Geologic Map of the Roswell North Quadrangle, Chaves County, New Mexico.

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Open-file Digital Geologic Map OF-GM 278

Scale 1:24,000

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STRATIGRAPHIC OVERVIEW

The Roswell North Quadrangle lies in the lower Pecos Valley of southeast New Mexico on the northwestern margin of the Roswell artesian basin (RAB). The quadrangle extends from 33°22′30″N to 33°30′N and 104°30′W to 104°37′30″W, covering approximately 158 km^2 (61 mi^2), and contains the majority of the city of Roswell. Elevations range from approximately 1,075 m (3,528 ft) where North Spring River flows out of the quad to the east, to the highest point on Sixmile Hill, 1,180 m (3,873 ft). Within the quad, three Pecos River tributaries, Middle Berrendo Creek, Berrendo Creek, and the Rio Hondo (from north to south) flow out of the Pecos Slope, containing Permian marine beds primarily of the San Andres and Yeso formations and cross the RAB over alluvial valley fill Pecos River terraces, ranging from 0-3.5 m thick on the west to 50+ m thick on the eastern side of the quad. The Rio Hondo is the largest tributary heading in the Sacramento Mountains some 100 km distant to the west. Where it flows out into the RAB, it has built a large (~150 km^2) fan. Its current fan channel is highly channelized on the far northern edge of the fan surface within the city of Roswell (Figure 1).

North Spring River, a significant tributary of the Rio Hondo on the Roswell North quad, heads at the now-extinct artesian North Spring site, west of Sycamore Avenue and south of College Boulevard, ~3 km south of Berrendo Creek. Similar to South Spring, located ~9 km southeast, on the South Spring quad south and east of Roswell North (McCraw, 2008), these are former perennial artesian-fed springs having accumulated lacustrine deposits 1 to >3 m thick. Agricultural artesian aquifer pumping in the RAB began in the late 1900s, and continues to present. This has caused North Spring, South Spring, and several other smaller springs to become extinct (Figure 2).

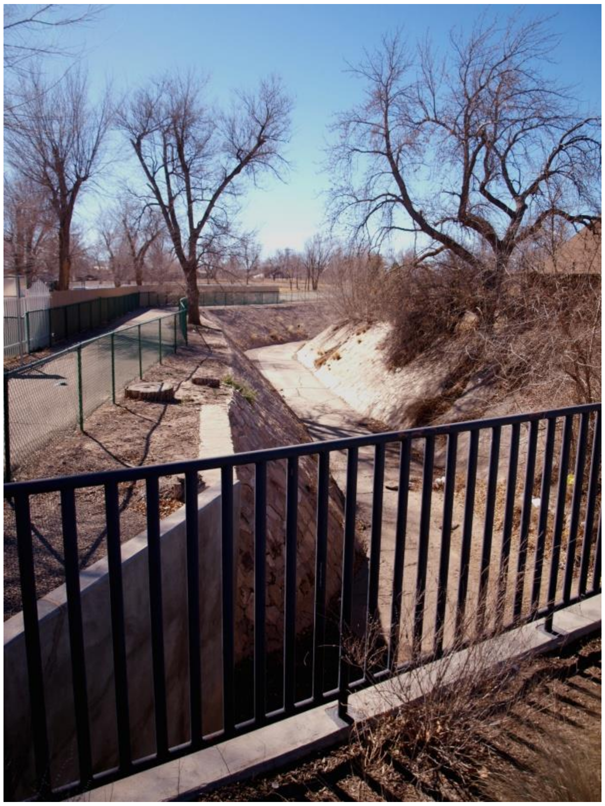


Figure 1. Channelized Rio Hondo, SE Roswell.

Quaternary/Neogene alluvial deposits

Pecos River tributaries alluvium

The Rio Hondo, after debouching from its fan onto the Pecos Valley floor, responded similarly to the Pecos River in the mid to late Holocene, downcutting and changing from a braided to meandering regime in the eastern RAB (McCraw, et al., 2007), just east of Roswell North quadrangle, and immediately downstream of North Spring River. North Spring River and Berrendo Creek (and tributaries) have periodically cut down into older Pleistocene Pecos Valley terrace deposits. As a result, small, inset terraces have been left, receiving periodic overbank deposition, within their entrenched floodplains. These grade downstream to younger Lakewood terrace deposits further east in the Bitter Lake quadrangle (Figure 3).

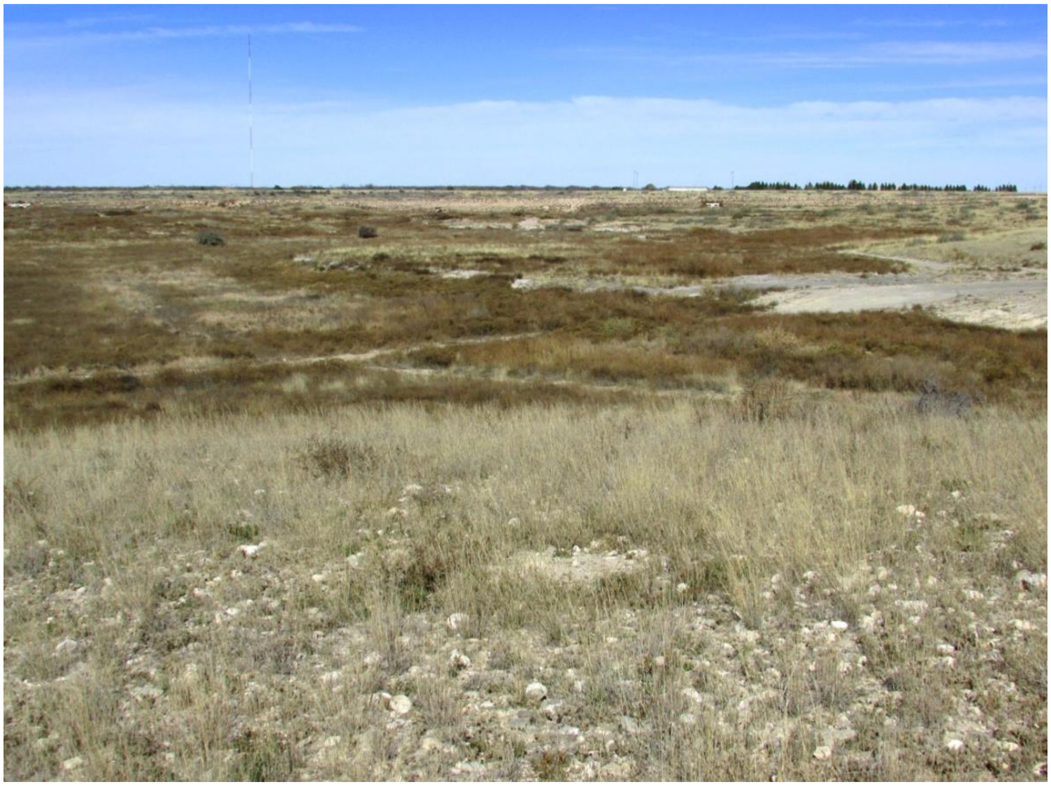


Figure 2. Looking north at North Spring from the Orchard Park (**Qot1**) surface with carbonate-coated, limestones and dolomites in foreground. Gray, lacustrine deposits can be seen in upper-center-right.

Northwest quadrangle alluvium

In the northwest quarter of the quadrangle, a broad area of alluvium, fan-like, but lacking a stream source occurs. These alluvial sediments contain abundant, lithic, igneous grains derived from the Capitan Mountains pluton, and reach up to 5 m in thickness, largely mantling Blackdom terrace deposits. Their tops have been subject to significant reworking by eolian processes, and exhibit numerous, anastomosing swales <1 m deep, in which sheetwash runoff dominates.

Depression, sinkholes, and lacustrine deposits

Depressions and sinkholes are numerous throughout the Bitter Lake quadrangle. Depressions are created by gradual subsidence of underlying carbonate terrane, either limestone-/dolomite-dominated in San Andres Formation deposits, or dolomite to gypsum deposits in the Artesia Group. These complexes consist of unconsolidated, well-sorted, fine-grained (fine sands to clay) sediments of alluvial, colluvial, eolian, and

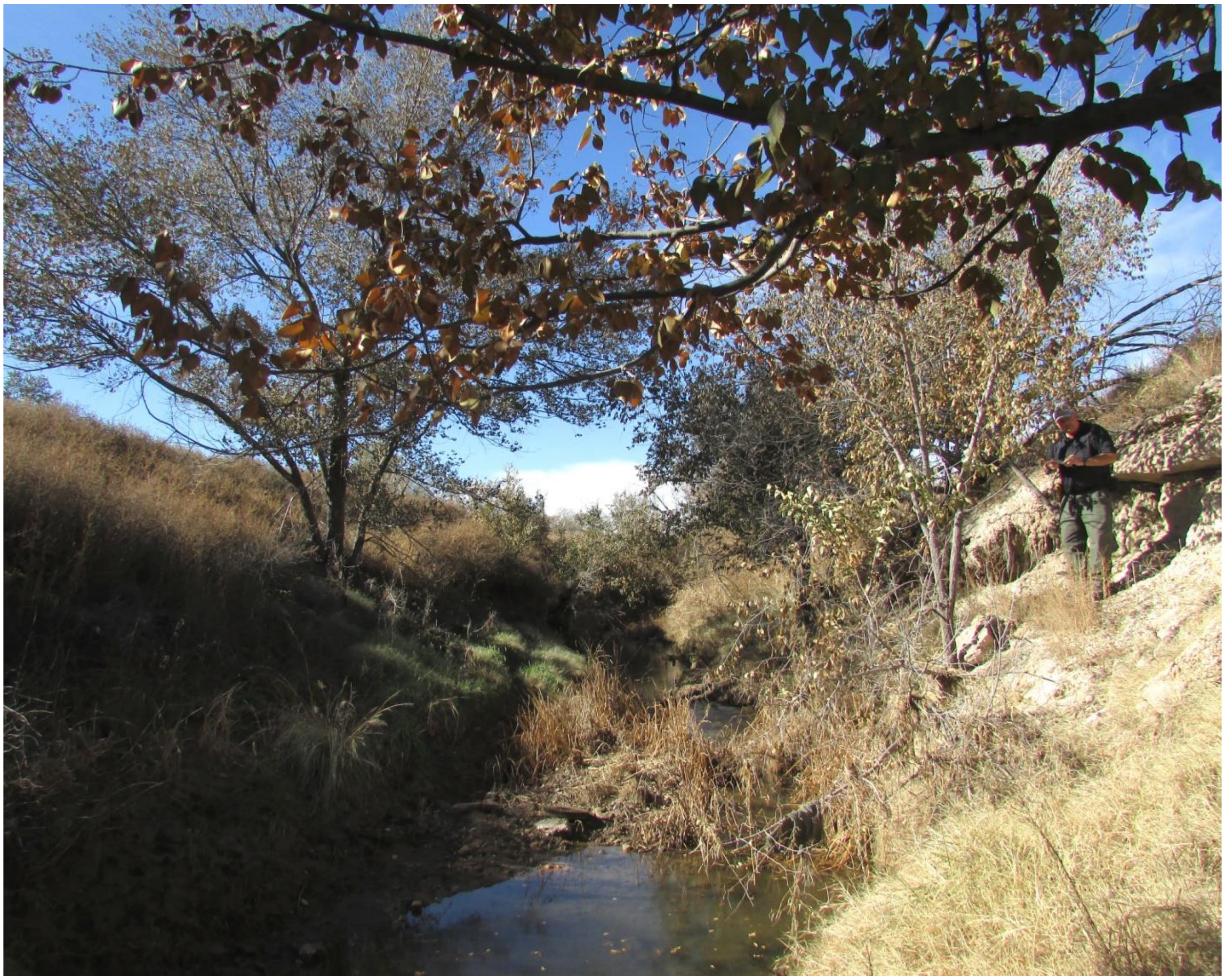


Figure 3. Michael McGee stands in front of Orchard Park (**Qot2**) terrace deposits along the bank of North Spring River, approximately 2 km west of its mouth.

occasional, fairly shallow lacustrine deposits (figure 4), often significantly modified by stream erosion and deposition, playa deposition, deflation, and mass wasting. Sinkholes, on the Roswell North quad, primarily result from collapse of **Psa** limestones into solutional cavities locally, and are found only in the southwestern bedrock highlands.

Pecos Valley terraces

Following the classic Fiedler and Nye (1933) study, establishing the Pecos River terrace nomenclature within the RAB of Lakewood, Orchard Park and Blackdom terraces (with

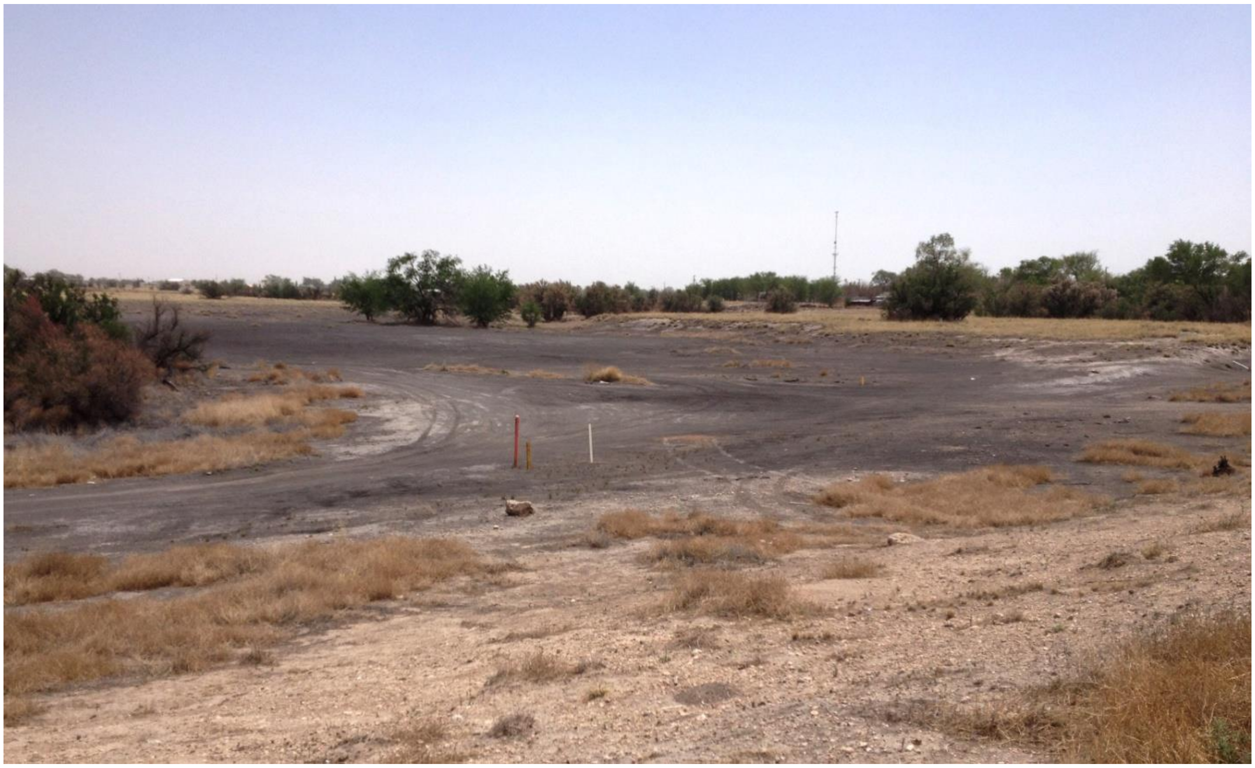


Figure 4. Lacustrine deposits in a depression just south and west of the U.S. 70/U.S. 285 interchange.

elevations above the Pecos River floodplain of <1 – 1.2, 1.2 – 6, and 6 -9 m; late to early Pleistocene, perhaps early Pliocene, respectively), McCraw, *et al*. (2007), in the Bitter Lake quad immediately east, further subdivided the youngest Lakewood into 3 distinct levels (**Qtl3-1**) and the Orchard Park into two surfaces.

On the Roswell North quad, only **Qlt1** Lakewood terrace is mapped along easternmost Berrendo Creek. However, along Berrendo Creek, the **Qbt1** terrace surface appears to grade into **Qlt2-3** surfaces on the Bitter Lake quad to the east. Elsewhere in the RAB, McCraw and Land (2008) recognized 2 distinct surfaces on the Orchard Park. On Roswell North, the distinct break on College Dr. immediately east of the train tracks, is mapped as a **Qot1-2** contact. While influenced by fluvial erosion of North Spring River just to the south, This **Qto1**-**Qto2** contact can be followed over a mile north before its obliterated by plowed/leveled suburban subdivisions. There are localized, clearer terrace distinctions to the south above Rio Hondo alluvium.

In the southwest section of the quadrangle, distinct contacts between the Orchard Park and Blackdom terraces are few, lithologies similar, and the Blackdom, at least in places is largely mapped on its elevation above the Pecos River floodplain. Consolidation of surface outcrops helped only locally when it could be determined to be non-pedogenic in origin. In the north, however Blackdom (**QTbt**) terrace deposits are easily distinguished, rising significantly above **Qot1** plains, often exhibiting more rounded, weathered surfaces (Figure 5).

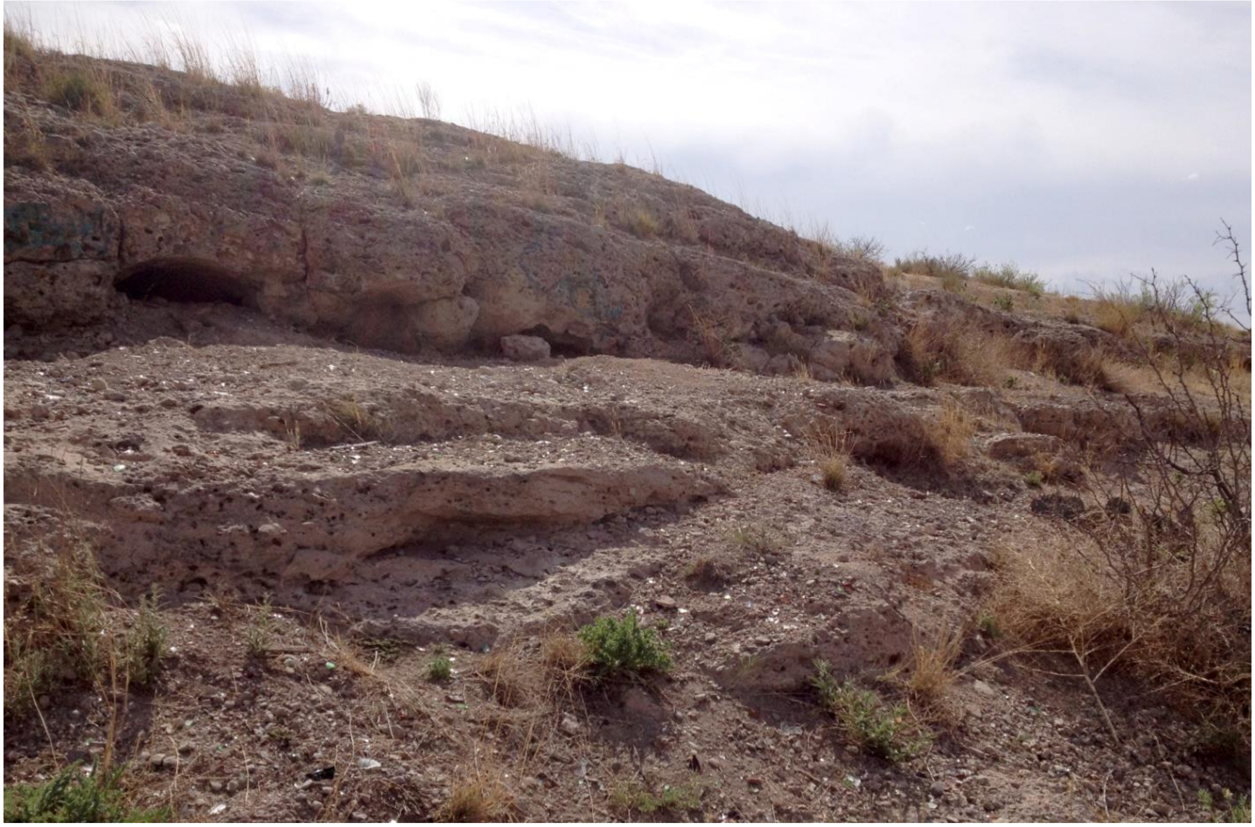


Figure 5. Typical outcrop of Blackdom terrace (**QTbt**) deposits in the north-central part of the quadrangle.

Permian bedrock

Exposed bedrock on the Roswell North quadrangle is limited to the two oldest (Guadelupian, Permian) Artesia Group formations, (Queen, **Paq**, and Grayburg, **Pag**), consisting of dolomites, gypsums, to clastics, which overly only in places, the (Leonardian, Permian) San Andres Formation limestones and dolomites. These only outcrop on the western side of the quad, on the RAB margin. The Artesia Group sediments are quite thin, unlike the San Andres, which can exceed 150 m in thickness.

Lovelace, *et al*. (1972) were the first to recognize the sediments in the southwest part of the quad as Artesia Group. Upon examination, this unit was determined to be part of the Queen Formation, due to its surficial clastic composition and color (Figure 6). The Artesia Group rocks exposed in the north along the Sixmile Buckle (see Figure 7 and below) are predominantly slabby dolomites, and were assigned to the Grayburg Formation here.

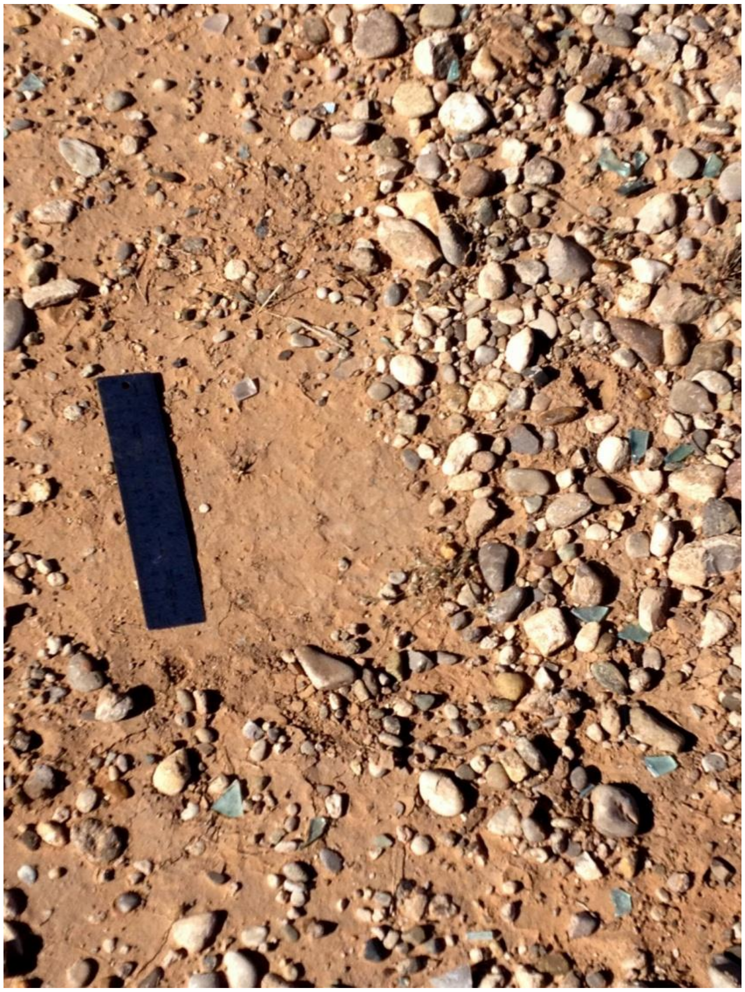


Figure 6. Surficial clastic exposure of Queen Formation (**Paq**) sediments which are comprised of pebbles of limestone, chert, and quartzite in an unconsolidated to loosely consolidated light yellowish brown (2.5YR7/2) to strong brown (7.5YR5/6) coarse to fine sand at the surface.

Figure 7. Grayburg Formation (**Pag**) dolomites adjacent to the Sixmile Buckle on the north side of the quadrangle. Note compass for scale.

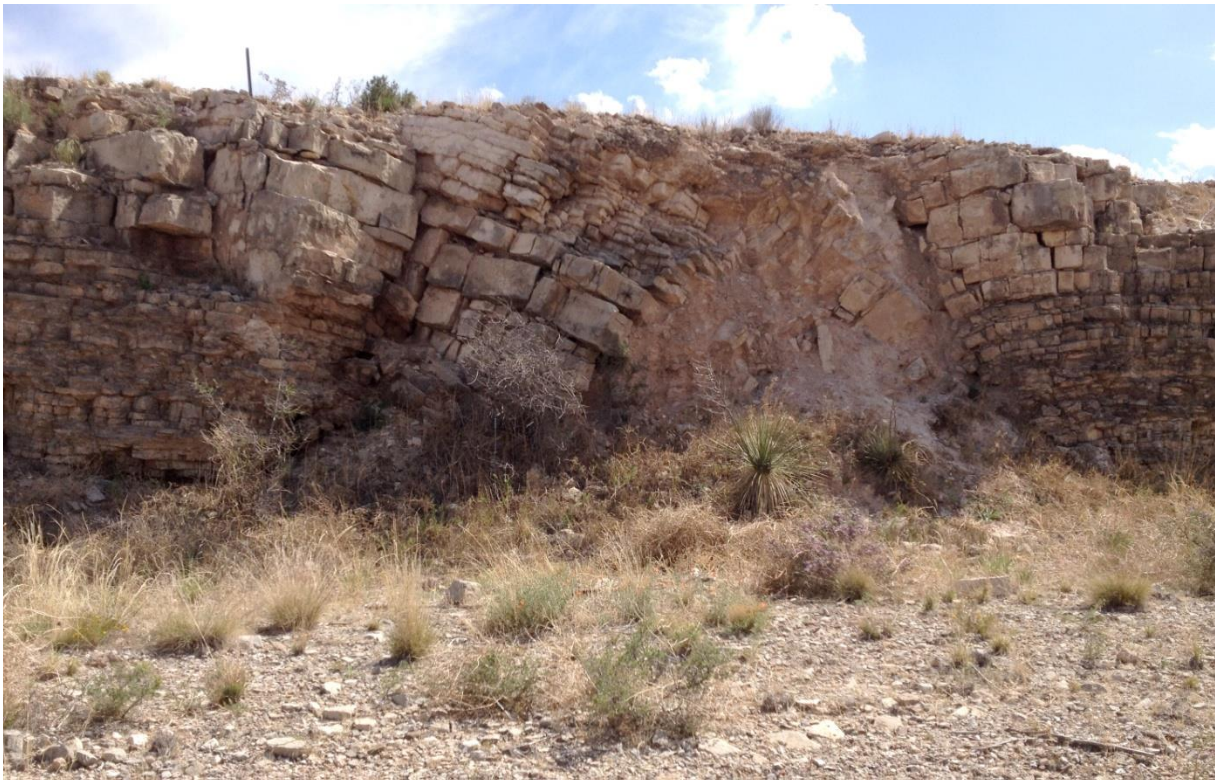
San Andres Formation (**Psa**) limestones and dolomites outcrop on Sixmile Hill, and to the north, on the western margin of the quad. These rocks contain the confined artesian aquifer that the RAB is known for, and are discussed further.

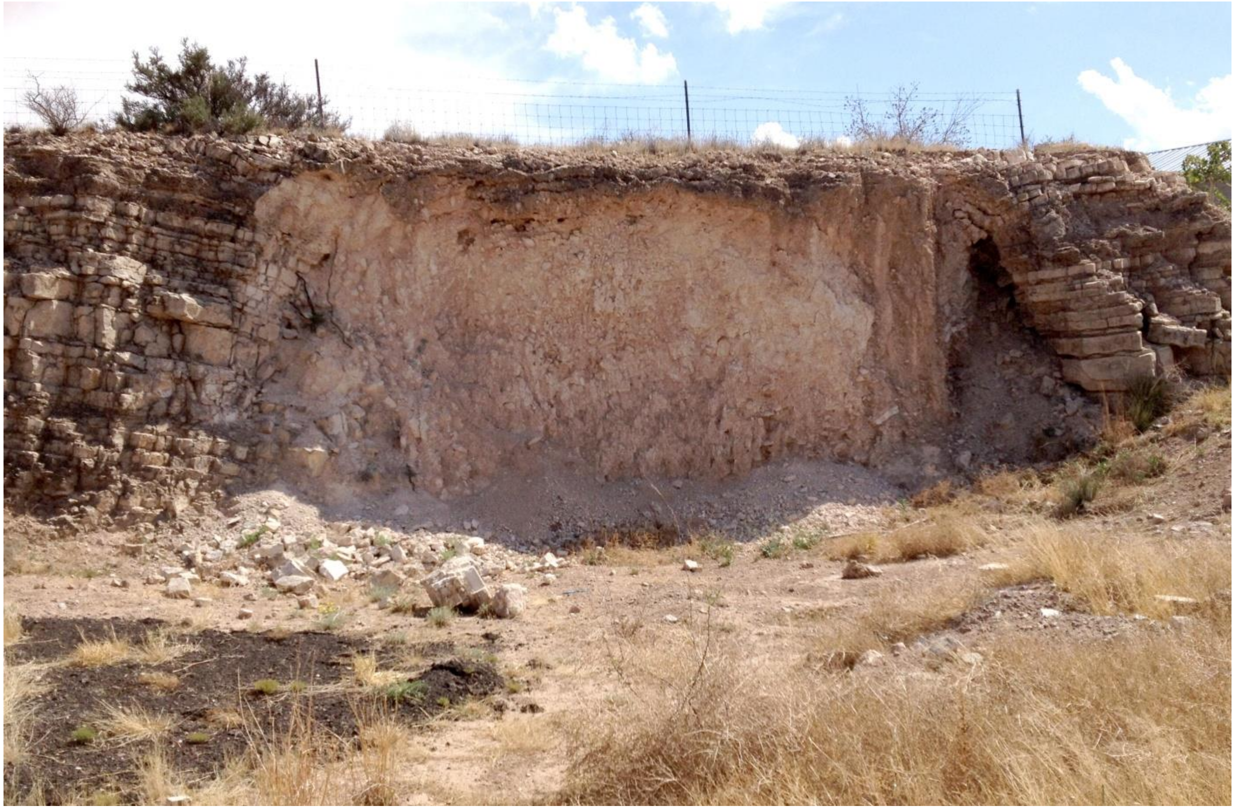
STRUCTURE

Along the Pecos Slope, a series of four, semi-parallel, NE-trending faults occur, some extending >100 km in length. These were first described by Merritt (1920), and greatly expanded upon by Kelley (1971), who called them "buckles," due to their complex geometries and movement history. They're believed to be Pennsylvanian-aged, reactivated during the Laramide, adding considerable vertical motion and localized folding on adjacent Permian rocks.

On the Roswell North quad, the left-lateral Sixmile Buckle fault system (the third of the four, from west to east) enters the quad in the southwest corner, where it can be clearly mapped through **Psa** rocks on Sixmile Hill (Figure 8), until it's buried by valley fill. It crops out again in the north in **Pag** dolomites (Figure 7). Its strike averages about N 40° E, and has a significant (Laramide) down-to-the-east throw as well, although evidence for this additional movement was unclear in the northern **Pag** rocks. Its surficial expression in cross section can be seen in Figures 9-10, which are exposed in a roadcut on U.S. 380, immediately to the west of the Roswell North quadrangle.

Figure 8. Sixmile Buckle extending through Sixmile Hill on the southwestern side of the quad.





Figures 9-10. Exposures of the Sixmile Buckle in a U.S. 380 roadcut, just west of the quad.

HYDROLOGY

The RAB was once considered a "southwestern oasis" by early workers (e.g., Fisher, 1906; Fiedler and Nye, 1933; Brown, 1936), where numerous artesian spring-fed streams like North Spring River, flowed directly into the Pecos River. Figure 11 shows significant perennial discharge from North Spring (Fisher, 1906, Plate IIa). A curator at the Roswell Historical Museum reported that a miniature paddle-wheeled boat provided rides for Roswell children on North Spring River in the early part of that century. Intensive 20th Century agricultural pumping and urban growth changed this.

U. S. GEOLOGICAL SURVEY WATER-SUPPLY PAPER NO. 158 PL. II

A. HEAD OF NORTH SPRING RIVER.

Figure 11. Reproduction of Fisher (1906, Pl. IIa), showing significant, perennial artesian head-related discharge from North Spring, flowing towards the North Spring River.

The agriculture in this arid region (mean precipitation = ~25 cm/yr) must be sustained by irrigation, drawing both from a shallow, water table aquifer made up of sand and gravel of the Pecos River floodplain and alluvial terraces, as well as the artesian, karstic **Psa** aquifer. These aquifers are separated by leaky, confining redbeds and gypsum of the Artesia Group.

Recharge to the artesian aquifer occurs on the Pecos Slope, west of Roswell, where the San Andres limestone is exposed in outcrop. Some recharge occurs directly via precipitation, but most recharge is derived from underflow and from losing streams (such as the Rio Hondo) flowing eastward across the Pecos Slope. Groundwater flows eastward (downgradient) through the San Andres to a few kilometers west of the RAB, where the San Andres becomes a confined aquifer, beneath the Artesia Group sediments. Artesian head causes upward flow of groundwater from the artesian aquifer into the shallow alluvial aquifer. A significant amount of recharge to the shallow aquifer is derived from this upward leakage rather than from precipitation (Welder, 1983; Land and Newton, 2008).

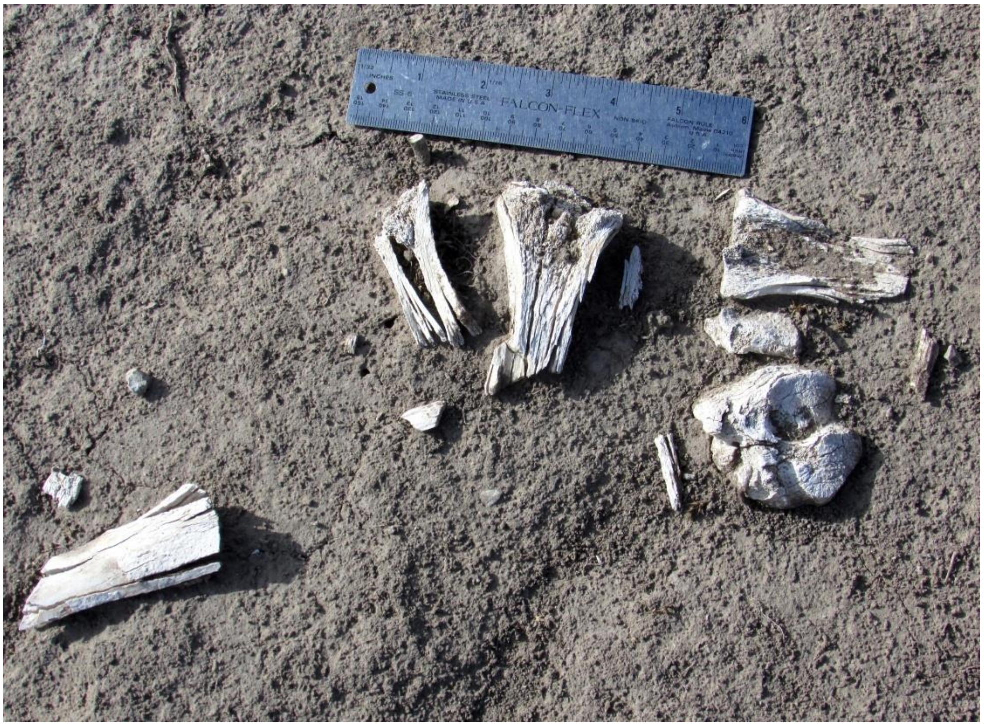
Wells

A rich water well dataset exists for Roswell North, probably numbering 200 or more. A sample of drillers logs from the NM Office of State Engineers W.A.T.E.R.S. were examined to determine the alluvial valley-fill thickness and to map out the subcrop **Psa** surface combining and comparing these data to that of Welder's (1983). The San Andres Formation slips below the surface quickly on the western quad margin and quickly reaches depths of 5-15 m. Its top gradually slopes to the east to where it lies 52+ m below the surface. A curious exception is a large depression in the surface essentially below where the Berrendo Creek enters the RAB proper, i.e., roughly from 537500 3699000 to 539500 3701500. Here, the valley-fill thickness reaches 25 m, before **Psa** rocks are encountered.

While there are numerous oil exploratory wells on the Bitter Lake quad to the east, only one was drilled (Emerson #1, 544550 3698788, T.D. = 2,250′) on Roswell North. A second well, (1Hahn, 541970 36892223, T.D. = 4,100′) approximately 8 km south of the cross section A-A′ was also utilized in cross section construction.

PALEONTOLOGY

Michael McGee, of the BLM Roswell Office shared with me his discovery of a bone bed being actively exposed along an ORV trail on the north shore of former North Spring in 2014 (Figures 12-13). I excavated a partial femur, and took it and numerous photos to share with Gary Morgan (New Mexico Museum of Natural History-since retired). He quickly identified the femur as being bison, and thought the photographs of other bone fragments were quite likely the same. Morgan (personal communication), strongly suggested that, while the bones could be Pleistocene in age, they were quite likely Holocene, and fairly recent, considering the condition of the femur fragment. As no evidence for a paleoindian kill was found, and funding for radiocarbon analysis were not available, no further studies were carried out.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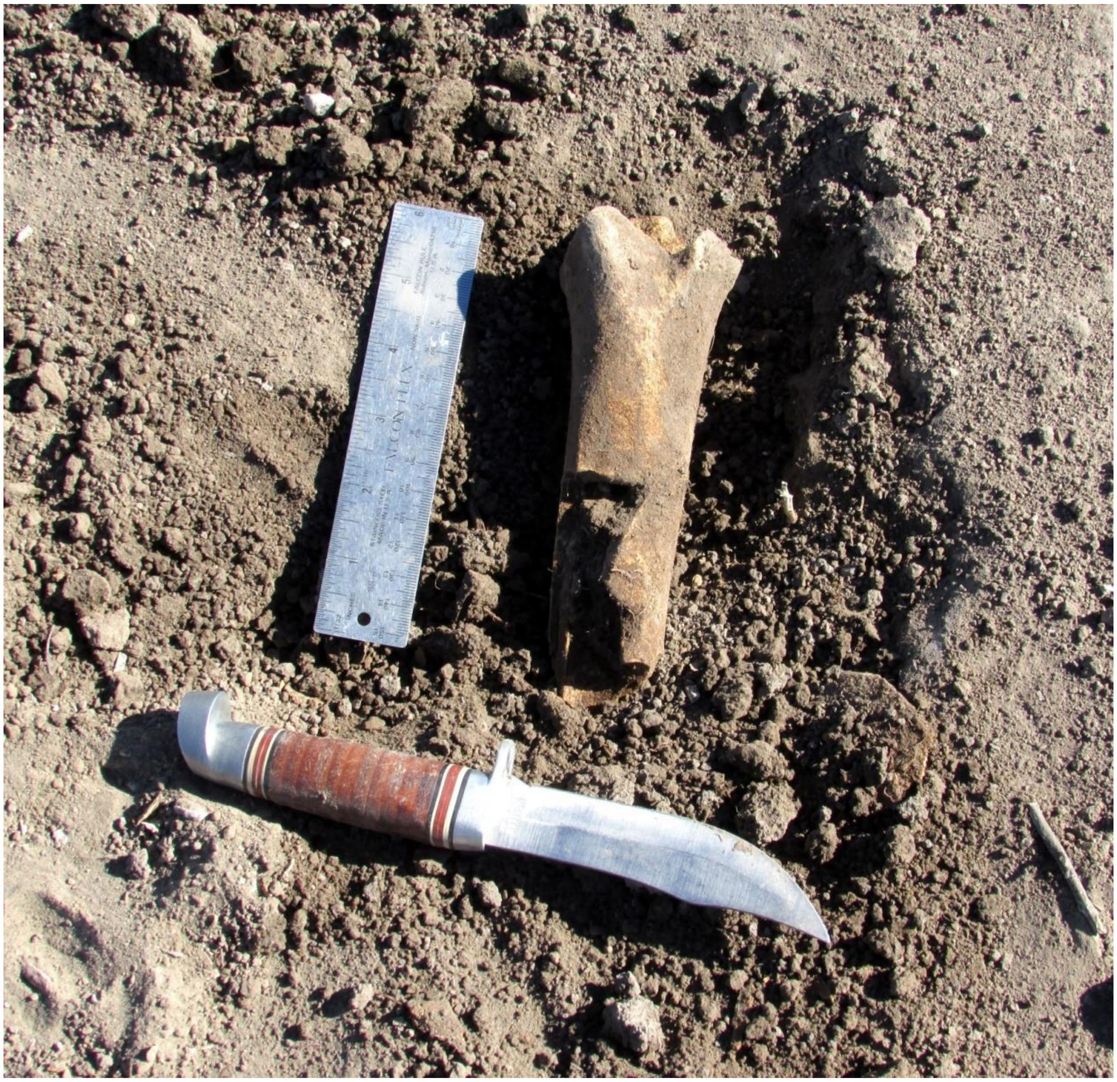

Figures 12-13. Bison bone fragments found along the former northern shoreline of North Spring.

DESCRIPTION OF MAP UNITS

QUATERNARY/NEOGENE

Alluvium, colluvium, eolian, and anthropogenic deposits

daf **Disturbed surface and/or artificial fill (Historic)**—Disturbed areas, dumped fill, and areas affected by other human disturbances. Mapped where deposits or extractions are areally extensive. Includes the US285/285 By-Pass/70 interchange and the old, abandonded Roswell municipal airport, as well as numerous borrow or gravel pits.

Qa	**Quaternary stream alluvium and/or valley-fill alluvium (Historic-upper Pleistocene)—**Brown (7.5YR4/2) to pinkish gray (7.5YR6/2), unconsolidated, moderately sorted, pebbly sand, silt, and clay, often gypsiferous in the east. Varies considerably in thickness from <1 m to ≥15 m in large valley-fill settings on the eastern side approaching the Pecos floodplain.
Qae	**Quaternary valley-slope alluvium with eolian sand and silt (Holocene-upper Pleistocene)—**Pinkish gray (7.5YR6/2) to light gray (2.5Y7/1), unconsolidated, coarse- to fine-grained sand and silt alluvial sediments intermixed with a significant eolian input. In the northwest, deposits contain many lithic, igneous grains derived from the Capitan Mountains pluton. Thicknesses vary considerably from 1 to ≥ 5(?) m.
Qaes	**Quaternary sheetwash swale channel alluvium with eolian sand (Holocene)—** Brown (7.5YR4/2) to pinkish gray (7.5YR6/2) to light gray (2.5Y7/1), unconsolidated, medium- to fine-grained sandy alluvium, intermixed with a finer-grained, eolian component. Deposits occur in lower-lying swales, within **Qae** deposits, and are predominantly derived from sheetwash flow and overland runoff. Thicknesses vary from 1-2+ m.
Qca	**Quaternary colluvial and/or valley-slope alluvial deposits, undifferentiated (Holocene-upper Pleistocene)—**Boulders, rubble blocks, cobbles and gravels, to thin, channel alluvial sands in valley bottoms. In the south, clasts are mostly **Psa** limestones; unconsolidated, poorly-sorted sediments vary from light gray (2.5Y7/1) to pale brown (10YR6/3). In the north, clast composition varies considerably from plutonic granitic gravels to Artesia Group dolomites and sandstones, in unconsolidated, poorly-sorted, pinkish gray (7.5YR6/2) to light gray (2.5Y7/1) sands. Thicknesses vary from <1 m in **Psa** upland settings to 2-3 m.
Qc	**Quaternary colluvium (Holocene-upper Pleistocene)—**In **Psa** upland settings, boulders, rubble blocks, cobbles, and gravels are found on steep slopes, in unconsolidated, to poorly-consolidated, poorly-sorted, coarse- to medium-grained sands, varying from light gray (2.5Y7/1) to brown (7.5YR4/2). Surrounding North Spring, sediments generally consist of limestone gravels in

unconsolidated, moderately to well sorted, light gray (2.5Y7/1) to very pale brown (10YR7/4) sands and silty-sands. Thicknesses vary considerably from ~1 to 6+ m in headslope to footslope settings in upland areas and <1 to 2 m, respectively, surrounding North Spring.

Pecos River tributaries alluvial deposits

Qah **Quaternary Rio Hondo alluvium (Historic-upper Pleistocene)—**Cobbles and gravels of predominantly limestone, with occasional chert, quartzite, and gray and green, porphyritic igneous rock clasts, in brown (10YR5/3) to dark yellowish brown (10YR3/4), unconsolidated, poorly to moderately sorted, coarse- to fine-grained sand, silty sand, silt (largely calcareous), sandy clay, and clay.

Qac **Quaternary stream alluvium in active channels (Historic-Holocene)—** Predominantly limestone gravels in brown (7.5YR5/4) to light gray (10YR7/1), unconsolidated, moderate to poorly sorted, gravel, pebbly sand, coarse- to fine-grained sand, silty sand, and silt. Often gypsiferous in the east. Thickness ranges from 1 to ~8 m.

Qbt3 **Quaternary stream overbank alluvium deposited along lowest Berrendo Creek and tributaries terrace surfaces (Historic-Holocene)—**Predominantly limestone gravels in brown (7.5YR5/4) to light gray (10YR7/1), unconsolidated, moderately sorted, pebbly sand, coarse- to fine-grained sand, silty sand, and silt. Forms first terrace 0.6-1.2 m above channel. Gypsiferous sediments increase in abundance in the east, especially along Middle Berrendo Creek. Thickness ranges from <1 to 2 m.

Qbt2 **Quaternary stream overbank alluvium deposited along middle Berrendo Creek and tributaries terrace surfaces (Historic-Holocene)—**Brown (7.5YR5/4) to light gray (10YR7/1), unconsolidated, moderately sorted, pebbly sand, and coarse- to fine-grained sand. Forms second terrace 1.4 to 2.2 m above channel. Gypsiferous sediments increase in abundance in the east. Thickness ranges from <1 to 2.6 m.

Qbt1 **Quaternary stream overbank alluvium deposited along upper Berrendo Creek and tributaries terrace surfaces (Historic-Holocene)—**Brown (7.5YR5/4) to light gray (10YR7/1), unconsolidated, moderately sorted, coarse- to fine-grained sand.

Forms upper terrace and terrace-slope which grades to lower Lakewood terrace surfaces on the Bitter Lake quad, immediately to the east. In the highly entrenched eastern-third of the quad, terrace occurs 2.5 to ~4 m above channel; while to the west, it can slope lower, extending from ~1.8 to ~4 m. Gypsiferous sediments increase in abundance in the east. Thickness ranges from 1.5 to 4 m.

Depression, sinkhole, and lacustrine deposits

Qd **Depression fill, primarily caused by subsidence (Historic-Pliocene?)—** Unconsolidated, moderate- to well-sorted, fine-grained (fine sands to clay) complexes of alluvial, colluvial, eolian, and occasional lacustrine deposits within closed depressions created by either gradual subsidence or sudden collapse followed by gradual subsidence of underlying carbonate in the west and/or gypsum in the northeast. Usually 1-3 m thick but can reach thicknesses in excess of 10 m.

Qds **Sinkhole fill, primarily caused by collapse (Historic-Pliocene?)—**Slumped limestone blocks and rubble in unconsolidated, poorly- to moderately-sorted sand. Thickness ranges from <1 to 3? m.

Ql **Quaternary lacustrine deposits (Historic-upper Pleistocene)—**Unconsolidated, well-sorted, fine-grained silty sands, silt, and clay deposited primarily by lakes fed by artesian springs or runoff into depressions. May have a significant interbeded alluvial component in their composition. Thickness 1-2 m.

Pecos Valley terrace deposits

Qlt1 **Quaternary Lakewood terrace, upper surface (Upper Pleistocene)—**Occasional gravels and pebbles (predominantly limestone) in a brown (7.5YR5/3) to dark yellowish brown (10YR3/4), unconsolidated, moderately sorted, coarse- to fine-grained sand, silty sand, silt and sandy clay. Stage I-II pedogenic carbonate. Surface tread ~7 m above Pecos River floodplain. Thickness ranges from ~2 to 6? m.

Qot2 **Quaternary Orchard Park terrace, lower surface (Upper Pleistocene)—**Cobbles, gravels and pebbles of predominantly limestone, with clasts of dolomite, sandstone, and chert in a very pale brown (10YR7/4) to reddish brown (5YR4/4), unconsolidated, moderately sorted, coarse- to fine-grained sand, silty sand, silt, and sandy clay. Stage III pedogenic carbonate. Surface tread ~8 m above Pecos River floodplain. Thickness ranges from 2 to ~12 m.

Qot1 **Quaternary Orchard Park terrace, upper surface (Upper to middle Pleistocene)—**Cobbles, gravels and pebbles of predominantly limestone, with clasts of dolomite, sandstone, and chert in a very pale brown (10YR7/4) to reddish brown (5YR4/4), unconsolidated, moderately sorted, coarse- to fine-grained sand, silty sand, silt, and sandy clay. Strong stage III pedogenic carbonate.Surface tread ~9-10.5 m above Pecos River floodplain. Thickness ranges from <1 to 51 m.

QTbt **Quaternary-upper Neogene Blackdom terrace (Middle Pleistocene-upper Pliocene)—**Cobbles, gravels and pebbles of limestone, chert, and quartzite in yellowish brown (10YR5/4) to reddish brown (5YR4/4), unconsolidated, moderately sorted, coarse- to fine-grained sand, silty sand, silt, and sandy clay. Strong stage III-III+ pedogenic carbonate. Western quadangle surfaces tread 18.3-24 m above Pecos River floodplain. Isolated remnants on Orchard Park terrace are common. Thickness ranges from 15 to 30? m.

PALEOZOIC

PERMIAN

Guadelupian

Paq **Queen Formation (Guadelupian, upper Permian)—**Pebbles of limestone, chert, and quartzite in an unconsolidated to loosely consolidated light yellowish brown (2.5YR7/2) to strong brown (7.5YR5/6) coarse to fine sand at surface. Unit described to the south comprised of red sandstone, mudstone, dolomite, and gypsum. Thickness ranges from 10 to 30? m.

Pag **Grayburg Formation (Guadelupian, upper Permian)—**Light- to dark-gray ridge-forming dolomite with relatively thin interbedded mudstones and muddy gypsum. Thickness ranges from 10 to 30? m.

Paqg **Queen and Grayburg Formations, undifferentiated (Guadelupian, upper Permian)—**Cross section only.

Leonardian

Psa **San Andres Formation (Leonardian, upper Permian)**—Light- to dark-gray limestone with interbedded dolomite and gypsum. Thickness ranges from 10 to 150+ m.

Pg **Glorieta sandstone (Leonardian, upper Permian)**—Cross section only.

Py **Yeso Formation (Leonardian, upper Permian)**—Cross section only.

Pa **Abo Formation (Permian)**—Cross section only.

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