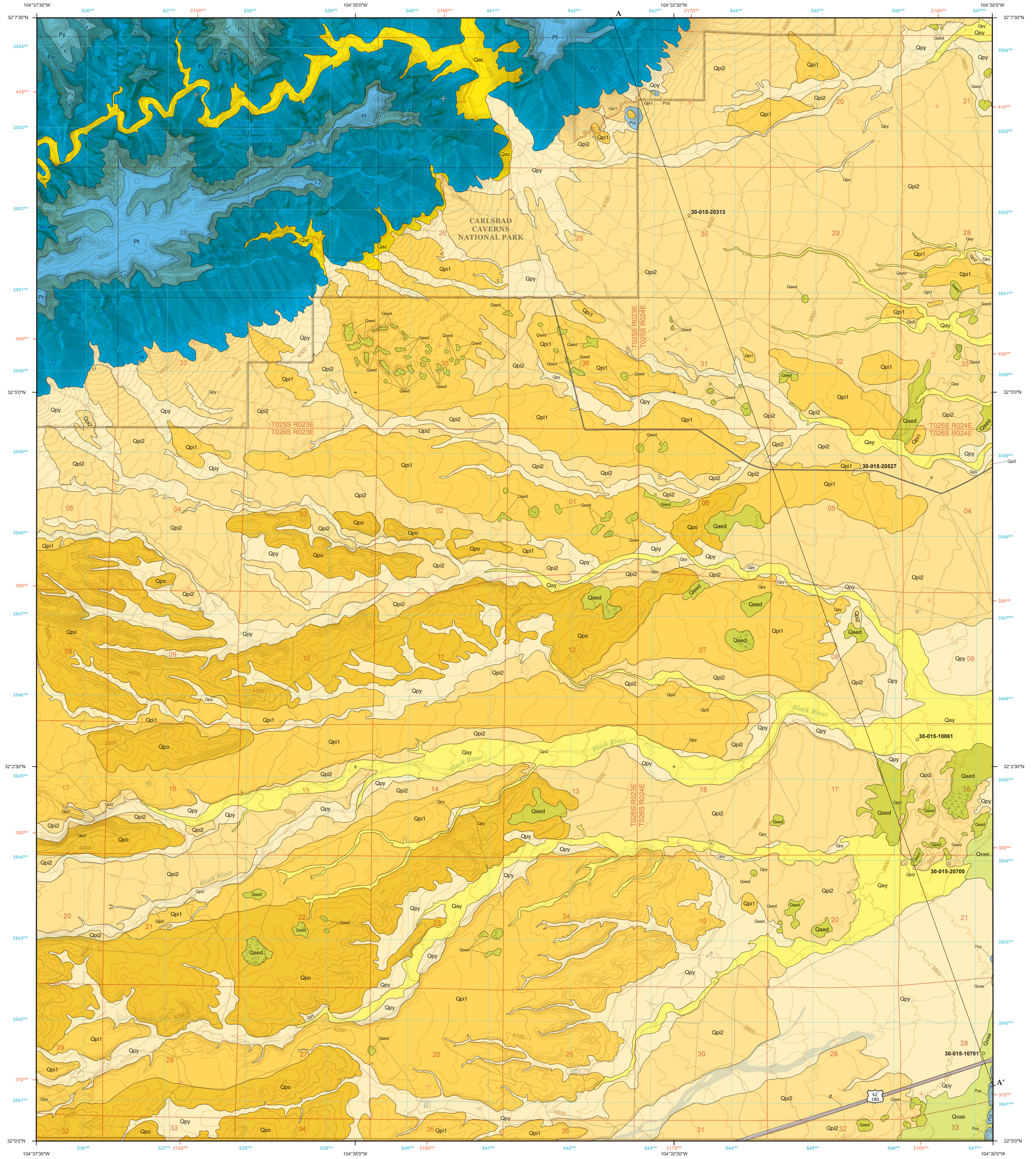
NEW MEXICO BUREAU OF GEOLOGY AND MINERAL RESOURCES A RESEARCH AND SERVICE DIVISION OF NEW MEXICO INSTITUTE OF MINING AND TECHNOLOGY

NMBGMR Open-File Geologic Map 309

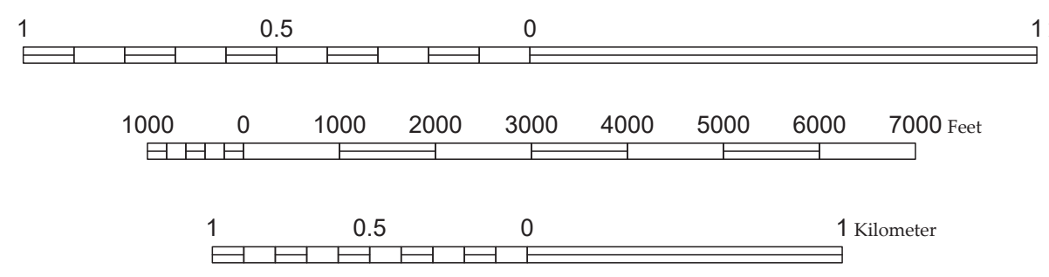
Last Modified August 2024



Base map from U.S. Geological Survey 2023. 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.

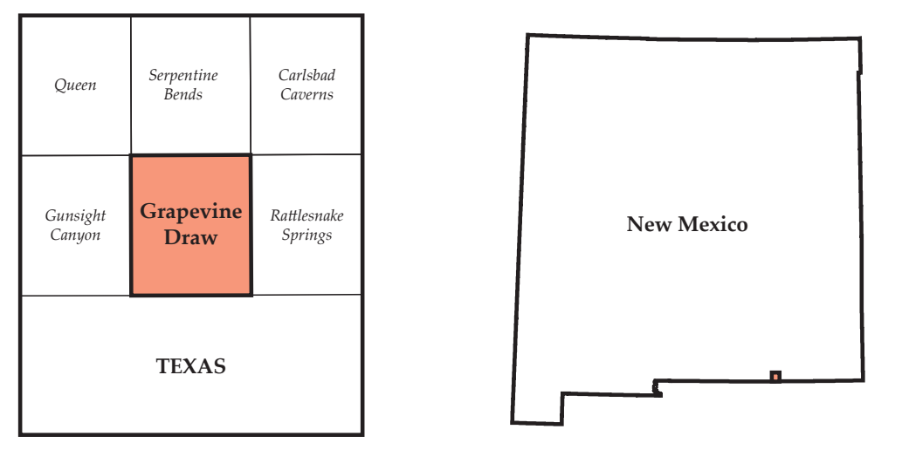
Roads	U.S. Census Bureau, 2015–2016
Names	GNIS, 2016
Hydrography	National Hydrography Dataset, 2014
Contours	IFSAR 4.5 m Digital Terrain Model, 2008
Wetlands	FWS National Wetlands Inventory 1977–2014

1:24,000

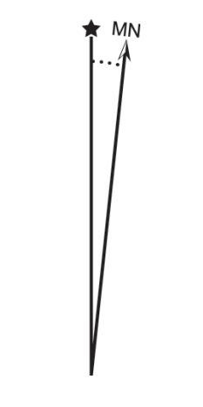


Contour Interval 20 Feet

North American Vertical Datum of 1988



Quadrangle Location



Magnetic Declination
September 2023
6° 45' East
At Map Center

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

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Open-File Geologic Map 309

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Geologic Map of the Grapevine Draw 7.5-Minute Quadrangle, Eddy County, New Mexico

September 2024

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, a 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 (drill hole) 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 human-made structures.

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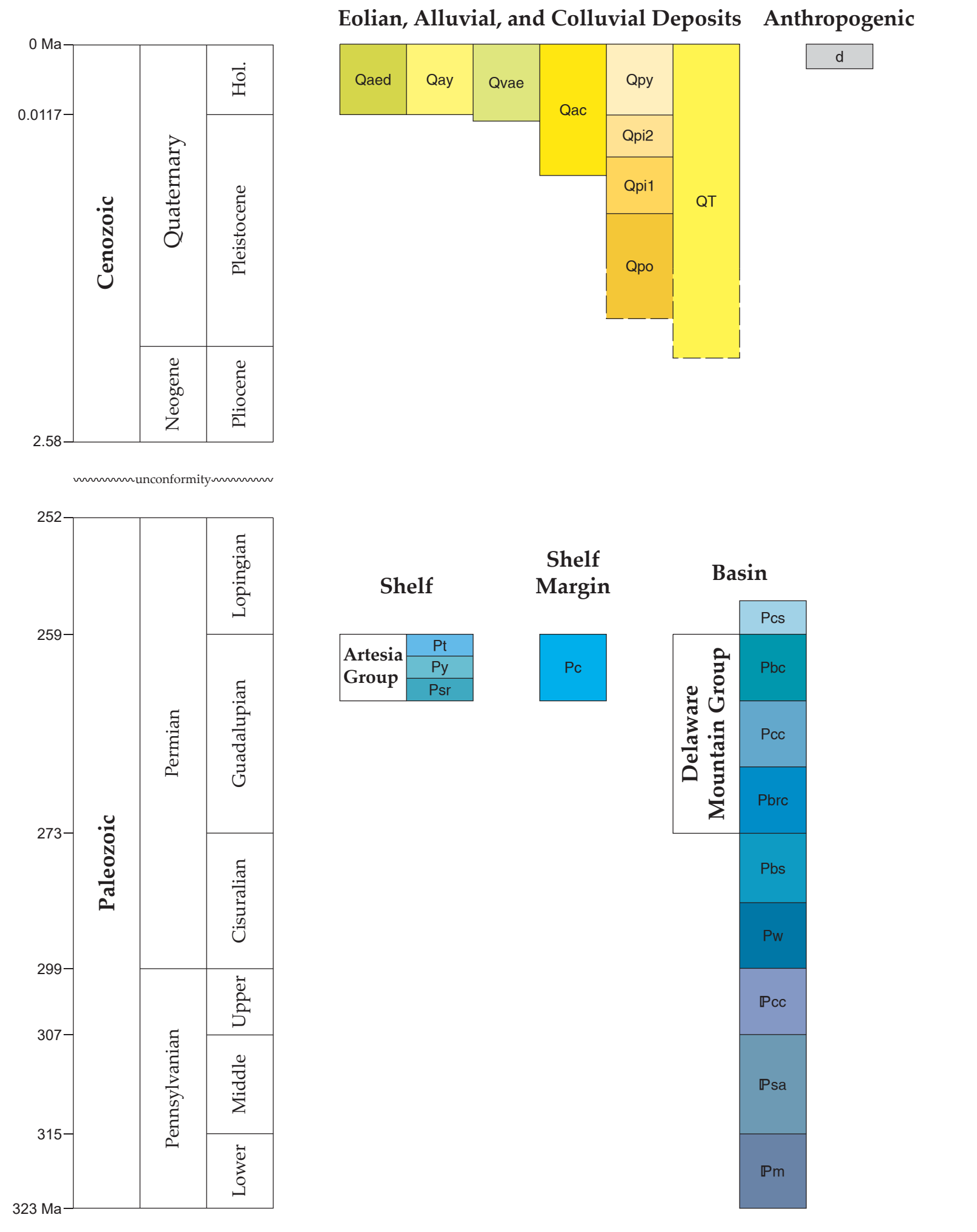
Correlation of Map Units



Explanation of Map Symbols

——— — —?— —	Contact—Identity and existence are certain or questionable where queried. Location is accurate where solid and dashed where approximate.
〰〰〰	Unconformable contact—Identity and existence are certain. Location is accurate.
68 ⁄	Inclined bedding—Showing strike and dip.
—Pt—	Map unit line—**Pt**—Cross Section only. Identity and existence are certain. Location is accurate.
30-015-10861 ○	Drill hole for hydrocarbon exploration or exploitation—Showing API number.
A ├──┤ A′	Cross section line and label
▨	Area of sand in Bone Spring Formation (**Pbs**). Cross Section only.
⊥ 30-015-20313	Well location (in cross section)—The location and depth of a well used to establish stratigraphy and geologic unit depth, shows API number.

Description of Map Units

CENOZOIC ERATHEM
Quaternary System
Anthropogenic

d **Disturbed areas (Modern)**—Highway 62-180 and the road to Slaughter Canyon.

Eolian, alluvial, and colluvial deposits

Qaed **Alluvial and eolian silt, sand, clay and gravel in closed or nearly closed depressions (Holocene)**—Primarily silt and sand; may contain gravel and cobbles washed in from depression margins. Fines are generally pale-tan to brown. Most of the depressions are probably karstic structures resulting from subsurface dissolution of Permian evaporites. Fills in smaller depressions may be thin (< 1 m) to a few meters thick; thicker fills may be present in depressions in the southeastern part of map area.

Qay **Alluvium along active drainages (Holocene)**—Alluvial sand, mud, and gravel along active drainages, including deposits underlying low terraces within and adjacent to modern channel systems. Deposits commonly contain abundant, poorly sorted pebbles, cobbles, and boulders of Permian carbonate rocks, although in some reaches surface deposits are comparatively fine-grained pale-tan to reddish-brown silty sand, sand, and pebbly sand. Unit is typically inset against younger piedmont alluvium (**Qpy**) on the distal piedmont slope, and merges with **Qpy** toward the mountain front. Thickness of the deposits including low fill terraces is probably less than a few meters in most areas.

Qvae **Sand, mud, gravel and gypsite underlying the upper Black River valley floor (Upper Pleistocene to Holocene)**—In general, sediment is relatively fine-grained and likely contains significant amounts of wind-blown dust trapped by grasses and shrubs, together with gypsite washed in from embankments eroded in Permian evaporites. The southeastern corner of the map area contains small areas of **Qvae**, which is more extensively represented to the east along the escarpment that forms the eastern margin of the upper Black River valley. Unit ranges from brown to pale-gray in color and contains significant contributions of sand and gravel from alluvial aprons and piedmont drainages to the west. Available water-well logs from the upper Black River valley floor suggest that approximately 20 m of clayey sediment is present beneath the surface in some areas; other areas are underlain at shallow depth by "white gypsum." Shallow groundwater emerges at the surface to the east of the map area along the perennial upper reach of the Black River and in the Bottomless Lakes sinkhole pond.

Qac **Undivided valley alluvium and colluvium in the Guadalupe Mountains (Middle Pleistocene to Holocene)**—This composite unit includes alluvium along active channels, terrace deposits, hillslope colluvium along canyon walls, and unmapped areas of bedrock along scoured channel reaches and cut banks. Deposits consist of pale-tan to brown siliciclastic silt and sand, gravel, cobbles and boulders. Larger clasts are dominantly pale-colored dolomite and gray limestone derived from surrounding Permian shelf and shelf-margin strata of the Artesia Group and Capitan Formation. Accumulations of sediment above active channels are commonly cemented. Deposits may locally be several meters thick beneath terraces and colluvial wedges. Map unit merges eastward with piedmont alluvium in the vicinity of the mountain front.

Qpy **Younger piedmont alluvium (sand, gravel, cobbles, boulders and mud) (Upper Pleistocene to Holocene)**—Coarser debris, including cobbles and boulders in the vicinity of the mountain front, are Permian carbonate rocks derived from the Guadalupe Mountains and from reworking of older piedmont alluvium. Pale-tan to reddish-brown, silty sand, sand, and pebbly sand comprise much of the unit in some areas. Gravelly deposits are present in lenticular channels and in more continuous, decimeter- to meter-scale beds, and are commonly indurated with calcium-carbonate cement. Includes accumulations of sediment in active channels, together with deposits graded to levels a few meters above active channels and colluvium or slope wash at the base of older fan remnants. Focusing of surface runoff toward areas underlain by younger piedmont alluvium is commonly expressed by a relative abundance of vegetation and darker shades on aerial imagery. Surface roughness (microtopography) is locally pronounced close to the mountain front where cobble- and boulder-sized clasts are plentiful. Some drainages floored by **Qpy** deposits exhibit subvertical walls deeply cut into cemented gravel of older alluvium. Cutbank exposures of **Qpy** deposits up to a few meters thick are present in some areas.

Qpi2 **Intermediate piedmont alluvium, younger map unit (Upper Pleistocene to Holocene?)**—In the map area, these deposits are graded to a somewhat higher level than deposits of **Qpy**, and are inset against older piedmont alluvium along the larger valleys and draws that drain eastward from the Guadalupe Mountains. Bar and swale microtopography is evident on depositional surfaces. Comparatively young deposits of gravelly alluvium in the western Delaware Basin, including relatively young deposits underlying the piedmont slope in the map area, are commonly cemented with calcium carbonate. This probably reflects a predominance of carbonate dust and debris in the region and the arid climate. Preservation of microtopography and inset relations with other piedmont map units suggest a relatively young age for **Qpi2** deposits. Erosion of older piedmont deposits, transport of sediment from the Guadalupe Mountains and **Qpi2** deposition may have occurred primarily during the last glacial episode. Thickness of the deposits is variable, ranging from decimeters to perhaps several meters. Exposures in deeply incised drainages near the mountain front generally reveal up to a few meters of **Qpi2** sediment overlying surfaces scoured into older alluvium.

Qpi1 **Intermediate piedmont alluvium, older map unit (Middle Pleistocene)**—Deposits are graded to a higher level than deposits of **Qpi2**, and remnant surfaces are generally smoother. **Qpi1** fan remnants underlie interfluvial ridges and isolated knolls in the northern part of the map area, and extend eastward up to 20 m above the floors of larger drainages in the southern part of the map area. Gravelly strata are well-cemented and finer grained deposits are typically poorly exposed, even in subvertical drainage cuts. Episodes of landscape erosion, sediment mobilization, and accumulation of **Qpi1** alluvium may be associated with any of the glacial-interglacial climatic fluctuations that occurred during the mid-Pleistocene. Unit probably ranges from less than one to several meters in thickness.

Qpo **Older piedmont alluvium (Lower? to Middle Pleistocene)**—Surface exposures are generally well-cemented conglomerate, containing subangular to rounded pebbles, cobbles and boulders derived from Permian carbonate rocks in the Guadalupe Mountains. Finer grained strata are poorly exposed. Remnants of older piedmont alluvium are preserved as east-west oriented ridges that have been eroded and stripped down to resistant conglomeratic strata. Interfluvial summits underlain by **Qpo** remnants rise up to 40 m above adjacent drainages. Slumping and tilting of the deposits, likely due to solution subsidence over extended periods of time, is evident in places. Hale (1955), based on borehole lithologic logs available at that time, reported an estimated maximum thickness of 60 m of accumulated fill sediment in the upper Black River valley, with gravel (conglomerate) comprising a comparatively small proportion of the total alluvial fill.

QT **Undivided clastic deposits (Pliocene? to Holocene)**—Cross section only. The maximum thickness of **QT** depicted on the cross section is somewhat larger than Hale's (1955) estimate of 60 m, based on interpretations of more recent borehole logs and the probability that thicker accumulations may be present locally due to dissolution of Permian evaporites and subsidence of overlying fills.

PALEOZOIC ERATHEM
Permian System
Lopingian Series

Pcs **Castile and Salado Formations, undivided (Lopingian)**—Finely crystalline calcium sulfate (hydrated to gypsum near the land surface), interlaminated with calcite (typical Castile Formation lithology), or vaguely laminated to structureless anhydrite (Salado Formation). The Castile Formation overlies the Bell Canyon Formation in the subsurface, and the Salado Formation is overlain by the Rustler Formation to the east of the map area. The Castile Formation consists mainly of laminae of white to pale-gray gypsum (anhydrite) and thinner, dark-gray laminae of calcite, which alternate repetitively through hundreds of meters of section. Regionally, the formation also contains a thin, basal laminated limestone, and discrete halite intervals that provide a basis for dividing the formation into members (Anderson et al., 1972). Intervals of nodular anhydrite and breccia resulting from dissolution of halite and collapse are commonly encountered in drill cores in the basin. The Salado Formation overlies the Castile Formation in the subsurface east of the Pecos River, where it consists of a thick sequence of halite and other soluble chloride salts, some named anhydrite beds, and minor amounts of admixed and intercalated siliciclastic mud. It is unclear if or how much of the Salado Formation is present in the western Delaware Basin; soluble salts in the Salado Formation that may have been present have been removed by dissolution, and the thick accumulations of chloride salts present in deeper parts of the Salado Formation depositional basin to the east may be represented by sulfate facies in basin-margin areas to the west. The small area mapped as **Pcs** in the southeastern corner of the map area is close to the well-known state-line roadcut that exposed typical laminated Castile Formation strata, and outcrops on the Gypsum Plain just above and east of the highway also consist of the interlaminated anhydrite calcite lithology, characteristic of the Castile Formation. In contrast, the small exposures of Permian gypsum near the mouth of Slaughter Canyon do not exhibit the sharply defined calcite laminae of the Castile Formation, and may represent accumulation of post-Castile Formation anhydrite. The combined thickness of Castile and Salado Formations strata remaining along the cross-section line ranges from about 65 to 200 m, with all of the original halite and much of the sulfate apparently removed by dissolution. The unit likely extends along the mountain front at least as far south as Double Canyon, as indicated by a group of sinkholes on intermediate fan remnants there. Several kilometers to the southwest along the escarpment, near the mouth of Big Canyon, Castile and Salado Formation strata have been completely removed, and the Bell Canyon Formation is exposed at the surface.

Guadalupian Series
Deposits of the Guadalupian carbonate shelf
Formations of the Artesia Group

Pt
Pt
Tansill Formation of Artesia Group (Guadalupian)—Pale-weathering, light-gray to tan, bedded, dolomitic grainstone, packstone, wackestone and mudstone. In general, carbonate sediments deposited near the shelf margin are fossiliferous grainstones and packstones forming centimeter- to meter-scale beds that are variously planar-laminated, cross-laminated, nodular, wavy bedded, or structureless. Common fossils include macroscopic skeletons and fragments of crinoids, brachiopods, and gastropods; fusulinids, calcareous algae (e.g., Mizzia), and other microfossils are apparent under magnification in some samples. Shelfward (west) from the Guadalupe Mountains escarpment, beyond the map area, tabular to wavy beds containing abundant pisoliths are common. Farther shelfward, thinly bedded carbonate mudstone exhibiting fenestral fabric is commonly exposed at the surface. Lateral changes in carbonate lithofacies are also expressed as vertical changes through the Tansill Formation succession, with carbonate lithofacies alternating vertically in meter-scale, shoaling-upward bed sets or parasequences. This stratigraphic cyclicity in Tansill Formation and underlying Artesia Group carbonates has received detailed study in the Guadalupe Mountains, leading to reconstructions of relative fluctuations in sea level during Guadalupian time. Rarely exposed siliciclastic intercalations in the upper part of the Tansill Formation are pale, yellowish-brown laminae and thin beds, consisting dominantly of siltstone with scattered grains of very fine-grained sand. Approximately 90 m thick in the map area.

Py **Yates Formation of Artesia Group (Guadalupian)**—Beds of light-gray to tan dolomitic carbonate, interbedded with yellowish-brown siltstone to fine-grained sandstone. The Yates Formation is distinguished from the overlying and underlying Tansill and Seven Rivers Formations by a relative abundance of siliciclastic beds, which generally facilitates identification of the formation on aerial photographs and borehole gamma-ray logs. Carbonate beds in the Yates Formation exhibit an array of bedding types, sedimentary structures and fabrics, similar to the Tansill Formation and other formations of the Artesia Group. Exposures of siliciclastic intervals in cutbanks reveal decimeter- to meter-scale beds of yellow, greenish-gray, and brown siltstone and fine-grained sandstone that are commonly planar- or cross-laminated. In most areas, siliciclastic intervals weather to colluviated slopes that support a relative abundance of vegetation. Approximately 100 m thick in the map area.

Psr **Seven Rivers Formation of Artesia Group (Guadalupian)**—Bedded, cliff-forming dolomitic carbonate is the dominant lithology; siliciclastic intervals are minor compared to the overlying Yates Formation. Carbonate facies of the Seven Rivers Formation accumulated in the map area immediately shelfward of the western margin of the Delaware Basin, and are similar to carbonate facies in the overlying Yates and Tansill Formations. The Seven Rivers Formation overlies the Queen Formation of the Artesia Group to the west. As with the Yates and Tansill Formations, the Seven Rivers Formation grades eastward into shelf-margin facies of the Capitan Formation, and to the west of the map area merges rather abruptly with strata containing redbed and evaporite lithofacies. Approximately 80 m thick in the map area.

Deposits of the Guadalupian carbonate shelf margin

Pc **Capitan Formation (Guadalupian)**—The Capitan Formation consists of gray fossiliferous limestone, and is distinguished from Artesia Group strata by an apparent paucity of bedding. This distinction between bedded carbonate of the Artesia Group and the comparatively structureless Capitan Formation carbonate is generally apparent on aerial photographs and was mapped on that basis. The Capitan Formation has traditionally been divided into shelf-margin and shelf-slope facies. Viewed from a distance, this distinction is generally apparent along the mountain front as pale-colored carbonate cliffs overlying darker-gray, vaguely bedded strata that appear to be inclined 10 to 20° toward the basin. Exposures in scoured reaches of drainages reveal a diverse assemblage of macrofossils in the Capitan Formation, including sponges, corals, brachiopods, bryozoans, gastropods, and crinoids. This rich biogenic framework was apparently engulfed quickly by marine carbonate cement as the Guadalupian carbonate shelf aggraded and prograded into the Delaware Basin. Slumpage of deposits as the carbonate shelf advanced into the basin may have resulted in local systems of subvertical fractures that today stand as conspicuous "blades" rising above surrounding cliffs in some of the canyons along the Guadalupe Mountains escarpment. Exposed surfaces of the Capitan are commonly pitted or vuggy, and in places exhibit centimeter- to decimeter-scale elongate voids, variously filled with calcite spar. The rocks locally appear brecciated, with dark-gray angular carbonate clasts floating in a lighter-gray matrix. Conspicuous fractures, several centimeters in width and meters in length, filled with Archaeolithoporella and other microbial remains, are common in the Capitan Formation. Sandstone dikes of two types, relatively thin wispy fractures with fine-grained siliciclastic fill, and thick (meter-scale), shelf-parallel dikes with coarse-grained (karstic?) fill have been documented. As reported in the extensive literature concerning the Capitan Formation, the unit transitions down slope into crudely bedded carbonate containing talus blocks and assorted debris, with comparatively steep, basinward dips. These slope deposits comprise the bulk of the formation's thickness. The carbonate deposits of the Capitan Formation interfinger with siliciclastic basin-fill sediment of the Bell Canyon Formation; the gradational contact between the two is symbolized with a saw-toothed line on the cross section. A short distance west of the map area, the Capitan Formation overlies the Goat Seep Formation, which is the shelf-margin equivalent of Artesia Group shelf strata immediately underlying the Seven Rivers Formation. As depicted on the cross section, the Capitan Formation is on the order of 450 m thick in the map area.

Deposits of the Guadalupian marine basin
Formations of the Delaware Mountain Group

Pbc **Bell Canyon Formation of Delaware Mountain Group (Guadalupian)**—Cross section only. Predominately buff to brown, fine-grained sandstone to siltstone, with five named carbonate intervals (from oldest to youngest the Hegler, Pinery, Rader, McCombs and Lamar Members), which thin to the east of the Guadalupe Mountains. Siliciclastics are similar to those in the underlying Cherry Canyon Formation, consisting mainly of fine-grained quartz and lesser feldspar (arkose to subarkose), coarse siltstone (many intervals enriched in organic matter), and minor, thin shaly beds. Siltstone and fine-grained sands are commonly finely laminated. Siliciclastic sediment is commonly present as channel fills, reflecting submarine density-flow processes. Carbonate intervals are dark- to light-gray, fossiliferous, thin- to medium-bedded limestone, which thicken and grade into the Capitan Formation along the margin of the Delaware Basin. The uppermost named limestone, the Lamar Member, extends farther basinward than the underlying carbonate intervals, and is readily apparent on gamma-ray logs. The top of the Bell Canyon Formation beneath the Castile Formation in the basin is picked at the top of a mixed siliciclastic-carbonate interval (Reef Trail Member) that overlies the Lamar Member limestone beds. The Bell Canyon Formation is approximately 260 m thick in the map area.

Pcc **Cherry Canyon Formation of Delaware Mountain Group (Guadalupian)**—Cross section only. Predominantly buff to brown, fine-grained sandstone to siltstone, with three named carbonate intervals (the Getaway and overlying South Wells and Manzanita Members) that thin eastward of the Guadalupe Mountains. Siliciclastic beds are thinly to thickly bedded, frequently occupying discontinuous, submarine channels, are predominantly composed of quartz and lesser feldspar grains (generally altered), and are typically finely laminated. Carbonates are tan to dark-gray, fossiliferous, and dolomitic. The contact between the Cherry Canyon and Brushy Canyon Formations was historically chosen in outcrop, to the southwest of the map area, at a lithologic change from comparatively coarse-grained channel sands of the Brushy Canyon Formation to finer-grained sand in the Cherry Canyon Formation beneath the Getaway Member limestone interval. Neutron density-porosity logs commonly show a distinct, laterally traceable log response that is compatible with such a change, although this response is poorly expressed in the logs examined for the map area. The top of the Cherry Canyon Formation is placed at the base of the lowest carbonate interval (Hegler Member) in the Bell Canyon Formation. Based on log picks, the Cherry Canyon Formation is approximately 355 m thick in the map area.

Pbrc **Brushy Canyon Formation of Delaware Mountain Group (Guadalupian)**—Cross section only. Very fine- to coarse-grained, tan and brown siliciclastic sandstone and siltstone, with shaly intervals in the lower part; unit may contain rare, thin beds of gray-brown carbonate and conglomerate near the base of the unit. The unit is thinly to thickly bedded; coarser grained sandstones are commonly present in lenticular channels. Sandstone and siltstone is commonly finely laminated. The contact between siliciclastic deposits at the base of the Brushy Canyon Formation and uppermost Bone Spring Formation carbonates is readily identified on borehole geophysical logs. Unlike the overlying formations of the Delaware Mountain Group, the Brushy Canyon Formation does not grade shelfward into transitional carbonate shelf-margin deposits; instead, it thins westward and overlaps the Bone Spring and Victorio Peak Formations, with a relatively thin, intervening interval of deposits (Cutoff Formation) that are discontinuously present in outcrops to the southwest of the map area (e.g., Harris, 1987). The combined Brushy Canyon Formation, including possible Cutoff Formation strata, is approximately 375 m thick in the map area.

Cisuralian Series

Pbs **Bone Spring Formation (Cisuralian)**—Cross section only. Dark-gray to brown, thinly bedded carbonate mudstone, with varying amounts of intercalated dark-gray calcareous shale. Contains three regionally recognized sandy intervals, (in descending order) the first, second and third Bone Spring sands, consisting of light-gray to tan, fine-grained sand with micaceous, shaly or calcareous intervals (the stratigraphic position of the first and third Bone Spring sands are indicated on the cross section). The Bone Spring Formation merges westward (off the map area) with carbonate-bank deposits of the Victorio Peak Formation. The Bone Spring Formation is approximately 725 m thick in the map area.

Pw **Wolfcamp Formation (Cisuralian)**—Cross section only. Greenish-gray, brown, and black calcareous and carbonaceous shale, with some carbonate and siliciclastic sand. The top of the Wolfcamp Formation, as depicted on the cross section, lies beneath the third Bone Spring sand; the base of the unit was chosen on wireline-logs at the top of a sequence of alternating shale and carbonate beds assigned to the Upper Pennsylvanian Cisco and Canyon Formation interval. The Wolfcamp Formation interval is relatively thin in the map area, ranging from about 60 to 195 m thick.

Pennsylvanian Subsystem
Upper Pennsylvanian Series

Pcc **Cisco and Canyon Formations, undivided (Upper Pennsylvanian)**—Cross section only. Interbedded carbonate and shale, with lesser amounts of coarser siliciclastic sediment likely present. Gamma-ray logs suggest carbonate and shale beds alternate on a scale of meters to several meters. The base is picked at the top of a prominent carbonate interval assigned here to the top of the Strawn Formation. The Cisco and Canyon Formation interval is relatively thin in the map area, ranging from about 15 to 80 m in thickness.

Middle Pennsylvanian Series

Psa **Strawn and Atoka Formations, undivided (Middle Pennsylvanian)**—Cross section only. Interbedded carbonate, sandstone, and shale. Strawn Formation carbonates are gray to brown and fossiliferous; phylloid algal mounds are reportedly present in the Strawn Formation interval on the Northwest Shelf southeast of Carlsbad, New Mexico. Sandstones are tan to brown and generally medium-grained, with some pink feldspar grains reported from cuttings. Black shale is also reported. The underlying Atoka Formation in the Delaware Basin contains gray to brown carbonate and shaly limestone, some of which is cherty. The base of the Strawn and Atoka Formation interval is chosen at the top of the upper Morrow Formation carbonate interval, as indicated by gamma-ray and resistivity logs. Approximately 200 m thick in the map area.

Lower Pennsylvanian Series

Pm **Morrow Formation (Lower Pennsylvanian)**—Cross section only. The upper part of the Morrow Formation consists of brown to gray fossiliferous limestone and shaly limestone, some of which is oolitic or cherty, together with brown to gray, fine- to medium-grained sandstone, and shale. The lower part of the Morrow Formation contains intervals with an abundance of fine- to coarse-grained quartz sandstone, and lesser shale. None of the boreholes projected onto the line of the cross section completely penetrate the Morrow Formation, which is estimated from other logs to be approximately 220 m thick in the map area. The Morrow Formation overlies Mississippian strata consisting of shaly and underlying carbonate lithofacies in the map area.

Mississippian Subsystem

€Mu **Phanerozoic sedimentary rocks, undivided (Cambrian (?) through Mississippian)**—Cross Section only.

Geologic Cross Section A–A'