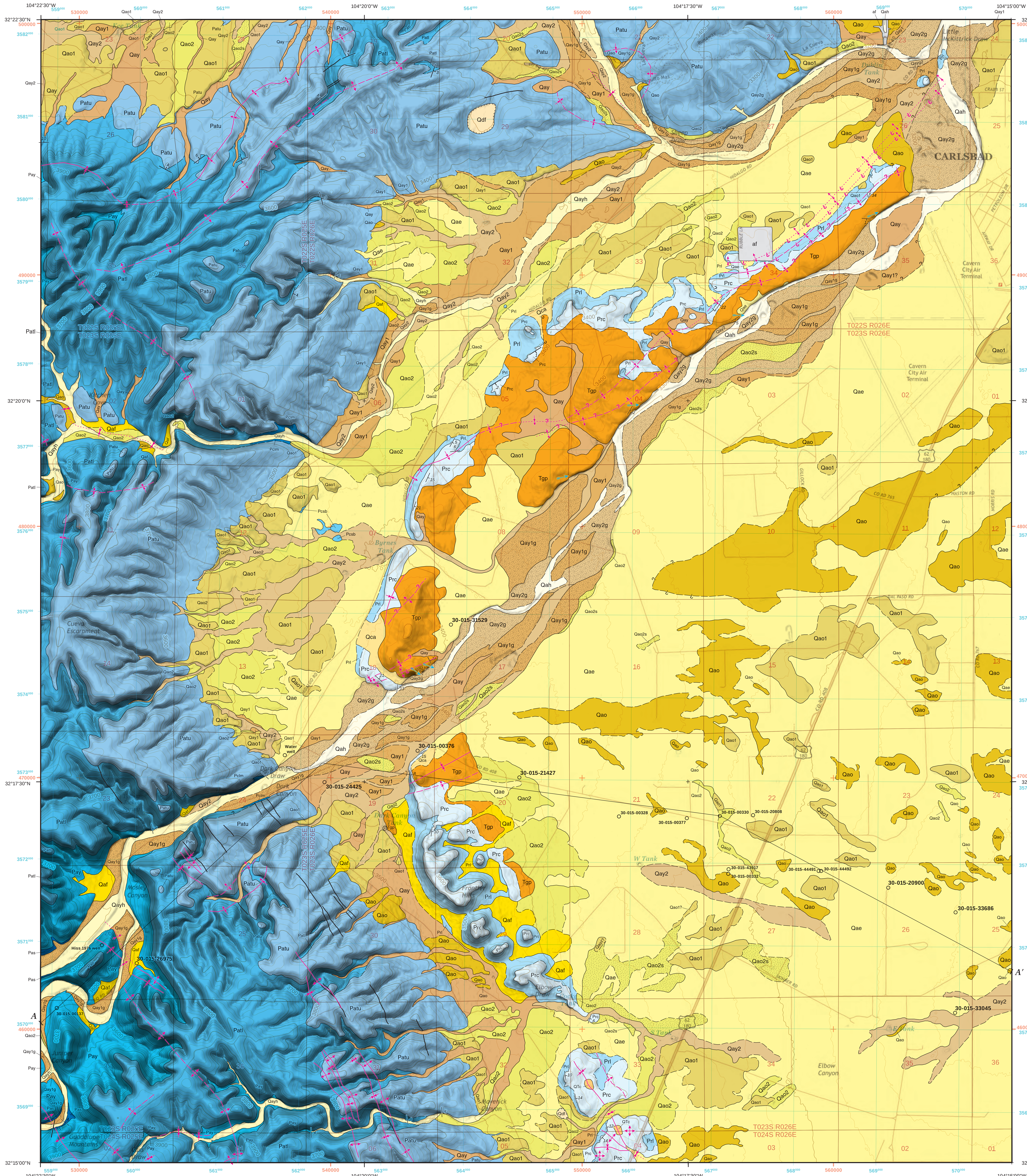


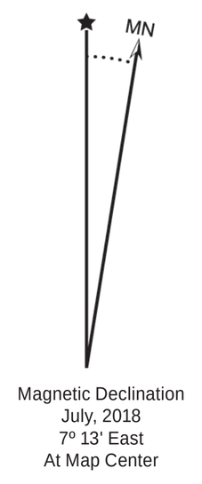
Base map from U.S. Geological Survey 2017.
North American Datum of 1983 (NAD83)
Projection and 1,000-meter grid: Universal Transverse Mercator, Zone 13S, shown in blue.
10,000-foot ticks: New Mexico Coordinate System of 1983 (east zone), shown in red.

Roads............U.S. Census Bureau, 2015–2016
Names............GNIS, 2016
Hydrography............National Hydrography Dataset, 2014
Contours............IFSAR 4.5 m Digital Elevation Model, 2008
Public Land Survey System............BLM, 2011
Wetlands............FWS National Wetlands Inventory 1977–2014

1:24,000

Contour Interval 20 Feet
North American Vertical Datum of 1988

Quadrangle Location



Magnetic Declination
July, 2018
7º 13' East
At Map Center

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 276

Mapping of this quadrangle was funded by a matching-funds grant from the STATEMAP program of the National Cooperative Geologic Mapping Act (Fund Number: G18AC00201), 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 Kitchen Cove 7.5-Minute Quadrangle, Eddy County, New Mexico

June 2019

by
Colin T. Cikoski

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

Comments to Map Users

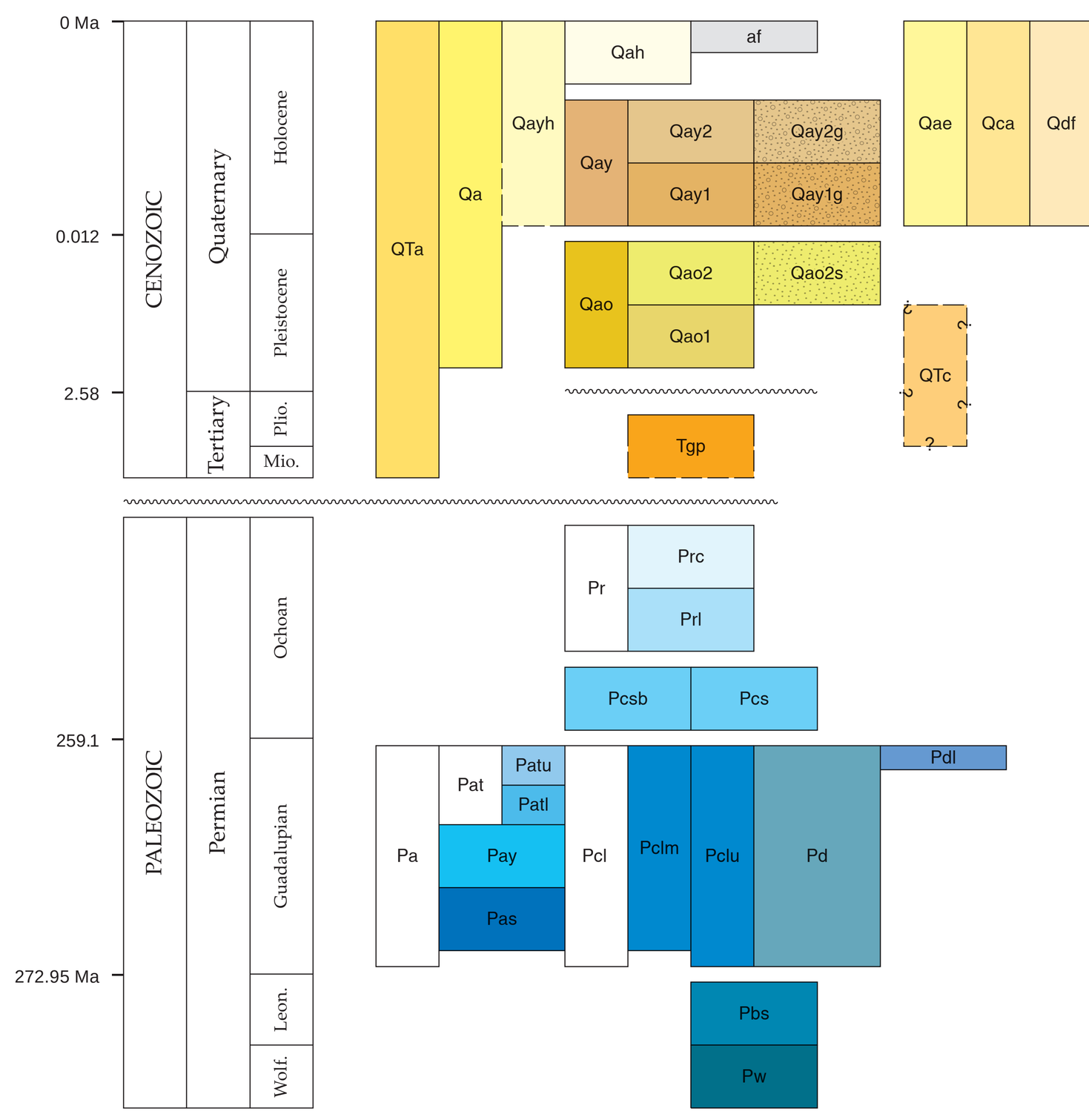
A geologic map displays information on the distribution, nature, orientation, and age relationships of rock and deposits and the occurrence of structural features. Geologic and fault contacts are irregular surfaces that form boundaries between different types or ages of units. Data depicted on this geologic 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.

The New Mexico Bureau of Geology and Mineral Resources created the Open-file Geologic Map Series to expedite dissemination of these geologic maps and map data to the public as rapidly as possible while allowing for map revision as geologists continued to work in map areas. Each map sheet carries the original date of publication below the map as well as the latest revision date in the upper right corner. In most cases, the original date of publication coincides with the date of the map product delivered to the National Cooperative Geologic Mapping Program (NCGMP) as part of New Mexico's STATEMAP agreement. While maps are produced, maintained, and updated in an ArcGIS geodatabase, at the time of the STATEMAP deliverable, each map goes through cartographic production and internal review prior to uploading to the Internet. Even if additional updates are carried out on the ArcGIS map data files, citations to these maps should reflect this original publication date and the original authors listed. The views and conclusions contained in these map documents are those of the authors and should not be interpreted as necessarily representing the official policies, either expressed or implied, of the State of New Mexico, or the U.S. Government.

Digital layout and cartography by the NMBGMR Map Production Group:
Phil L. Miller, Amy L. Dunn, Katherine J. Sauer, and Kelly K. Boyd

Correlation of Map Units



Explanation of Map Symbols

	Contact—Identity and existence are certain or questionable where queried. Location is accurate where solid, approximate where long-dashed, inferred where short-dashed, or concealed where dotted.
	Gradational contact—Identity and existence are certain. Location is accurate where solid or dashed where approximate.
	Collapse structure or sinkhole (drawn to scale)
	Joint—Identity and existence are certain and the location is accurate.
	Anticline—Identity and existence are certain or questionable where queried. Location is accurate where solid, approximate where dashed, or concealed where dotted.
	Syncline—Identity and existence are certain or questionable where queried. Location is accurate where solid, approximate where dashed, and concealed where dotted.
	Monocline, anticlinal bend—Identity and existence are certain or questioanble where queried. Location is accurate where solid, approximate where dashed, or dotted where concealed.
	Monocline, synclinal bend—Identity and existence are certain or questionable where queried. Location is accurate where solid, dashed where approximate, or dotted where concealed.
A A′	Cross section line
	Unconformity in the Correlation of Map Units
	Well location—Showing in cross section the location and depth of a well used to establish stratigraphy and geologic unit depth.
	Well location—Showing in cross section the projected location and depth of a well used to establish stratigraphy and geologic unit depth.
11	Inclined contact—Showing dip value and direction
	Sediment transport direction determined from imbrication
28	Minor inclined fault
	Small, minor dome
87	Inclined bedding
	Collapse structure or sinkhole (too small to draw to scale)
30-015-21427	Drill hole from which data was collected for constructing cross-section A-A′, showing API number

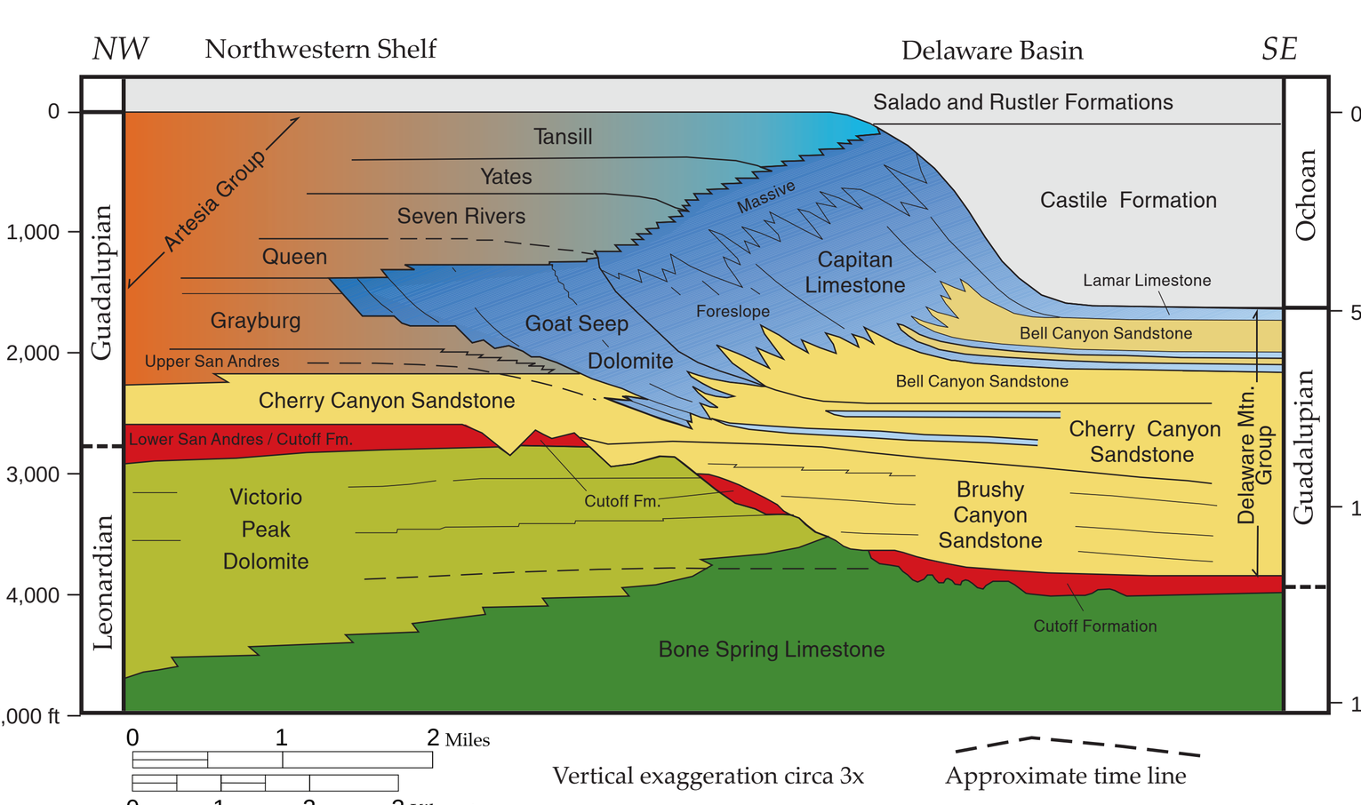
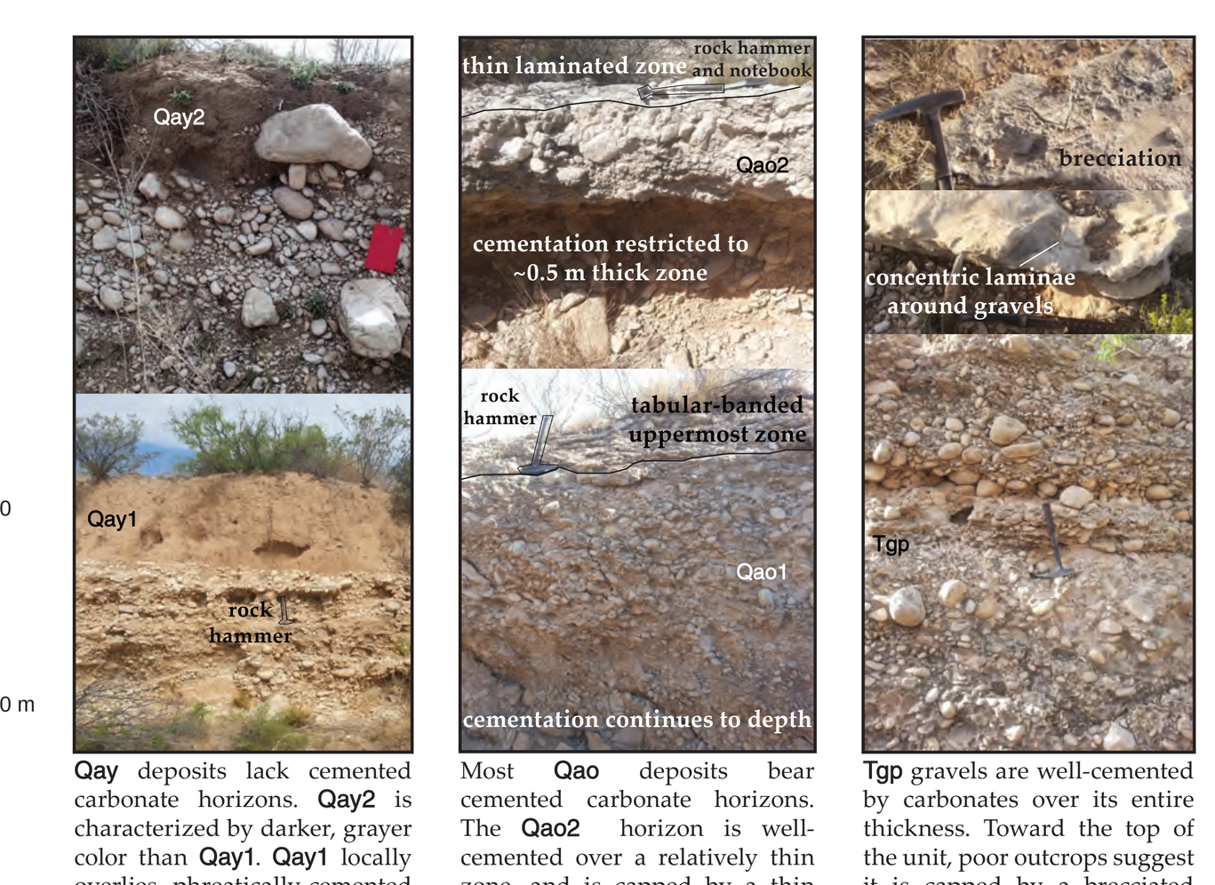


FIGURE 1—Classic depiction of the stratigraphy of the Permian strata exposed in the Guadalupe Mountains. Modified from Scholle et al. (2007). Abbreviations: Fm. = Formation, Mtn. = Mountain. Note that in cross-section A-A′: the Formations and most Members of the Delaware Mountain Group are combined (unit Pd); the Castile and Salado Formations are combined (Pcs); the massive and foreslope members of the Capitan Limestone (plus the Goat Seep Dolomite, if present) are combined (Pclu); and the Victorio Peak and Cutoff Formations, if present, are combined with the Bone Spring Limestone (Pbs).



Qay deposits lack cemented carbonate horizons. Qay2 is characterized by darker, grayer color than Qay1. Qay1 locally overlies phreatically-cemented gravels.

Most Qao deposits bear cemented carbonate horizons. The Qao2 horizon is well-cemented over a relatively thin zone, and is capped by a thin laminated zone. The Qao1 cementation continues to over 1 meter depth, and is capped by an undulatory tabular banded zone.

Tgp gravels are well-cemented by carbonates over its entire thickness. Toward the top of the unit, poor outcrops suggest it is capped by a brecciated zone of nearly pure carbonate cement, and concentric laminations around gravels are locally present.

FIGURE 2—Features of the Cenozoic alluvial deposits on the Kitchen Cove quadrangle

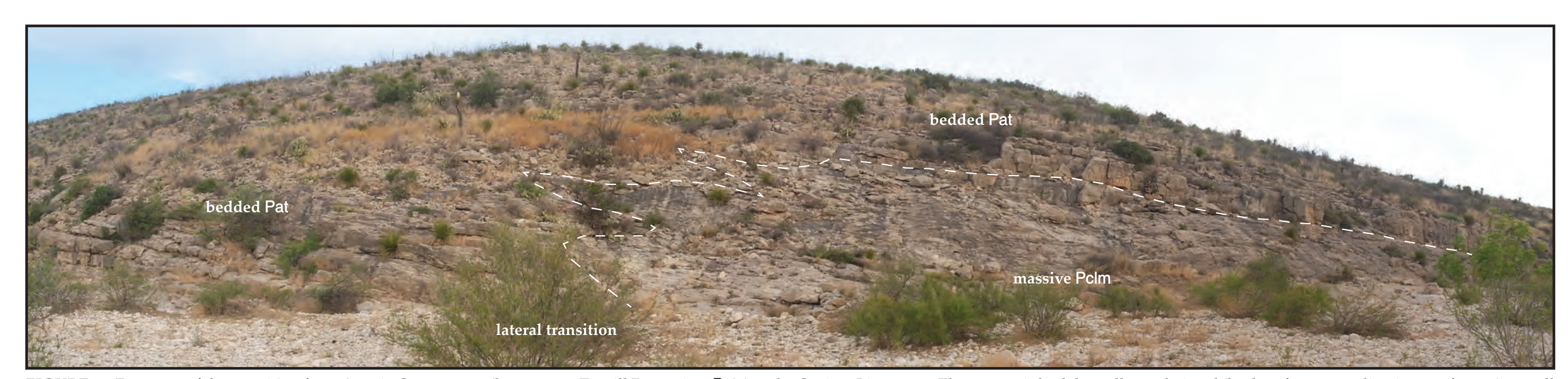
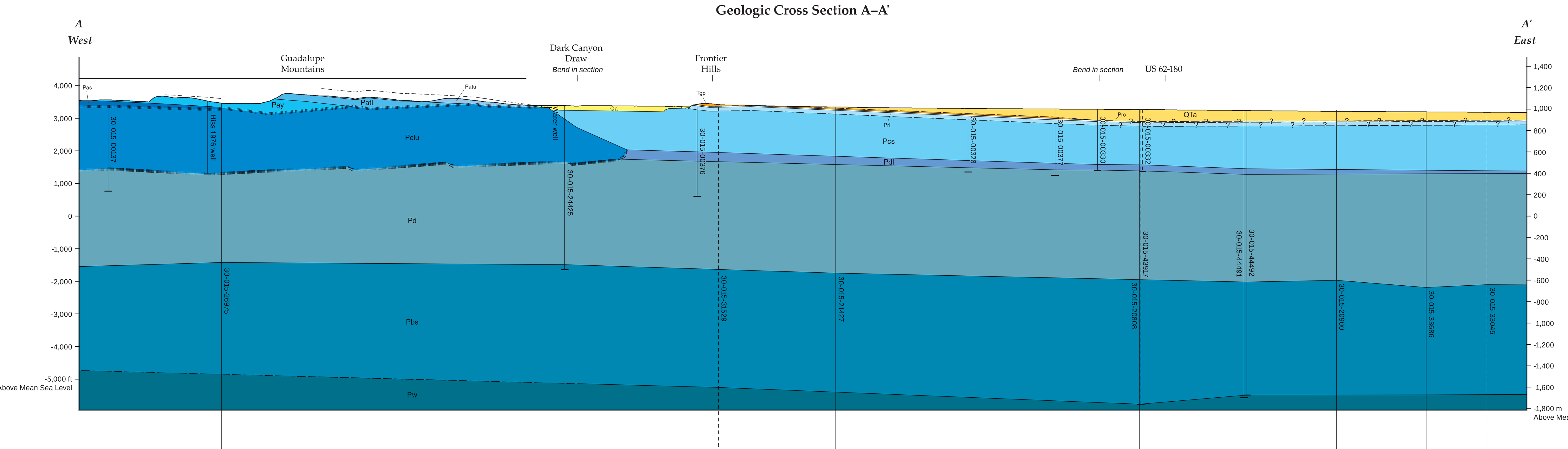


FIGURE 3—Exposure of the transition from Artesia Group strata (here, upper Tansill Formation, Patu) to the Capitan Limestone. The contact is both laterally gradational (backreef strata grading into reef strata) as well as vertical (backreef strata prograding over the reef).

Geologic Cross Section A–A′



Description of Map Units

CENOZOIC ERATHEM
Artificial Deposits

af — **Artificial Fill**—Variously compacted sands, gravels, and muds emplaced by anthropogenic means. Only mapped where the deposit is of significant areal extent, thickness, or masks underlying geologic relationships. 0 to perhaps 10 m thick.

Alluvial Deposits

Qa — **Undivided Quaternary Alluvium**—Cross section only. May include areas of any or all of the Quaternary alluvial deposits described below. Well logs suggest unit thickness may be as much as 64 m.

QTa — **Undivided Quaternary–Tertiary Alluvium**—Cross section only. May include areas of any or all of the Quaternary or Gatuña Formation alluvial units described below. Well data from Bjorklund and Motts (1959) suggest an on-quadrangle alluvium thicknesses of as much as 110 m.

Qaf — **Small-Scale Fan Alluvium**—Generally thin veneers of alluvial gravels and sands deposited as small, coalescing alluvial fans by low-order tributary drainages. Sediments are poorly sorted and of compositions reflective of upstream rock or sediment types. Surface soil characteristics are highly variable, but often include carbonate horizons with Stage I to IV morphology. Deposits are poorly exposed, but thicknesses likely 0 to perhaps 3 m.

Qah — **Historic Alluvium**—Poorly or unvegetated sandy gravels along active drainage channels. Deposits are dominantly poorly sorted, rounded pebbles to trace boulders of mainly limestone/dolomite lithologies with lesser amounts of material derived from other upstream-exposed units. Most deposits are matrix-poor and loose, and exhibit no evidence of appreciable soil development. Locally overtops the treads of low terraces along the channel flanks. Map unit includes small unmappable Qay terrace deposits and anthropogenically-emplaced material along active and abandoned gravel pit operations. Deposits are 0 to perhaps 4 m thick.

Qayh — **Historic and Undivided Younger Alluvium**—Gravels, sands, and muds within and along narrow active drainage channels. Used where historic alluvium and younger terrace deposits cannot be mapped separately with accuracy at the map scale, and is dominated by historic alluvium that often overtops the low treads of adjacent terrace alluvium. Terrace alluvium is mainly of Qay2/Qay2g type. Deposits are 0 to perhaps 4 m thick.

Qay — **Younger Alluvium, undivided**—Undifferentiated Holocene alluvial sands, muds, and gravels. Deposits are principally like those of Qay2 and/or Qay1, and less commonly like Qay2g, Qay1g, and/or Qah. This undivided map unit is used where map scale, poor exposure, and/or a lack of differentiating features precludes subdivision. Deposits are 0 to perhaps 7 m thick.

Qay2 — **Younger Subunit of the Younger Alluvium**—Brown to yellowish brown fine sands to silts and lesser clays and gravels along active drainage channels and swales or underlying low terraces with no appreciable surface soil development. Most deposits are massive to laminated, poorly sorted, sandy silts to silty sands with trace rounded pebbles derived from nearby alluvial gravel deposits. Rare paleochannel fills of poorly sorted, rounded, clast-supported pebbles occur as thin lenticular ribbon-shaped interbeds. Map unit also includes lesser historic alluvium, commonly consisting of cobbly pebble gravel deposits along active drainage channels with common bar-and-swale topography and little to no vegetation. Sand and silt colors of 10YR 5/3–5/4 were measured. Deposits are 0 to perhaps 5 m thick.

Qay2g — **Gravel-Dominated Deposits of the Younger Subunit of the Younger Alluvium**—Gravels and lesser brown to yellowish brown sands and trace muds underlying low terraces exhibiting no appreciable surface soil development. Deposits are mostly found along the flanks of larger drainage channels, and consist dominantly of poorly sorted, rounded to well-rounded, cobbly pebbles and trace boulders, of mainly limestone/dolomite lithologies with rare sandstone and Culebra Dolomite clasts as well as trace reworked conglomerate clasts and well-rounded siliceous pebbles (chert, quartzite), in thick to medium, clast-supported, unconsolidated, uncemented, massive planar tabular or broadly lenticular beds. Irregular sand beds as much as 40 cm thick but commonly pinching out laterally are up to 40% of outcrops, typically becoming more abundant up-section, and consist of poorly sorted, well-rounded to rounded, very fine to fine grains of principally siliceous material and carbonate lithics. Sand colors of 10YR 5/3–5/4 were measured. Deposits are 0 to perhaps 5 m thick.

Qay1 — **Older Subunit of the Younger Alluvium**—Dominantly light brown to pink alluvial sands with lesser gravels underlying terraces bearing surface soils characterized by weak A/Bk soil horizonation. Sands are mostly poorly sorted, silty-clayey, fine- to less commonly medium-grained, predominantly of carbonate lithics, and occurring in massive intervals that bear trace pebbles and surround thin pebbly paleochannel fills. Gravels are predominantly poorly sorted sandy pebbles consisting of limestone/dolomite lithologies and rare sandstone clasts in poorly structured lenticular beds. Surface soils most commonly consist of a darkened A horizon overlying sands with thin, fine filaments and fine nodules of carbonate (Stage I carbonate horizon morphology). Sand colors of 7.5YR 6/3–7/4 were measured. Deposits are 0 to perhaps 7 m thick.

Qay1g — **Gravel-Dominated Deposits of the Older Subunit of the Younger Alluvium**—Dominantly gravels with lesser light brown to pink sands underlying terraces with surface soils characterized by A/Bk soil horizonation. Gravels are dominantly poorly sorted, rounded to well-rounded, cobbly and/or sandy pebbles of mainly limestone/dolomite lithologies with rare sandstone and Culebra Dolomite clasts, in medium-thickness, massive to cross-stratified lenticular beds. Sands are like those described for Qay1, occurring mostly as massive tabular or irregular interbeds surrounded by or capping gravel deposits. Locally, such as along Dark Canyon, variable amounts of phreatic carbonate cements the gravel beds. Surface soils most commonly consist of a darkened sandy A horizon overlying a carbonate horizon exhibiting Stage I to Stage II morphology. Sand colors of 7.5YR 6/3–7/4 were measured. Deposits are 0 to perhaps 7 m thick.

Qao — **Older Alluvium, undivided**—Alluvial gravels bearing surface soils characterized by Stage IV or V morphology petrocalcic carbonate horizons. Commonly subdivided based on the level of soil development. The undivided map unit is used where map scale, poor exposure, or a lack of differentiating features precludes subdivision. Deposits of Qao are like those of Qao1 and/or Qao2.

Qao2 — **Younger Subunit of the Older Alluvium**—Alluvial gravel and lesser light brown to white sand deposits bearing surface soils characterized by Stage IV morphology petrocalcic carbonate horizons. These carbonate horizons typically consist of a 4 to 20 cm-thick laminated top consisting of undulatory laminations 2 to 10 mm thick with common entrained alluvial gravels, which overlies a 30 to 40 cm-thick carbonate-cemented zone that grades down-profile into uncemented gravels and/or sands. Any previously overlying A or B horizons have been stripped. Deposits dominantly consist of poorly sorted, rounded, cobbly pebble gravels and trace boulders, of mainly limestone/dolomite lithologies with rare sandstone clasts. Sands are mainly poorly sorted, silty-clayey, subangular to rounded, very fine to medium grains of mainly carbonate lithics occurring in thick massive intervals. Sand colors of 7.5YR 6/4–8/4 were measured. Clay films are found below the carbonate horizon as rare to common bridges between grains and as gravel coats. Deposits are locally capped by up to 20 cm of eolian or slopewash sands similar to those of unit Qae. Gravel deposits are 0 to perhaps 5 m thick.

Qao2s — **Sand-Dominated Deposits of the Younger Subunit of the Older Alluvium**—Alluvial sand and lesser gravel deposits underlying surfaces that occur at comparable levels to surfaces capping Qao2 deposits. Deposits are poorly exposed but appear to consist principally of light brown, moderately sorted, siliceous, variably silty, very fine to fine sands in massive beds. A sand color of 7.5YR 6/4 was measured. Gravels are poorly sorted, rounded to well-rounded cobbly pebbles and trace boulders, of mainly limestone/dolomite lithologies with rare sandstone clasts and trace well-rounded siliceous pebbles, occurring in thick lenticular or ribbon-shaped beds that pinch out laterally into sand intervals. No preserved surface soil was found in outcrop for this unit; however, along the edges of terrace treads there are commonly thin carbonate coats completely encircling gravels as well as rare float of carbonate-cemented gravels, suggesting a minimum Stage II carbonate soil horizon is or was at one point present. Deposits 0 to perhaps 5 m thick.

Qao1 — **Older Subunit of the Older Alluvium**—Alluvial gravel deposits bearing surface soils characterized by Stage V morphology petrocalcic carbonate horizons. These carbonate horizons typically consist of a 25 to 40 cm-thick tabular-structured top zone consisting of undulatory bands of dominantly carbonate cement that are 3 to 10 cm thick, which overlies a carbonate-cemented zone 30 to 70 cm thick, with cementation decreasing down-profile; engulfing, but only weakly cementing, carbonate continues below the well-cemented zone to at least 4 m depth. Any previously overlying A or B horizons have been stripped. Deposits dominantly consist of poorly sorted, rounded, cobbly pebble gravels and trace boulders, of mainly limestone/dolomite lithologies with rare sandstone clasts. Sand beds are very rare, and typically consist of carbonate-engulfed very fine to fine sand grains in medium to thick, moderately cemented, massive, tabular, pale pink beds; a sand color of 9.5YR 7/2 was measured. Deposits are locally capped by up to 20 cm of eolian or slopewash sands similar to those of unit Qae. Gravels and soil may correlate to the Upper Gatuña Formation of Cikoski (2019). In outcrop, gravel deposits are 0 to about 4 m thick; well logs suggest thicknesses may be up to 64 m or more.

Tgp — **Gatuña Formation, Piedmont Facies**—Alluvial conglomerates and rare sandstones along the east flank of the Frontier Hills. Deposits dominantly consist of cobbly pebble gravels and trace boulders, of mainly limestone/dolomite lithologies with lesser sandstone clasts and trace well-rounded quartzite and chert, in medium to thick, moderately well-cemented, clast-supported, often cross-stratified, lenticular beds. Pink sandstone interbeds are rare, and consist of poorly sorted, rounded, grain-supported, very fine to coarse grains of siliceous and carbonate lithologies, in thick, generally poorly cemented, massive, tabular beds. Sand bed colors of 7.5YR 7/3–7/4 were measured. No complete exposure of a surface soil was found. Partial exposures suggest a well-cemented near-surface zone exhibiting smooth, micritic cement textures; brecciation and recementation features; thin concentric laminations around gravels; and a level of induration that typically causes fractures to traverse through gravels rather than around gravels. This near-surface zone could be a poorly exposed Stage VI carbonate horizon. Deposits are 0 to at least 25 m thick; well records suggest thicknesses may exceed 46 m.

Miscellaneous Deposits

Qae — **Alluvial and Eolian Sediment**—Pink to pale brown piedmont-blanketing slopewash and windblown silts and fine sands. Dominantly silts, with lesser very fine sands and trace pebbles, in massive deposits. A silt color of 7.5YR 7/3 was measured. Surface soils are weak and characterized by rare fine carbonate nodules up to 2 mm across occurring throughout deposits below about 30 cm depth (Stage I or less carbonate horizon morphology). Deposits are commonly thin but can be as much as 3 m thick.

Qdf — **Depression Fill**—Silts, sands, and clays accumulating in closed or nearly closed depressions. Dominantly slopewash- and eolian-transported muds and very fine sands, with trace coarser material. Surface soils were not observed in outcrop, but no evidence of significant soil development was found. Deposits are likely 0 to perhaps 2 m thick.

Qca — **Undivided Colluvium and Alluvium**—Uncemented sands and gravels transported by gravitational or unconfined alluvial mechanisms. Mapped only where concealing underlying geologic relationships, principally between map unit Tgp and underlying Rustler Formation strata. Sediments are mainly derived from upslope Tgp deposits, and hence consist of similar assemblages of gravels and sands. Deposits are 0 to perhaps 1 m thick.

QTc — **Uncorrelated Caliche**—"Deposits" of pure(?) carbonate cement along the east flank of the Frontier Hills. No entrained sediments or bedrock blocks were found in these caliche zones. Caliche is poorly exposed, but upturned blocks reveal common laminations 1 to 6 mm thick with local pisolitic textures. Caliche is white to light gray (7.5YR 7/1 was measured), very well-indurated, and locally fractured or jointed. Caliche is 0 to perhaps as much as 2 m thick.

PERMIAN SYSTEM
Ochoan Series

Rustler Formation (Pr)

Prc — **Culebra Dolomite Member of the Rustler Formation**—Cream-colored to white, ledge-forming, conspicuously vuggy dolomite, locally grading laterally into light yellowish to grayish brown limestone. Dolomite beds are thin, planar tabular, very fine-grained, and commonly internally massive. Abundant to rare vugs are fine in size (1 to 10 mm in diameter) and distinctive to the unit. Limestones are mainly fine-grained, carbonate mud-rich packstones and lesser wackestones, in thin tabular beds that are locally internally cross-, planar-, or concentrically-laminated. Unit is locally highly fractured, with fractures variously filled with caliche/carbonate cement, particularly adjacent to map units Tgp and QTc. Measured colors range from white for dolomite outcrops to mainly 2.5Y 6/3 and locally 2.5Y 5/1–5/2 and 10YR 6/6 for the limestones. Preserved unit thickness is up to about 6 to 9 m.

Prl — **Los Medaños Member of the Rustler Formation**—Pale red to reddish yellow mudstones, isolated masses of gypsum, and rare brown sandstones. Mudstones are laminated, weakly indurated, and very poorly exposed, and often only apparent as reddish brown silts and clays in colluvial slopes. Sandstones occur as typically thin but locally thick lenticular intervals of very fine- to fine-grained, cross-laminated, very thinly bedded siliceous sandstones interlayered with lesser light brown siltstones. Gypsum occurs as irregular white to light gray masses generally cropping out of otherwise colluvial slopes. Colors of 5YR 6/6–7/6 (mudstones) and 2.5Y 7/4 (sandstones) were measured. The base of the unit is unexposed. The exposed unit thickness is up to 25 m, while Powers and Holt (1999) report a thickness of 34.4 m in the type section.

Castile and Salado Formations, undivided

Pcsb — **Breccia of Castile and Salado Formation Rocks**—Irregular breccia blocks and outcrops of mainly Castile Formation lithologies with subordinate Salado Formation residue. Breccia blocks are up to 1 m across and consist of erratic mixtures of principally gypsum with lesser selenite and clay. Some blocks and outcrops bear subparalleling laminations that may be remnant bedding planes, while other blocks consist of discordant, unaligned crystalline material with irregular thin bands of clays. Blocks and outcrops are principally white to gray (circa 2.5Y to 10YR 7–8/1–2 was measured), less commonly pink to red (5YR 6/4 and 10R 6/8 and 4–5/6 were measured), with redder colors more common to clay-enriched blocks. Deposits are poorly exposed, and breccia unit thickness is poorly constrained; at depth, the breccia grades into intact gypsum and anhydrite below the depth of weathering and dissolution, but the depth of this transition was not determined. Maximum total thickness of Castile and Salado deposits is around perhaps 405 m.

Pcs — **Castile and Salado Formations, undivided**—Cross section only. Includes Castile-Salado breccia and intact Castile Formation at depth. Cross section interpretations indicate a maximum thickness of approximately 405 m.

Guadalupian Series

Capitan Limestone (Pcl)

Pclm — **Massive Facies of the Capitan Limestone**—Light gray, weathering medium gray, massive fossiliferous limestone. Conspicuous fossils include calcareous sponges and fragments of brachiopod and gastropod shells and crinoids. Commonly vuggy, locally brecciated or fractured, with breccia and fractures recemented by carbonate mud. Grades laterally westward and vertically up-section into the Tansill Formation at the surface, and into the Yates and Seven Rivers Formations in the subsurface. Contact is placed along the transition from bedded Artesia Group to massive Capitan carbonates. Base unexposed.

Pclu — **Undivided Capitan Reef Complex**—Cross section only. In the subsurface, the Capitan reef complex may include areas of the massive facies of the Capitan Limestone (map unit Pclm), areas of Capitan Limestone talus slope breccia (cf., Newell et al., 1953, and Hayes and Koogle, 1958), and potentially areas of Goat Seep Dolomite, a precursor to the Capitan Limestone (Newell et al., 1953; Hiss, 1975; Standen et al., 2009). King (1948) reports a thickness range of 300 to 600 m at the surface, and as much as 820 m in the subsurface. Well data from Hiss (1975) and Standen et al. (2009) indicate the on-quadrangle thickness ranges from about 315 to 643 m, decreasing to 0 m within the Guadalupian Delaware basin.

Artesia Group (Pa)

Pat — **Tansill Formation**—Principally white to light gray thinly bedded dolomite grainstones to packstones, with local interbedded siltstones/mudstones in the upper portion. Typically subdivided into lower and upper map units, with the contact placed along a conspicuous and continuous ledge developed along the base of a siltstone interval in the Ocotillo Silt Member of DeFord and Riggs (1941). Both map units consist principally of grainstones and packstones in tabular beds 10 to 40 cm thick that are variously internally massive, planar-laminated, or cross-laminated. Rarely, beds are pisolitic, and locally bear paleokarst-filling silt or are capped by silt. Near to the Capitan Limestone, pisolites become more common, beds thicken, and mollusc and brachiopod fossils as well as tepee structures are found. Interbedded mudstones, more common in the upper map unit, are pale brown to pink, dominantly siltstones, tabular, very thinly bedded to laminated, and commonly moderately well-indurated by carbonate cement. Colors of 2.5Y 8/1, 6/1, and 7/2 to 10YR 8/1 (dolomites) as well as 2.5Y 7/4–8/3 (siltstones) were measured. Preserved unit thickness is about 80 to 90 m.

Patu — **Upper Map Unit of the Tansill Formation**—White to light gray thinly bedded dolomite grainstones to packstones with rare mudstones overlying a conspicuous and continuous ledge in the Ocotillo Silt Member. Principally consists of dolomites as described above; mudstones are rare but occur at several stratigraphic levels (particularly at the base) and paleokarst-filling silt is more common than in the underlying lower map unit. Pisolitic beds are overall rare, but are common just above the basal contact and near to the Capitan Limestone. The top of the unit is not preserved on the quadrangle.

Patl — **Lower Map Unit of the Tansill Formation**—White to light gray thinly bedded dolomite grainstones to packstones below a conspicuous and continuous ledge in the Ocotillo Silt Member. Principally consists of dolomites as described above; mudstones are a trace element of the map unit and silt as paleokarst fill is more rare than in the overlying upper map unit. Pisolites are generally only found near to the Capitan Limestone.

Pay — **Yates Formation**—Interbedded white to light gray dolomite grainstones to packstones and lesser pale brown siltstones to very fine-grained sandstones. Dolomites are comparable to those described for the Tansill Formation. Clastic rocks are subordinate to dolomites, and occur in 0.3 to 2.5 m-thick intervals of thinly planar bedded, internally planar- or cross-laminated, very fine-grained sandstones and undulatory-laminated siltstones. Beds are moderately well-indurated by carbonate cements, but generally erode more readily than the interbedded carbonates and are often poorly exposed. Colors of 10YR 7/3–7/4 (sandstones) and 10YR 6/6–7/6 (siltstones) were measured for the clastic intervals. Unit thickness is about 80 to 90 m.

Pas — **Seven Rivers Formation**—A distinctive interval of light gray to white micrites to packstones and oolites, tentatively assigned to the Seven Rivers Formation based on mapping by Motts (1962). Oolites are typically thinly lenticular-bedded, cross-laminated, poorly sorted, "clast-supported," and micritic mud-rich. Micrites, wackestones, and packstones are variously structured, including: massive, planar-laminated, or internally crenulated medium-thickness tabular bedding; planar-, cross-, or undulatory-laminated thin lenticular bedding; and crenulated thin lenticular bedding, all bearing absent to rare ooids, absent to rare detrital carbonate, and absent to trace clots of sparry carbonate that could be either filled vugs or replaced shells. The interval is thoroughly replaced by carbonate mud; ooids and sedimentary structures are only apparent on weathered faces, while fresh faces are uniformly light gray (circa 10YR 7/2, weathering to circa 7.5YR 7/2 or 10YR 8/1) carbonate mud in which structures and clasts are not apparent. The lower part of the exposed interval is variously brecciated and intraformationally faulted; faults do not extend upsection to the top of the unit. The base of the unit is unexposed; Motts (1962) reports thickness estimates of 80 to 140 m for the Seven Rivers Formation, while cross section A–A′ suggests an on-quadrangle preserved thickness of up to about 55 m.

Delaware Mountain Group

Pd — **Delaware Mountain Group, undivided**—Cross section only. Dominantly arkosic to subarkosic very fine- to fine-grained sandstones and siltstones, with minor detrital carbonates (King, 1948). Cross section interpretations, constrained by well logs, suggest a unit thickness of about 979 to 1,060 m thick along cross section A–A′; well logs report thinner sections in the northwest corner of the quadrangle, where the thickness is about 670 to 727 m.

Pdl — **Lamar Limestone Member of the Bell Canyon Formation of the Delaware Mountain Group**—Cross section only. The uppermost detrital carbonate of the Delaware Mountain Group provides a distinct marker horizon in geophysical logs. King (1942) reports the limestone is gray to black, fine grained, thinly bedded to thinly laminated, and 5 to 10 m thick at its type locality but thickening westward to as much as 46 m thick at the surface closer to the Guadalupe Mountains. Cross section interpretations constrained by well logs suggest the unit may be thicker still in the subsurface here, with a maximum thickness of about 60 m, thinning eastward to about 36 m. This thickness may include beds of the Reef Trail Member overlying the Lamar Limestone.

Leonardian and Wolfcampian Series

Pbs — **Bone Spring Limestone**—Cross section only. King (1948) and Hayes (1964) suggest the unit consists dominantly of brownish gray to black, thinly bedded, rarely cherty limestone with lesser black to dark brown shale and dark brown shaly limestone. Well logs report a unit thickness of about 1,005 to 1,224 m here.

Pw — **Wolfcampian Series**—Cross section only. Hayes (1964) suggests the unit consists of subequal amounts of gray, black, or brown shale and finely crystalline, rarely cherty, brownish limestone in wells drilled about 5 to 6.5 km south of this quadrangle (Union Crawford 1-26 and Gulf Estill 1-AD in Sections 26 and 29 of T24S, R26E), where the series is about 454 to 527 m thick. A stripog for the Western Oil McKittrick Federal 1 (Section 25 of T22S, R25E, in the northwestern corner of the quadrangle) suggests the series consists of interbedded gray to dark brown limestone and white to dark gray very fine-grained sandstone; here the unit is reported to be 454 m thick. Additional well logs in the quadrangle area report thicknesses from about 153 to 462 m, appearing to generally thin northward and westward.

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