Geologic Map of the Jumping Spring 7.5-Minute Quadrangle, Eddy County, New Mexico

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Setting

The Jumping Spring 7.5-minute quadrangle (Figure. 1) lies within the northwestern part of the Pennsylvanian-Permian Delaware basin, extending 35 kilometers south of Carlsbad, NM southward to the New Mexico-Texas state line. Paved roads in the northern part of the map area and many dirt roads provide access. The Black River drainage clips the northwestern corner of the map area and continues northeastward to the Pecos River about 35 kilometers downstream. The Jumping Spring quadrangle is named for a spring in Ben Slaughter Draw near its confluence with Hay Hollow.

Drainage is eastward across the map area. Major drainages from north to south include Cottonwood Draw, Ben Slaughter Draw, and Hay Hollow. Located in the Chihuahuan Desert, the climate is semi-arid and vegetation is sparse. The Cottonwood Hills and Rattlesnake Springs quadrangles to the east and west, respectively, of the Jumping Spring map area have recently been mapped by the NM Bureau of Geology and Mineral Resources, and this compilation fills the intervening gap.

The map area is part of a larger area extending southward into Texas known as the Gypsum Plain, which is underlain at shallow depth by upper Permian evaporite rocks (largely calcium sulfate) of the Castile and overlying Salado formations. Dissolution of evaporites has resulted in extensive karst development on the Gypsum Plain, and the map area is pockmarked by features associated with solution subsidence. This bedrock gypsum is blanketed over most of the map area by a thin cover of eolian dust and alluvium and is probably weathered to depths of at least a few meters in most areas. Drainage cuts and scattered knolls that expose relatively intact gypsum bedrock are present; these areas are depicted, map scale permitting, as bedrock.

The Salado Formation is overlain by upper Permian strata of the Rustler Formation, which is a succession of mixed siliciclastic silt, fine sand and red mud, dolomitic carbonate, and evaporites (more gypsum). Middle and Upper Permian strata in the subsurface are gently tilted to the east, so Castile-Salado evaporites give way near the land surface to the Rustler Formation in the eastern part of the map area. Rustler carbonate intervals are resistant to weathering and are commonly exposed at the land surface; fine-grained siliciclastic and evaporite strata are not. Although small isolated patches and hills of Rustler carbonate and underlying red mud and gypsum are present in the map area, some exposures of post-Castile/Salado strata on the Gypsum Plain have apparently been displaced downward by solution subsidence.

To the northwest of the map area, the escarpment of the Guadalupe Mountains rises abruptly from the plains. The Guadalupe Mountains expose carbonate-shelf strata of the Permian Capitan Formation and Artesia Group, marking the western side of the Delaware Basin during mid-Permian (Guadalupian) time. The rocks forming the margin of the Guadalupian carbonate shelf enclose the Delaware basin on three sides (west, north and east), forming an arched, curvilinear path through Eddy and Lea counties. Correlative strata deposited in the basin are assigned to the Bell Canyon Formation, which consist largely of fine-grained siliciclastic sediment. Thus, the Bell Canyon and older formations of the Guadalupian Delaware Mountain Group (Cherry Canyon and Brushy Canyon formations) underlie the Castile Formation in the basin.

The disposition and thicknesses of older Permian and Pennsylvanian sedimentary rock units in the map area are depicted on the cross section. These older rocks consist of marine and marginal-marine carbonate and siliciclastic sediment that accumulated in the Delaware Basin at equatorial latitudes along the western margin of Pangea. Ordovician through Devonian sedimentary rocks, not depicted on the cross section, were deposited in the Tobosa Basin, a precursor to the greater Permian Basin. The Tobosa basin gradually subsided during early Paleozoic time, accumulating a relatively complete sequence of sedimentary deposits. Collision of Gondwana with Laurussia beginning in the early Carboniferous led to segmentation of the Tobosa Basin into the uplifts and basins commonly associated with the Permian Basin (i.e. Diablo and Central Basin platforms, Delaware and Midland basins). This late Paleozoic episode of crustal deformation is expressed in the subsurface, as depicted on the cross-section, by a flexure in the Pennsylvanian strata, which corresponds with a northwest-southeast trending structural feature referred to in the literature as the Huapache monocline. Much of the structural relief on the Huapache monocline was buried by the Lower Permian (Cisuralian) Wolfcamp and Bone Spring formations.

Regional uplift of western North America during the late Cretaceous–Paleogene Laramide orogeny was followed by late Cenozoic basin and range faulting along the western side of the Guadalupe Mountains and flexural uplift of the range. In the vicinity of the map area, sedimentary rocks overlying the Castile, Salado and Rustler formations, including an indeterminate thickness of Mesozoic strata, have been eroded and removed from the landscape. Fan-piedmont deposits have spread eastward from the Guadalupe Mountains, and progressive entrenchment of the Pecos River valley below the level of the High Plains (Ogallala) constructional surface has ensued. An interesting facet of the late Neogene–Quaternary development of the lower Pecos Valley involves dissolution of Permian evaporates and associated land subsidence over a range of spatial scales.

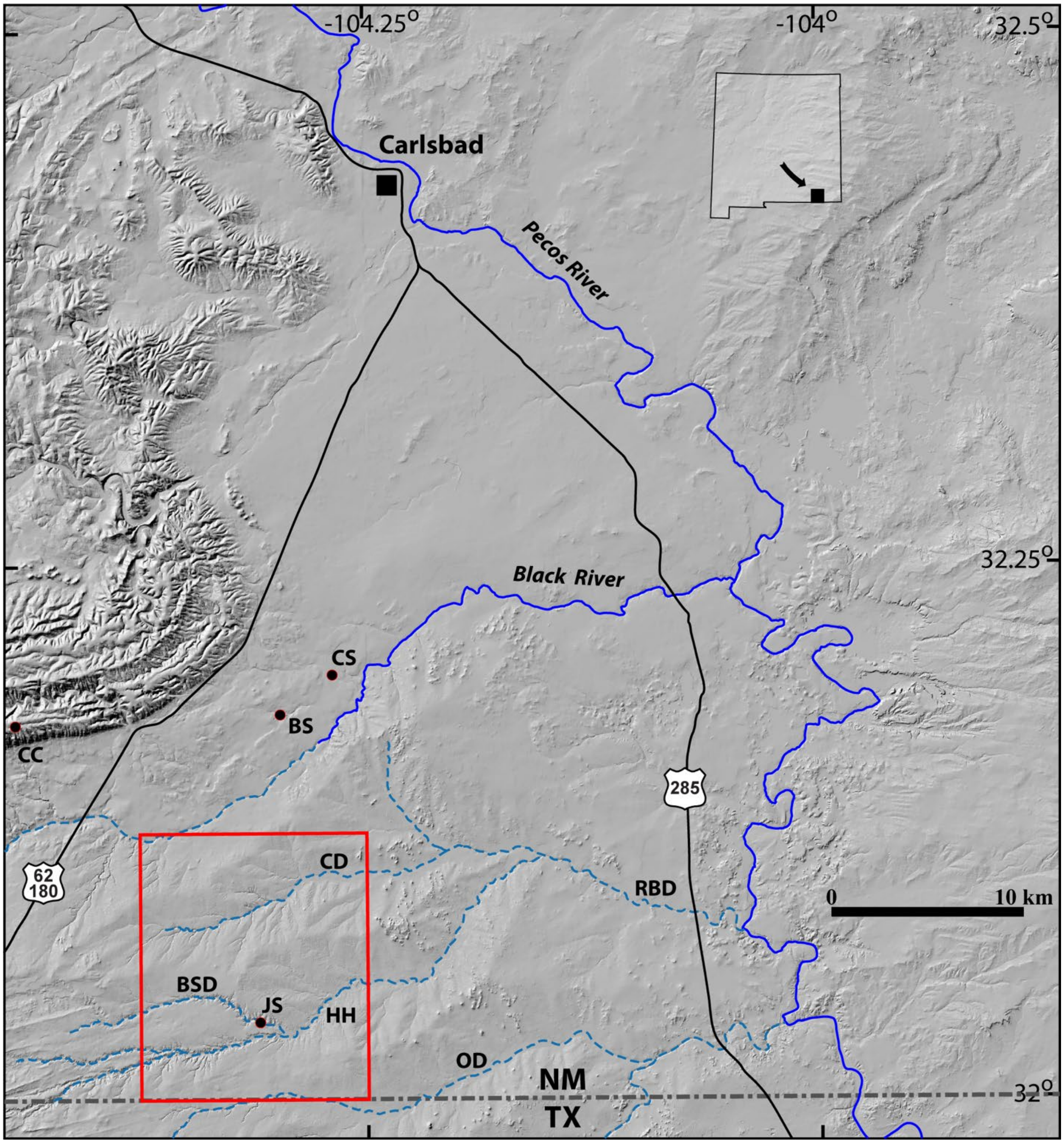

Figure 1—The location of the Jumping Spring quadrangle in southeastern New Mexico. Labeled point features on the map: Castle Spring (CS), Blue Spring (BS), Jumping Spring (JS), Cottonwood Draw (CD), Ben Slaughter Draw (BSD), Hay Hollow (HH), Red Bluff Draw (RBD), Owl Draw (OD), and Carlsbad Caverns (CC).

Description of Map Units

Cenozoic Erathem

Quaternary System

Anthropogenic

d Disturbed areas (paved roads).

Eolian, alluvial, and colluvial deposits

Qay Alluvium in active drainages (Holocene)—Alluvial sand, mud, and gravel associated with active drainages, including deposits underlying low terraces adjacent to incised channels. Sediment is generally pale-tan, brown, or reddish-brown silt and sand. Includes significant amounts of pale-colored gypsite in some areas. Deposits are generally less than two meters thick.

Qaed Accumulations of eolian and alluvial silt, sand, clay, and minor gravel in closed or nearly closed depressions (Holocene)—Map unit generally consists of pale-tan to brown silt and sand with minor amounts of locally derived coarser alluvium. Many depressions likely represent areas that have undergone subsidence caused by the dissolution of underlying Permian evaporites. Depressions are aligned in some areas to form subtle, linear drainages, making the distinction between fills in active drainages (unit Qay) and depressions (unit Qaed) somewhat arbitrary. Depression fills range from decimeters to perhaps a few meters or more in thickness.

Qae Windblown silt and fine sand, fine- to coarse-grained slope-wash alluvium, and minor amounts of rocky colluvium and regolith, generally forming a thin mantle over weathered Castile-Salado and Rustler bedrock units (Holocene)—Siliciclastic deposits range in texture from silty-sandy mud to gravelly sand, and are generally pale-tan, brown, or pale-red in color. This lithologically heterogeneous unit includes areas surfaced by pale-gray gypsite, which may represent accumulations of gypsum dust and/or weathering of near-surface Permian gypsum bedrock. Rocky colluvial deposits bordering remnants of Rustler carbonate strata are locally present, and weathered residuum on top of lower Rustler Formation, red mud and calcium sulfate, are apparent on aerial photographs in the vicinity of Cottonwood Draw in the northeastern part of the map area. Although a significant proportion of the surficial cover is likely composed of eolian sediment, extensive deposits of eolian sand (dunes) are not present in the map area. Deposits generally range from less than one meter to a few meters in thickness.

Qvae Valley-floor sand, mud, gravel, and gypsite underlying floodplains and low terraces of larger drainages (Upper Pleistocene to Holocene)—In general, deposits are relatively fine-grained and likely contain significant amounts of wind-blown dust trapped by grasses and shrubs, together with pale-colored gypsiferous sediment, reddish-brown mud derived from the lower part of the Rustler Formation in the eastern part of the map area, and coarser-grained gravelly deposits along the Black River. Small unmapped exposures of weathered Castile-Salado gypsum are locally exposed along cutbanks and channel floors in gullied and scoured reaches; some of these exposures rarely include blocks of Rustler strata let down by solution subsidence. Ephemeral seeps and areas subject to flooding are apparent in local reaches of the larger drainages. **Qvae** deposits along the Black River are generally light-brown sand and mud underlying narrow, vegetated flood plains a few meters above the present channel. Coarser-grained and commonly cemented gravel deposits carried in during floods are also present. Valley-floor fills are generally on the order of a few meters thick or less.

Qvg Valley-floor gypsite along major drainages (Upper Pleistocene to Holocene)—A relatively porous aggregate of gypsum silt, sand, and gravel in a fine-grained gypsiferous matrix, derived from weathering and transport of Permian bedrock gypsum. Unit is white to light-gray, is generally thinly mantled by brown eolian dust, and may exhibit a durable surficial crust. Cutbank exposures commonly reveal a basal, one or two meters, containing rounded pebbles of white gypsum, commonly cross-stratified and intercalated with pale-brown siliciclastic sediment, overlain by a meter or more of massive, fine-grained gypsite that may represent eolian deposition. **Qvg** deposits are present in the map area along Hay Hollow, but are present in other major drainages and tributaries to the east and west of the Jumping Spring quadrangle. Surface accumulations of gypsite that occupy higher positions on the landscape are included in map unit **Qae**.

Qbr Black River valley-border alluvium (Upper Pleistocene to Holocene)—Composite map unit consisting of alluvium and colluvium along the Black River; may locally overlie somewhat older alluvial-plain deposits, and is inset against bedrock gypsum along the southern side of the drainage. Surface deposits largely consist of tan and brown mud, sand, and gravel. Coarse deposits are sub-angular to rounded pebbles and cobbles of Permian carbonate, and minor sandstone derived from the Guadalupe Mountains to the west. Exposures of cemented gravel (sparse in the map area but increasingly common along incised reaches of the Black River downstream) contain rounded, siliceous pebbles likely recycled from Cretaceous conglomeratic strata that once covered the region. **Qbr** deposits underlie terraces up to 10 meters above the Black River flood plain in the map area. Gypsum bedrock is locally exposed along a short reach of the Black River in the map area, where it is overlain by several meters of unit **Qbr** mud, sand, pebbly sand, and lenticular beds of gravel.

Mesozoic Erathem

Cretaceous System

Lower

K Cretaceous karstic debris (Lower Cretaceous)—Sandstone, conglomerate, and carbonate present as broken blocks and debris on the Gypsum Plain. Cretaceous deposits apparently once covered the Delaware Basin and adjoining Guadalupe Mountains. As the regional landscape was denuded during the late Cenozoic, beds of siliceous gravel and coarse-grained sandstone were reworked into fissure fills in the Guadalupe Mountains, and incorporated in late Cenozoic alluvial fills along the Black River. For the most part, Cretaceous strata have been stripped from the area, leaving scattered remnants of siliceous gravel on the land surface and, locally, broken masses of rock likely displaced downward by solution-subsidence. Limestone fragments are gray wackestone to packstone, some of which are fossiliferous, containing Cretaceous bivalve and echinoid macro-invertebrate fossils (Lang, 1947). On the adjacent Rattlesnake Springs quadrangle to the west of the map area, tan to brown quartzose sandstone beds range in texture from coarse-grained channel fills with little internal stratification, to thin beds of medium-grained planar- to cross-laminated quartz sand, some of which also contain casts of marine bivalves. Conglomerate is present in decimeter- to meter-scale, clast-supported beds and channel fills; white to dark-gray clasts are dominantly rounded siliceous pebbles up to a few centimeters in diameter, set in a granular matrix cemented by calcium carbonate. One very weathered exposure of displaced Cretaceous rock debris is depicted on the map. The margins of this exposure also contain broken blocks of red siltstone and carbonate that are likely derived from the Rustler Formation. Examination of fossils from Lang's (1947) outcrop led Kues and Lucas (1993) to conclude that the strata are probably correlative to the middle part of the Washita Group of Texas, indicating a Lower Cretaceous (Albian) age for the deposits.

Paleozoic Erathem

Permian System

Lopingian Series

Pr Rustler Formation (Lopingian)—Lithologically heterogeneous strata consisting of siltstone, fine-grained sandstone, mudstone/shale, gypsum, and carbonate. Carbonate strata pertaining to the Culebra Dolomite Member, the next-to-lowest member of the Rustler Formation and the youngest Rustler strata recognized in the map area, is pale-gray carbonate mudstone forming thin, tabular beds, commonly exhibiting abundant, millimeter-scale voids or vesicles. An additional interval of gray, yellowish-weathering, vaguely bedded to structureless carbonate mudstone is commonly present several meters below the Culebra Member. Carbonate strata in the Rustler Formation are comparatively resistant to erosion, and form most of the exposures of Rustler strata in the map area. The Virginia Draw Member at the base of the Rustler Formation is largely composed of intervals of red, fine-grained siliciclastic sediment, and beds of gypsum. Virginia Draw strata are underlain by the Salado Formation and are generally poorly exposed, but are locally evident near the surface along the eastern side of the map area. Exposed remnants of Culebra carbonate in the map area are up to a few meters thick; underlying Virginia Draw strata are probably on the order of 50 to 70 meters thick.

Pcs Castile and Salado formations, undivided (Lopingian)—The Salado Formation underlying the map area consists mostly of gypsum (hydrated anhydrite). To the east of the Pecos River, in contrast, the Salado Formation consists dominantly of salt (halite) with economically important potash zones, a number of named anhydrite beds, and minor amounts of intercalated siliciclastic mud and fine sand. The lateral change from chloride (east) to sulfate (west) evaporite mineralogy may reflect post-depositional dissolution and removal of salt toward the west, and/or a westward facies zonation from halite to anhydrite precipitation in the basin as the Salado was being deposited. The Salado Formation is overlain by siliciclastic sediment and anhydrite of the lower part of the Rustler Formation. The boundary between the Salado and Rustler formations is generally captured on wire-line logs to the east of the map area. The Salado is underlain by the Castile Formation, which also consists largely of anhydrite. It is generally difficult to differentiate the Salado from the Castile in the map area based on available logs, so the units are combined here. The Castile Formation overlies the Bell Canyon Formation and is lithologically distinctive, consisting mainly of laminae of white to pale-gray gypsum (anhydrite) and thinner, dark-colored laminae of calcite, which alternate repetitively through hundreds of meters of section. The Castile also contains thick intervals of salt. Halite intervals in the Castile have been variably removed by dissolution across the Delaware basin. In the eastern part of the map area, the lower two halite intervals are largely intact, with a combined thickness of about 145 meters and the overall Castile-Salado thickness is about 555 meters. The combined Castile-Salado is about 420 meters thick near the western end of the cross section. This westward thinning probably reflects increasing amounts of dissolution and removal of Castile halite in that direction.

Guadalupian Series

Delaware Mountain Group

Pbc Bell Canyon Formation (Guadalupian)—Cross section only. Predominately buff to brown, fine-grained sandstone to siltstone, with 5 named carbonate intervals (from oldest to youngest the Hegler, Pinery, Rader, McCombs and Lamar members), which thin eastward from the Guadalupe Mountains. Siliciclastic sediment consists mainly of fine-grained quartz and lesser feldspar (arkose to subarkose), coarse siltstone (many intervals enriched in organic matter), and shaly intervals. Siltstone and fine sand are commonly finely laminated. Carbonate intervals are dark- to light-gray, fossiliferous, thin- to medium-bedded limestone, which thicken and grade into the shelf-margin carbonate facies of the Capitan Formation along the margin of the

Delaware Basin. The uppermost named limestone, the Lamar, 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 is picked at the top of a siliciclastic interval (Reef Trail Member) that overlies the Lamar limestone beds. The Bell Canyon Formation is approximately 280 meters thick in the map area.

Pcc Cherry Canyon Formation (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 from the Guadalupe Mountains. Siliciclastic deposits are predominantly composed of quartz and lesser feldspar (generally altered), and are typically finely laminated. Carbonates are tan to dark-gray, fossiliferous and dolomitic. The contact between the Cherry Canyon and underlying Brushy Canyon formations was historically chosen in outcrop, to the southwest of the map area, at a lithologic change from comparatively coarse-grained sand of the Brushy Canyon to finer-grained sand in the Cherry Canyon Formation. Neutron density-porosity logs show a distinct, laterally traceable log response that is compatible with such a change. The top of the Cherry Canyon Formation is placed at the base of the lowest carbonate interval (Hegler) in the Bell Canyon Formation. The Cherry Canyon Formation is approximately 340 meters thick in the map area.

Pbrc Brushy Canyon Formation (Guadalupian)— Cross section only. Fine- to coarse-grained, tan and brown, siliciclastic sandstone and siltstone, with shaly intervals in the lower part. May contain 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 reportedly present in lenticular channels. Sandstone and siltstone is commonly finely laminated. The contact between siliciclastic sediment at the base of the Brushy Canyon Formation and uppermost Bone Spring carbonate is readily apparent on gamma-ray and resistivity logs. Unlike the overlying formations of the Delaware Mountain group, the Brushy Canyon does not grade shelfward into transitional carbonate-shelf deposits; instead, it thins westward and overlaps the Bone Spring/Victorio Peak formations, with a relatively thin, intervening interval of deposits (Cutoff Formation) that are discontinuously present in outcrops near the southern end of the Guadalupe Mountains. The Brushy Canyon is approximately 460 meters 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 dark-gray calcareous shale. Contains three regionally recognized sandy intervals (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). Thickness of the Bone Spring Formation increases from 835 to 950 meters from west to east along the cross section.

Pw Wolfcamp formation (Cisuralian; unit may contain Upper Pennsylvanian strata in its lower part)—Cross section only. Greenish-gray, brown, and black calcareous and carbonaceous shale, with beds of carbonate and siliciclastic sand. The top of the Wolfcamp Formation lies directly beneath the third Bone Spring sand; the base of the unit is identified on wireline-logs at the top of a sequence of interbedded shale and carbonate assigned to the Upper Pennsylvanian Canyon–Cisco interval. The Wolfcamp Formation ranges in thickness from approximately 260 to 570 meters along the cross section.

Pennsylvanian Subsystem

Upper

IPcc 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 siliciclastic beds alternate on a scale of meters to several meters in the upper part of the unit, and that thicker carbonate intervals are present in the lower part. The base of the unit is placed at the top of a prominent carbonate interval assigned here to the top of the Strawn Formation. The Cisco-Canyon Formation interval ranges from 105 to 145 meters thick along the cross section.

Middle

IPsa Strawn and Atoka formations, undivided (Middle Pennsylvanian; may include Lower and Upper Pennsylvanian strata)—Cross section only. Interbedded carbonate, sandstone, and shale. Strawn carbonates are reportedly tan to brown and fossiliferous; sandstones are generally medium grained, with pink feldspar grains reported from cuttings. Black shale is also reported. The underlying Atoka Formation contains gray to brown carbonate and shaly carbonate in its upper part, some of which is cherty, and the unit becomes sandy in its lower part. The base of the Strawn–Atoka interval is chosen at the top of the upper-Morrow carbonate interval, as indicated by gamma-ray and resistivity logs. Approximately 200 meters thick.

Lower

IPm Morrow formation (Lower Pennsylvanian)—Cross section only. The upper part of the Morrow Formation consists of brown and gray fossiliferous carbonate, some of which is oolitic or cherty, together with beds of brown and gray, fine- to medium-grained sandstone and shale. Strata underlying this upper interval contain an abundance of fine- to coarse-grained quartz sandstone, with shale and carbonate interbeds. The Morrow Formation overlies Mississippian shaly strata of the Barnett Formation. Unit is approximately 235 meters thick.

Mississippian Subsystem

Upper

Mb Barnett Formation (Upper Mississippian)—Cross section only. Dark-brown to black shale and silty shale with minor amounts of fine-grained sandstone, siltstone and carbonate. The Barnett Formation overlies Mississippian limestone, and may be up to 100 meters thick in the map area.

Suggested Reading

Hill, C.A., 1996, Geology of the Delaware Basin, Guadalupe, Apache, and Glass Mountains, New Mexico and West Texas: Permian Basin Section SEPM, Publication No. 96–39, 480 p.

[This book provides a comprehensive summary of the geology of the region, and an extensive listing of pertinent scientific literature through 1996]

References

Kues, B.S., and Lucas, S.G., 1993, Stratigraphy, paleontology and correlation of Lower Cretaceous exposures in southeastern New Mexico: New Mexico Geological Society, Guidebook 44, p. 245–260.

Lang, W.B., 1947, Occurrence of Comanche rocks in Black River Valley, New Mexico: American Association of Petroleum Geologists Bulletin, v. 31, p. 1472–1478.