMR Open-File Geologic Map 282
Last Modified December 2020



Base map from U.S. Geological Survey 2020.
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.

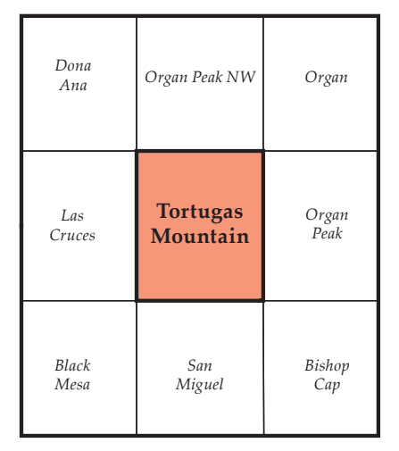
Roads.......U.S. Census Bureau, 2016
Names.......GNIS, 1980–2019
Hydrography.......National Hydrography Dataset, 2005–2018
Contours.......IFSAR 4.5 m Digital Terrain Model, 2008
Public Land Survey System.......BLM, 2011

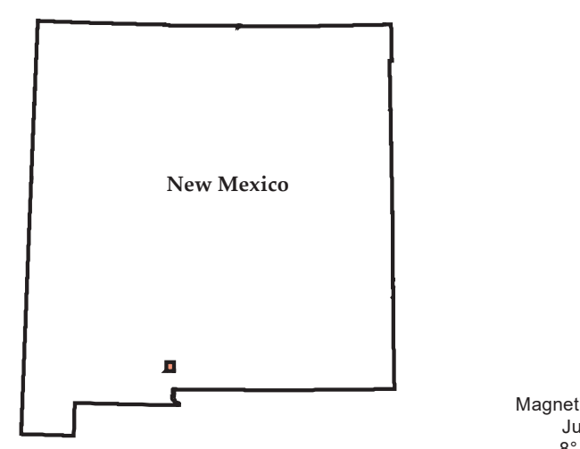
1:24,000



Contour Interval 20 Feet

North American Vertical Datum of 1988





Magnetic Declination
July, 2018
8° 14' 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

New Mexico Bureau of Geology and Mineral Resources
Open-File Geologic Map 282

Mapping of this quadrangle was funded by a matching-funds grant from the STATEMAP program of the National Cooperative Geologic Mapping Act (Fund Number: G19AC00226), administered by the U. S. Geological Survey and by the New Mexico Bureau of Geology and Mineral Resources, (Dr. Nelia W. Dunbar, Director and State Geologist; Dr. J. Michael Timmons, Assoc. Director for Mapping Programs).

Geologic Map of the Tortugas Mountain 7.5-Minute Quadrangle, Doña Ana County, New Mexico

December 2020

by
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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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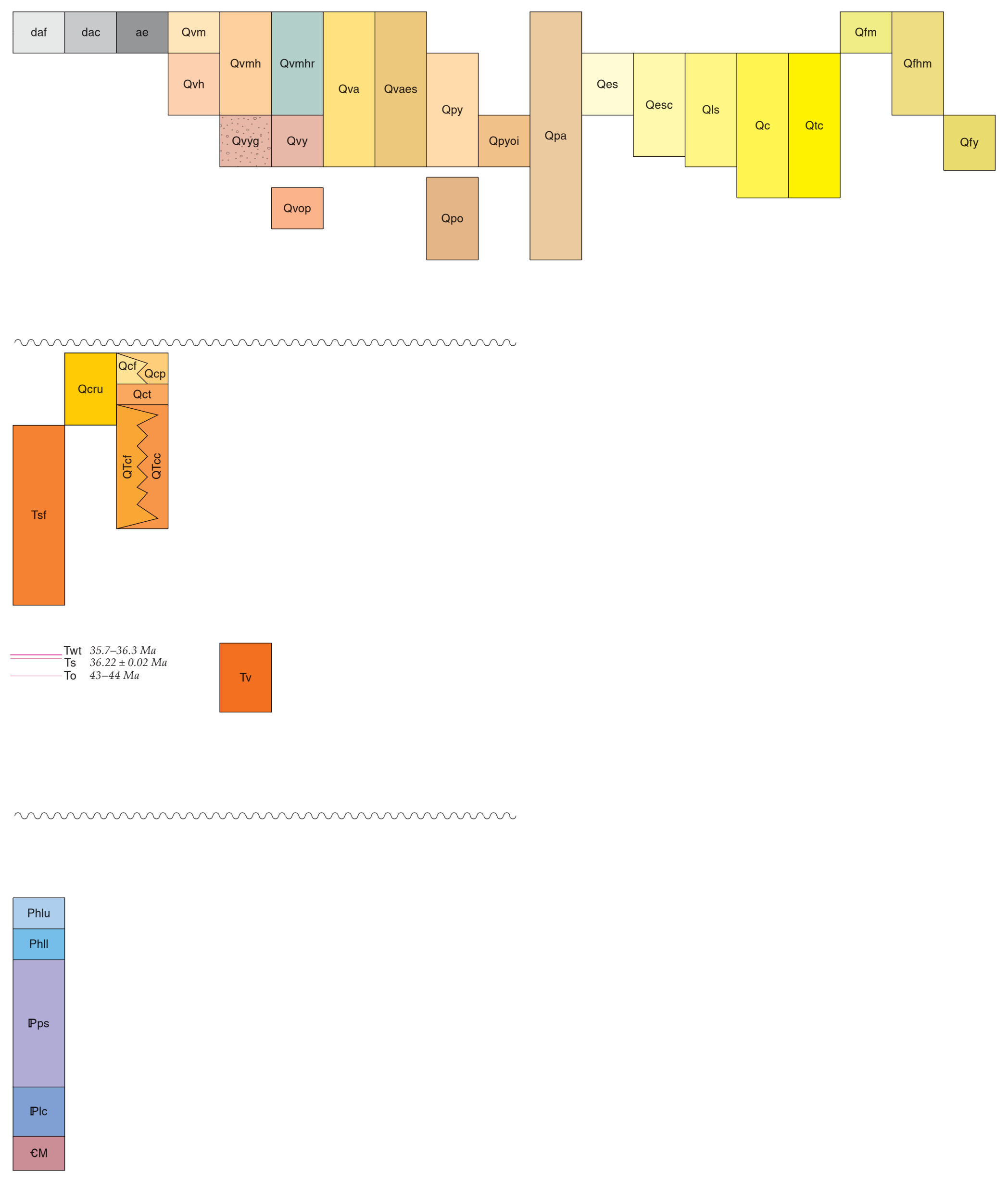
Digital layout and cartography by the NMBGMR Map Production Group:
Phil L. Miller, Amy L. Dunn, Ann D. Knight, and Justine L. Nicolette

Correlation of Map Units



Explanation of Map Symbols

Contact—The identity and existence are certain or questionable where queried. The location is accurate where solid, approximate where dashed, or concealed where dotted.

Internal contact—The identity and existence are certain. The location is approximate.

Gradational contact—The identity and existence are certain. The location is approximate.

Fault (generic; vertical, subvertical, or high-angle; or unknown or unspecified orientation or sense of slip)—The identity and existence are certain. The location is approximate where dashed or concealed where dotted. Tick represents a vertical or near-vertical fault. Arrow represents an inclined fault showing dip value and direction. Diamond tick represents a inclinded slickenline, groove, or striation on a fault surface showing bearing and plunge.

Normal fault—The identity and existence are certain. The location is accurate where solid, approximate where dashed, or concealed where dotted. Ball and bar on downthrown block. Arrow represents an inclined fault showing dip value and direction. Diamond tick represents a inclinded slickenline, groove, or striation on a fault surface showing bearing and plunge.

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

Syncline—The identity or existence are questionable. The location is accurate.

Eastern limit of Camp Rice fluvial facies.

A A' Cross section line and label.

⊕ Horizontal bedding.

Inclined bedding—Showing strike and dip.

Inclined flow banding, lamination, layering, or foliation in igneous rock—Showing strike and dip.

Paleocurrent transport direction determined from imbrication.

Unconformity shown in the Correlation of Map Units.

Fault (in cross section)—Arrows show relative motion.

Well location (in cross section)—The location and depth of a well used to establish stratigraphy and geologic unit depth.

FIGURE 1—Pictured is a view to the east from the top of Tortugas Mountain, showing modestly dissected piedmont slope and geomorphic surfaces with the Organ Mountains on the skyline. Houses in center midground were built on the Jornada I surface. The Jornada I surface consists of both erosional and constructional vgeomorphic surfaces atop the piedmont facies of the Camp Rice Formation (Qcp). Dripping Springs Road descends from the Jornada I surface to the Picacho morphostratigraphic unit in the center to lower left of the photo. 13S 340504 mE, 3574104 mN NAD83.

Description of Map Units

QUATERNARY

Anthropogenic Units

daf **Disturbed land and anthropogenic fill**—Dumped fill consisting of thick accumulations of sand, gravel, and clayey–silty sand. Mapped for thick road fill along Interstate 25, flood retention dams, and other areas affected by aggregate mining or urban development. The fill thickness is 1–10 m.

dac **Disturbed land and anthropogenic channelization**—Mapped where existing channels have been modified due to flood control efforts.

ae **Anthropogenic excavated ground**—Excavations associated with aggregate mining, landfills, and impoundments.

Eolian and Hillslope Units

Qes **Eolian sand and sheetwash, undivided**—Very fine to fine sand (<10-20% silt and medium- to coarse-grained sand) that is loosely consolidated and forms sheets that mantle high, relatively flat terrain or, less commonly, small coppice dunes. Colors range from reddish-brown (5YR 5/3–4) to brown (10YR 4–5/3); redder hues commonly result from the presence of argillic (Bt) horizons. The deposit is similar to unit Qesc but lacks gravelly sediment. On sand sheets, sparse to occasional pebbles weathered from underlying basin-fill may be scattered on the surface. Coppice dunes are vegetated (mostly mesquite, Prosopis juliflora) and largely formed 1885–1920 CE (Gile, 1966). The thickness is <2–3 m.

Qesc **Eolian sand, sheetwash, and colluvium, undivided**—Silty sand and pebbly gravel that are loosely consolidated in massive to medium (15–30 cm), tabular to wedge-shaped beds and mantle footslopes and toeslopes. The sand is composed of yellowish-brown (10YR 5/4), weakly calcareous, internally massive to laminated or low-angle cross-stratified, very poorly to poorly sorted, angular to rounded grains up to cL in size with <15% silt. Grains consist of 70–80% quartz, 15–20% lithics (volcanics, ferromagnesian minerals), and 10–15% feldspar with trace brownish free-grain argillans. This sediment contains 5–15% floating subangular to rounded, fine to coarse pebbles with rare cobbles of volcanic lithologies and subordinate quartzite and chert. On steeper slopes, such gravel dominates the deposit and is clast- to matrix-supported; the deposit is massive or has vague to moderate slope-parallel fabric. The deposit commonly progrades over unit Qvh to a level 0.5–0.8 m above modern grade in larger drainages. Elsewhere, it grades laterally to unit Qvy deposits. It may be bioturbated by medium to very coarse roots and burrows. In places, Qesc may correspond to the Fillmore morphostratigraphic unit of Gile et al. (1981). The thickness is 0.75–2 m.

Qc **Colluvium**—Pebble–cobble–boulder to cobble–boulder gravel that is loosely consolidated, poorly sorted, and angular to subrounded. The deposit forms aprons or mantles on the footslopes of Tortugas Mountain. The deposit may be clast- to matrix-supported, with open-framework in places, and is internally massive or may feature slope-parallel fabric. The thickness is <5 m.

Qls **Landslide deposits**—An approximately 10,000 m^2 slide is found on the northeast side of Tortugas Mountain, where it forms a prominent toe and consists of blocks of Hueco Formation carbonate up to 6.5 m across. The maximum thickness is approximately 15 m.

Qtc **Talus and colluvium, undivided**—Cobbly to boulder talus deposits that are angular to subangular and underly high slopes on the north side of Tortugas Mountain with subordinate to subequal proportions of colluvium (Qc). The deposit is open-framework in many places with internally massive or slope-parallel fabric. The thickness is <5–8 m.

Valley Fan Units

Qfm **Modern fan alluvium**—Pebbly sand and sandy pebble gravel that are loosely consolidated and underly fan surfaces that gently grade to Qvm or Qvmhr deposits. Color, texture, and bar-and-swale topographic relief are similar to Qvm deposits with rare to occasional matrix-supported gravels. The thickness is <2 m.

Qfhm **Historical and modern fan alluvium**—Pebbly sand-silt and sandy pebble gravel that are loose to very weakly consolidated and underly fan surfaces graded at ≈2% slopes to Qvm, Qvh, or Qvmhr deposits. Pebble gravels are clast- or, less commonly, matrix-supported. Beds are tabular to broadly lenticular, and sedimentary textures range from massive to low-angle cross-stratified sand or weakly imbricated gravel. Color and grain/clast composition and texture are similar to Qvm and Qvh deposits found in Fillmore (San Miguel quadrangle) and Tortugas Arroyos. Typically non- or very weakly calcareous with little to no soil development. Tread height is <1 m above modern grade and inset up to 10 m below the Fillmore geomorphic surface of Ruhe (1962, 1964, 1967) and Gile et al. (1981) near the western boundary of the quadrangle. Surface possibly correlates to the Organ geomorphic surface of Gile et al. (1981), where the deposits are found in drainage ways on the piedmont slope. The thickness is <2 m in most places.

Qfy **Younger fan alluvium**—Pebbly sand and sandy pebble gravel that are loose to weakly consolidated and underly fan surfaces graded at 2–5% slopes to Qvy. Color, texture, and age correlations are similar to Qvy deposits; probably <3 ka in most places based on radiocarbon age from southeast Robledo Mountains (Gile et al., 1981). Stage I carbonate accumulation is common. The thickness is typically <2–4 m.

Valley-floor Units

Qvm **Modern alluvium**—Pebbly sand and sandy pebble or pebble–cobble gravel that are loosely consolidated. The deposit fills channels and forms longitudinal bars in ephemeral stream courses. Sand is composed of yellowish to light-yellowish-brown (10YR 5–6/4), horizontal-planar or low-angle cross-laminated, poorly to moderately sorted, subrounded to well-rounded, fL–cL grains. Grains consist of 65–75% quartz, 15–25% feldspar, and 10–20% lithics (volcanics, ferromagnesian minerals; granite and/or chert possible) with no clay. Gravels occur predominantly in bars and consist of clast-supported, poorly to moderately sorted, subangular to well-rounded pebbles (70–100%) and cobbles (0–30%) of mostly felsic volcanic lithologies with occasional granite, chert, and quartzite where stream courses drain QTcf exposures. The deposit features bar-and-swale topographic relief of 0.3–0.5 m. The thickness is <2–4.5 m (Gile et al., 1981).

Qvh **Historical alluvium**—Sandy pebble gravel that is loosely consolidated in thin to thick(?) (7+ cm), tabular to lenticular beds that underly low terraces along stream courses. The deposit is internally massive to moderately well-imbricated with occasional low-angle cross-stratification. Gravel consist of clast- to matrix-supported, poorly sorted, subrounded to well-rounded pebbles (>80%) and cobbles (<20%) of mostly felsic volcanic lithologies with occasional exotic clasts reworked from various facies of the Camp Rice Formation. The matrix consists of brown to yellowish-brown (10YR 5/3–4), weakly to moderately calcareous, poorly sorted, subangular to rounded, fL–cU sand composed of 55–65% quartz, 20–25% lithics (volcanic, possible chert), and 15–20% feldspar with little or no clay. Occasional (<20%), thin- to medium-bedded (5–15 cm), massive to horizontal-planar-laminated or planar cross-stratified, pebbly sand similar to gravel matrix may be observed. The deposit lacks significant soil development. Surface features subdued bar-and-swale topographic relief of up to 0.25–0.3 m. Tread height is 0.2–0.8 m above modern grade; the deposit surface commonly onlaps older surfaces on the piedmont slope or is inset 3–10 m below the Fillmore geomorphic surface of Ruhe (1962, 1964, 1967) and Gile et al. (1981) near the western boundary of the quadrangle. Probably postdates the Fillmore morphostratigraphic unit of Gile et al. (1981), who note that the Fillmore surface was stable and occupied by prehistoric peoples by ≈1 ka (p. 45).

Qvmh **Modern and historical alluvium, undivided**—Modern and subordinate historical alluvium, undivided. See descriptions for Qvm and Qvh.

Qvmhr **Modern and historical alluvium of the Rio Grande floodplain**—Sandy to clayey deposits that are grayish or light- to dark-brown (likely 10YR) with lesser pebble gravel underlying the Rio Grande floodplain in Mesilla Valley. Sand is fine- to coarse-grained. The deposit is frequently capped by loamy, organic-rich topsoil outside of modern and former channels. Portions of this unit mapped as Rop1844 and Rfp1844 indicate Rio Grande alluvium deposited before 1844 in a meander loop or floodplain (Ruhe, 1962). Radiocarbon ages from logs at depths of 5–7 m in correlative deposits west of Las Cruces suggest an age of <200 years old (Gile et al., 1981). Well logs indicate that the unit is less than 12–15 m thick in the southwest corner of the quadrangle (NMOSE, 2020).

Qvy **Younger alluvium**—Pebbly sand or sandy pebble gravel that is loose to weakly consolidated and frequently fines upward to loamy sediment. Sand is dark-yellowish-brown (10YR 4/3–4) near Tortugas Mountain and is internally massive to trough or planar cross-stratified. Surface soils feature cambic (Bw) to weak calcic horizons featuring stage I carbonate accumulation; the former are associated with reddish-brown hues (5–7.5YR). At valley-border locations, the deposit underlies a surface graded to as much as 9 m below or above the modern Rio Grande valley. Charcoal and shell 14C ages span an interval from ≈9,400 to 1,100 cal yr BP, with soil development indicating a stable period ≈7,000 cal yr BP (Gile and Hawley, 1968; Metcalf, 1969; Gile et al., 1981). This unit is correlative to the Fort Selden (Fillmore + Leasburg—valley border) and Organ and Isaacks' Ranch morphostratigraphic units (piedmont slope) of Ruhe (1962, 1964, 1967) and Gile et al. (1981). The thickness ranges from 2–3 m on the piedmont slope up to 16 m along the Rio Grande valley border (modified from Gile et al. [1981]).

Qvyg **Gray younger alluvium**—Occupies the same elevation position in the landscape as Qvy, but has a grayish-white hue in aerial imagery.

Qva **Valley-floor alluvium, undivided**—Varying proportions of modern (Qvm), historical (Qvh), and younger (Qvy) alluvium filling valley-floors and underlying modern channels. See detailed descriptions of each unit.

Qvaes **Valley-floor alluvium, undivided with eolian sand and sheetwash component**—Varying proportions of modern (Qvm), historical (Qvh), and younger (Qvy) alluvium filling valley-floors and underlying modern channels. This unit includes a substantial component of eolian sand and sheetwash (Qes), mostly as a thin mantle on alluvial sediment. See detailed descriptions of each unit.

Older Alluvial Units

Qvop **Picacho Alluvium**—Sandy pebble to pebble-cobble gravel that is weakly to moderately consolidated in massive or medium to very thick, tabular to broadly lenticular beds. The deposit is internally massive to moderately-well imbricated or locally cross-stratified. Gravel are mostly clast-supported, very poorly to poorly sorted, subangular to well-rounded, and consist of clasts of rhyolite and rhyolitic tuff to the south and felsic extrusives plus monzonite to the north. The matrix consists of moderately calcareous, poorly sorted, subangular to rounded, fine- to coarse-grained sand. Colors mostly range from reddish-brown to brown (5–7.5YR). A stage III calcic horizon commonly caps the deposit; rarely, a thin argillic (Bt) horizon is preserved above this. Tread height is 18–24 m above modern grade. The thickness is <15–21 m (modified from Ruhe [1967] and Gile et al. [1981]).

Alluvial Fan and Piedmont Units

Qpy **Younger fan-piedmont alluvium**—Similar to units Qvy and Qpy but occurring in mostly undissected fans, sheets, and lobes readily correlated to the Organ or Issacks' Ranch geomorphic surfaces of Ruhe (1964, 1967) and Gile et al. (1981). The thickness is 2–3 m.

Qpyoi **Younger fan-piedmont alluvium, Organ to Isaacks' Ranch morphostratigraphic unit**—Similar to units Qvy and Qpy but occurring in mostly undissected fans, sheets, and lobes readily correlated to the Organ or Issacks' Ranch geomorphic surfaces of Ruhe (1964, 1967) and Gile et al. (1981). The thickness is 2–3 m.

Qpo **Older fan-piedmont alluvium**—Pebble–cobble to pebble–boulder gravel that is loose to moderately consolidated in medium- to very thick (25–60+ cm), tabular to wedge-shaped beds. Gravel are mostly matrix-supported, internally massive to vaguely imbricated, very poorly to poorly sorted, angular to subrounded pebbles (50–70%), cobbles (30–50%), and boulders (<20%). The matrix consists of reddish-brown (5–7.5YR) or pale- to yellowish-brown (10YR, less common), strongly calcareous, very poorly sorted, angular to subrounded, silty, vfL–cU sand. A stage II+ calcic soil horizon is observed in the upper 0.8–1.3 m of the deposit. Moderate to strong varnish is observed on 10–15% of surface clasts. The deposit likely correlates to the Picacho surface of Ruhe (1967) and Gile et al. (1981). The thickness is 2–10 m.

Qpa **Fan-piedmont alluvium, undivided**—Varying proportions of younger (Qpy, Qpyoi) and older (Qpo) fan-piedmont alluvium. See detailed descriptions of each unit.

QUATERNARY–TERTIARY

Basin-fill Units

Qcf **Younger axial-fluvial facies of the Camp Rice Formation**—Sandy deposits underlying the Jornada I surface in the southern part of the quadrangle. Lithologically similar to unit QTcf. The thickness is <12–15 m.

Qcp **Younger piedmont facies of the Camp Rice Formation**—Pebble–cobble to pebble–boulder gravel that is weakly consolidated to carbonate-cemented in massive or in medium to thick (25–80 cm), tabular beds. Gravel clasts are matrix-supported (lesser clast-supported) and internally massive or with slope-parallel fabric. Clasts consist of very poorly sorted, angular to subrounded pebbles (40–70%), cobbles (30–45%), and boulders (0–30%). South and west of Tortugas Mountain, all clasts are Lower Permian carbonates, whereas clast lithologies are dominated (70–75%) by felsic volcanics (especially the Tuff of Squaw Mountain) to the east. White to pinkish-gray or pink colors (10YR 8/1; 7.5YR 7/2–3) result from carbonate cement; reddish-brown to brownish colors (5–7.5YR) are common in its absence. Occasionally, beds of tabular sand-silt similar to unit Qct are encountered. Gile et al. (1981) note that these facies may grade to loam or silt with gravel interbeds at distal piedmont positions, may contain buried soils, and that the unit is frequently capped by a laminar, petrocalcic horizon (stage IV carbonate accumulation). Well logs indicate a maximum thickness of 30–40 m.

Qct **Transitional facies of the Camp Rice Formation**—Silt–sand that is loose to very weakly consolidated in massive or thin to medium, tabular beds. The deposit consists of light-brown to pink (7.5YR 6/4–7/3), moderately to strongly calcareous, internally massive to vaguely low-angle cross-laminated, poorly to moderately sorted, subangular to rounded, silt to mL sand composed of 60–70% quartz, 20–30% lithics (volcanic, ferromagnesian minerals, possible chert), and 10–20% feldspar with little clay. Silt-sand is strong brown (7.5YR 4–5/6) east of Tortugas Mountain. Muddy beds of a similar color may also be present and are generally tabular and massive. The unit contains occasional buried cambic (Bw) to argillic or calcic (Bt, Btk/stage II) soil horizons with abundant small carbonate masses or medium to large nodules. Locally, Bw or Bt horizons are eroded, leaving only the calcic horizons. These paleosol packages are typically 20–80 cm thick. The maximum thickness is about 25 m.

QTcf **Older axial-fluvial facies of the Camp Rice Formation**—Pebble gravel and sand that is loose to moderately consolidated and calcite-cemented. Gravel is clast-supported, thin- to medium-bedded (7–40+ cm), broadly lenticular, and well-imbricated to trough or planar cross-stratified (foresets 20–40 cm tall). Clasts consist of poorly sorted, subrounded to well-rounded pebbles (75–100%) and cobbles (0–25%) of mostly felsic volcanics with subordinate amounts (2–10% each) of intermediate volcanics, basalt, quartzite, granite, chert, and sedimentary lithologies. The matrix consists of white to very pale-brown (10YR 8/1–2) where calcite-cemented, or brown to light-brownish-gray or pale-brown (10YR 5/3, 6/2–3), strongly calcareous, very poorly to poorly sorted, subangular to well-rounded, fL–cL sand composed of 75–80% quartz, 10–15% lithics (volcanic, ferromagnesian minerals, granite, chert) with no clay. Gravel underlies weakly to moderately calcareous, massive to thick-bedded (55+ cm), lenticular (occasionally tabular), internally massive to planar cross-stratified (foresets up to 35–40 cm tall), poorly to moderately sorted, subrounded to well-rounded, vfL–mL sand. Color and sand composition are similar to gravel matrix. Sand is mostly massive in the upper 2–4 m of the deposit. Massive clayey to loamy beds are locally present. Fossils of the proboscideans *Cuvieronius*, *Mammuthus*, and *Stegomastodon* have been recovered from this unit locally (Lucas et al., 1999; Houde and Peltier, 2018). Soils are generally not observed. Well logs indicate a thickness of 100–215 m.

QTcc **Older proximal piedmont facies of the Camp Rice Formation**—Pebble–boulder gravel/conglomerate that is weakly consolidated to carbonate-cemented in thin to medium (5–55+ cm), tabular (rarely lenticular) beds. The unit is mostly matrix-supported and internally massive with rare open-framework beds. Clasts consist of very poorly to poorly sorted, angular to subrounded pebbles (55–100%), cobbles (0–30%), and boulders (0–15%) of felsic volcanics derived from the western Organ Mountains. Monzonite clasts may be present to the north. The matrix consists of dark-reddish-brown (e.g., 5YR 3/4), very weakly calcareous, very poorly sorted, angular to subrounded, fU–vcL sand composed of 80–85% lithics (volcanic) and 15–20% quartz + feldspar with up to 20–25% reddish clay films. The unit contains 10–15% thin, tabular beds of pebbly sand similar to gravel matrix. Stage III–IV calcic horizons observed in the upper 1–2 m. The thickness is from 0 to perhaps 90 m.

Qcru **Camp Rice Formation, undivided**—Cross section only. Correlates to the upper Santa Fe (USF) unit of Hawley et al. (2020).

TERTIARY

Tsf **Santa Fe Group, undivided**—Cross section only. Includes the Middle Santa Fe and Lower Santa Fe facies of Hawley et al. (2020).

Tv **Undifferentiated volcanic rocks**—Cross section only. Lavas and ash-flow tuffs derived mainly from calderas in the Organ Mountains or Doña Ana Mountains.

Twt **West-side trachyte flows**—Porphyritic trachyte lavas that are dark- or purplish-gray weathering, reddish-brown, and massive to flow-banded. Phenocrysts are altered but include 10–20% crystals that are mostly fine to coarse plagioclase (<6 mm; subhedral to euhedral laths) with minor biotite and hornblende (Seager et al., 1981). Two K-Ar ages of ≈33.7 Ma were obtained for nearby flows (Seager, 1981; Seager et al., 1981), but more recent ^{40}Ar/^{39}Ar dating of the west side lavas by Zimmerer and McIntosh (2013) yield dates of 35.68 ± 0.09 Ma to 36.28 ± 0.23 Ma. Individual flows are up to 30 m thick; the overall thickness is up to 300 m (Seager, 1981).

Ts **Tuff of Squaw Mountain**—Cross section only. Densely welded tuff derived from the Organ Caldera (Seager, 1981). U-Pb date is 36.215 ± 0.016 Ma and ^{40}Ar/^{39}Ar date is 36.03 ± 0.16 Ma (Rioux et al. 2016; Zimmerer and McIntosh, 2013).

To **Orejon Andesite**—Cross section only. Gray andesite to dacite lava flows and debris flows reported in geothermal well Chaffee 55-25 south of Tortugas Mountain (Seager et al., 1987). U-Pb dates are 43–44 Ma (Creitz et al., 2018).

PALEOZOIC

Phlu **Upper part of the lower Hueco Formation**—Fossil-poor limestone that is tan to yellow-orange, cream, or light-gray and thin- to medium-bedded. It is found on the west side of Tortugas Mountain. Contact with underlying unit Phll is not well-exposed and may be gradational over a few meters. The exposed thickness is >5 m.

Phll **Lower part of the lower Hueco Formation**—Limestone, dolomite, and dolomitic limestone that are light- to medium-gray (less commonly dark-gray), mostly massive or medium- to very thick-bedded (>20 cm), internally massive or with rare light-colored wavy laminae, and fossil-poor to fossiliferous. Recrystallization is common. Some beds contain occasional to abundant fusulinids that may be disseminated or clustered; these are <1.5–5 mm long. Gastropods, bivalves, horn corals, crinoid stems, and burrows are less common; crinoids are commonly silicified where preserved. A microchonchid tubeworm observed in the lower part of the unit may be *Helicoconchus elongatus* (C. Dunn, pers. comm., 2018). At least one white chert bed is observed near the presumed base of the unit on the east side of Tortugas Mountain. Otherwise, chert occurs as sparse to pervasive lace or, less commonly, as nodules and lenses that are white or sometimes gray. Extensive silicification and local barite/fluorite mineralization may be encountered along fracture zones. The minimum thickness is 305 m.

Pps **Panther Seep Formation**—Sandstone, limestone, and breccia that are poorly exposed. Breccia consists of mostly white (rare gray), angular, pebble- to cobble-sized chert fragments in a reddish-yellow, clayey matrix. Sandstone is up to 2 m thick and consists of massive to horizontal-planar or perhaps cross-laminated, very fine siliceous grains. Below the sandstone is dark-gray limestone containing lenses, nodules, and beds of brown (minor white) chert. Seager et al. (1987) note that this unit includes shale and siltstone elsewhere. The exposed thickness is <45 m.

Plc **Lead Camp Limestone**—Cross section only. Limestone and dolomite are intercalated with shale and minor sandstone and conglomerate in the lower third of the unit (Seager et al., 1987). The thickness is about 200 m in the Organ Mountains (Seager, 1981).

€M **Undifferentiated Cambrian to Mississippian sedimentary rocks**—Cross section only. Dolomite, limestone, shale, and subordinate sandstone.

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Geologic Cross Section A–A'