Geologic Map of the Artesia Quadrangle, Eddy County, New Mexico

By

David J. McCraw and Shannon F. Williams

June 2011

New Mexico Bureau of Geology and Mineral Resources
Open-file Digital Geologic Map OF-GM 169

Scale 1:24,000

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New Mexico Bureau of Geology and Mineral Resources
801 Leroy Place, Socorro, New Mexico, 87801-4796

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OVERVIEW

The Artesia 7.5-minute quadrangle extends from 32°45'N to 32°52'30"N and 104°122' 30"W to 104° 30'W, is approximately 158 km^2 (61 mi^2). Elevations range from approximately 10016 m (3,333 ft) where Tumbleweed Draw flows off of the quad to the highest point of 1,096 m (3,597 ft)on the western edge in T. 17 N., R. 25 W. Sec 30, just north of the Eagle Creek. Physiographically, the majority of the quadrangle is comprised by distal parts of both the Rio Peñasco and Eagle Creek alluvial piedmont complexes, which grade to Pecos Valley terraces on the east side of the quadrangle.

The major drainages are the Eagle Creek and Tumbleweed Draw, a former course of the Rio Peñasco. Eagle Creek (or Eagle Draw as it is referred to further west) heads on the easternmost flank of the southern Sacramento Mountains in Permian San Andres Formation (*Psa*) carbonate rocks flow eastward to the Pecos River. The gravel component of its piedmont alluvial complex reflects the lack of Yeso formation (*Pye*) clastic rocks; it is almost completely comprised of limestone. The headwaters of the Rio Peñasco, on the other hand, reach high into the Sacramento Mountains into both *Psa* and

Pye rocks. Its piedmont gravels, delivered to the southern part of the quad via Tumbleweed Draw and other fan courses north of the Rio Peñasco, though dominated by limestone, also contain dolomite, chert, yellowish brown sandstone, conglomerate, and quartzite.

The surficial piedmont deposits are up to 140 m thick and thin updip in the oldest Plio-Pleistocene sediments. The oldest deposits of both the Eagle Creek and the Rio Peñasco piedmont alluvial complex presumably grade east to a river system comprising the Gatuña formation. The oldest Rio Peñasco piedmont deposit, Tpp_1, is not present on the Artesia quadrangle. All piedmont deposits are underlain by Permian evaporates of the Artesia Group and unsurprisingly, karstic depressions and sinkholes are common.

COMMENTS TO MAP USERS

This quadrangle map has been Open-filed in order to make it available to the public. The map has not been reviewed according to New Mexico Bureau of Geology and Mineral Resources standards, and due to the ongoing nature of work in the area, revision of this map is likely. As such, dates of revision are listed in the upper right corner of the map and on the accompanying report. ***The contents of the report and map should not be considered final and complete until published by the New Mexico Bureau of Geology and Mineral Resources.***

A geologic map graphically displays information on the distribution, nature, orientation, and age relationships of rock and surficial units and the occurrence of structural features such as faults and folds. Geologic contacts are irregular surfaces that form boundaries between different types or ages of units. Data depicted on this geologic map are based on 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. Significant portions of the study area may have been mapped at scales smaller than the final map; therefore, the user should be aware of potentially significant variations in map detail. Site-specific conditions should be verified by detailed surface mapping or subsurface exploration. Topographic and cultural changes associated with recent development may not be shown everywhere.

The cross section is constructed based on exposed geology, and where available, subsurface and geophysical data. Cross sections are interpretive and should be used as an aid to understand the geologic framework and not used as the sole source of data in locating or designing wells, buildings, roads, or other structures. Finally, the views and conclusions contained in this document are those of the authors and should not be interpreted as necessarily representing the official policies, either expressed or implied, of either the State of New Mexico or the U.S. Government.

STRATIGRAPHY

As alluded to above, surficial depositional units are Quaternary and late Neogene in age and are almost entirely made up of piedmont sediments. Of the Pecos Valley alluvial terraces, both the oldest Lakewood terrace (Qlt_1), and the Orchard Park terrace (*Qot*) are found on the east side of the quad. All deposits are underlain by the youngest

Permian Artesia Group (Guadalupian) Queen and Grayburg formations (*Pgq*), comprised of evaporates, redbeds, and interbedded dolomites.

Pecos Valley alluvial terrace complexes

Alluvial terraces of the Pecos River and its tributaries were first described in the classic study of Fiedler and Nye (1933). They recognized 3 terraces: (from lowest to highest) the Lakewood, the Orchard Park, and the Blackdom. On the Artesia quad, much of the higher Rio Peñasco and Eagle Creek piedmont alluvial complexes are erroneously mapped by Fiedler and Nye (1933) as Blackdom terrace. These materials, however, are all derived from these western tributaries, not the Pecos River. The most extensive of these terraces is the Orchard Park (*Qot*), which rises about 3 m above the Lakewood terrace and 10.5 to 20 m above the Pecos floodplain. The Lakewood terrace, with an elevation of <1 to 9 m above the floodplain, flanks the inset Pecos floodplain. McCraw, *et al.* (2007) differentiated three distinct, low-lying (upper to middle(?) Pleistocene) "Lakewood terraces." The highest and oldest (Qlt_1), equivalent to Fiedler and Nye's original at 6 to 9 above the floodplain, extends into the southeast part of the quad. The lowest and youngest (Qlt_3) extends up Tumbleweed Draw.

Piedmont alluvial complexes

Kelley (1971) mapped the entire piedmont alluvial complex in the Artesia quadrangle area as "Quaternary tributary alluvium." He apparently ignored the high, upland remnants that are found here. These old, Plio- (Mio-?)-Pleistocene deposits have been problematic. As summarized in Hawley (1993), these old, often high alluvial deposits have been mapped as "quartzose conglomerate" (Meinzer, *et al.,* 1923), as well as Ogallala and Gatuña by other workers (see Figure 7). Pedogenic carbonate varies within these deposits from stage IV to VI, indicating antiquity, a ground-water system supersaturated with respect to $CaCO_3$, or both. We suggest that they form the oldest deposits of the piedmont and most likely grade to the river system that formed the Gatuña formation.

Permian bedrock

Artesia Group rocks are backreef equivalents of the Capitan Reef formation, which is exposed along the southeast escarpment of the Guadalupe Mountains southwest of Carlsbad. The Artesia Group strata are most notable for their dramatic and sometimes abrupt variations in lithofacies north of the Capitan Reef complex (Kelley, 1971). The Group consists primarily of well-bedded dolomite in the near-backreef area of the Guadalupe Mountains. Farther to the north, lithology of the Artesia Group becomes increasingly evaporitic, consisting of interbedded gypsum, reddish-brown mudstone and siltstone, and thin interbeds of dolomite, typical of deposition in a far-backreef intertidal-supratidal-sabkha environment.

Defining formation contacts within evaporitic facies of the Artesia Group is often challenging. Some previous workers (e.g., Motts and Cushman, 1964) have chosen to designate these predominantly gypsum strata as the Artesia *Formation* where the individual units of the Artesia Group are not distinguishable. For consistency with previous geologic mapping in this area (Kelley, 1971; Delher, *et al.,* 2005; McCraw and Land 2008), we have combined the Queen and Grayburg formations (*Pqg*) that underlie the Artesia quad.

STRUCTURE

Structural geology of the Artesia quad is not complex. Regionally, Artesia Group strata dip gently to the east at approximately 1° (~100 ft/mile). Oil and gas well log data examined to construct the cross section indicates the dip of these strata here is slightly enhanced to approximately 3-4° east.

DESCRIPTION OF MAP UNITS

QUATERNARY and NEOGENE

Alluvium and anthropogenic deposits

daf **Disturbed land and/or artificial fill** — Dumped fill and areas affected by human disturbances, mapped where deposits or extractions are areally extensive. Especially notable are the numerous constructed oil and gas well pads. Also includes the U.S. Bureau of Reclamation's Kaiser Channel of the Pecos River, as well as other straightened reaches.

Qa **Quaternary alluvium, undifferentiated (Historic to uppermost Pleistocene)** — Brown (7.5YR4/2) to light brown (7.5YR6/3), unconsolidated, moderately sorted, pebbly sand, silt, and clay. Contains primarily carbonate gravels and pebbles. Varies considerably in thickness from <1 to 3 m in tributaries and up to 10-12 m in the floodplain.

Pecos Valley alluvial terrace complex

Alluvial terraces of the Pecos River and its tributaries were first described in the classic study of Fiedler and Nye (1933). They recognized 3 terraces: (from lowest to highest) the Lakewood, the Orchard Park, and the Blackdom. On the Artesia quad, much of the higher Eagle Creek and Rio Peñasco piedmont alluvial complexes are erroneously mapped by Fiedler and Nye (1933) as Blackdom terrace. These materials, however, are all derived from these western tributaries, not the Pecos River.

Lakewood terrace alluvial deposits (upper to middle Pleistocene) — Following McCraw, *et al.* (2007) and McCraw and Land (2008), three distinct, low-lying (upper to uppermost middle(?) Pleistocene) "Lakewood terraces" are recognized. Fiedler and Nye's original Lakewood terrace, equivalent here to Qlt_1, has an elevation of 6 to 9 m above the floodplain and is located on the eastern edge of the quad. The lowest and youngest, Qlt_3, is <1-2 m above the floodplain and extends up Tumbleweed Draw. These are comprised of occasional gravels and pebbles, brown (10YR5/3) to dark yellowish brown (10YR3/4), unconsolidated, moderately sorted, coarse- to fine- grained sand, silty sand, silt and sandy clay. Pedogenic carbonate increases from stage I to stage II+ (occasionally III) from Qlt_3 to Qlt_1. Mostly non-gypsiferous.

Qlt_3 **Youngest Lakewood terrace alluvial deposits (upper Pleistocene)** — Thickness <1 to 2 m.

Qlt_1 **Older Lakewood terrace alluvial deposits (upper to middle Pleistocene)** —Thickness 6 to 9 m.

Qot **Orchard Park terrace alluvial deposits (upper Pliocene (?) to upper Pleistocene**) — According to Fiedler and Nye (1933), the Orchard Park terrace rises 1-3 m above the Lakewood terrace and 10.5-20 m above the Pecos floodplain. It is comprised of gravels and pebbles of dolomite, limestone, sandstone, chert, and quartzite 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. Pedogenic carbonate is a strong stage III. Thickness ranges from 3 to 15 m.

Rio Peñasco alluvial piedmont complex

Rio Peñasco alluvial piedmont deposits (Upper Pleistocene to Late Miocene(?)) — The headwaters of the Rio Peñasco are located high in the Sacramento Mountains in predominantly carbonate rocks of the San Andres formation (*Psa*) and clastic sediments of the Yeso formation (*Pye*). Where it leaves the Permian highlands, it has built a large piedmont alluvial complex, which coalesces with Eagle Creek to the north and the Seven Rivers to the south. These piedmont deposits grade to and onto the Pecos Valley alluvial terraces in the Artesia area. Oldest, highest remnant surfaces (Tpp_1 and $QTpp_2$) are Pliocene or older, and likely graded to a river system which forms Gatuña formation deposits today. Middle to upper Pleistocene piedmont deposits (Qpp_{3-4}) are inset into these and grade to *Qot*. The youngest, Qpp_5, grades to Qlt_3. Several channels (e.g., Tumbleweed Draw) on this piedmont surface were likely former Rio Peñasco channels.

Lithologically, the Rio Peñasco piedmont deposits are distinctly different from those of Eagle Creek to the north and Seven Rivers to the south. While gravels are dominated by limestone clasts, dolomite, chert, yellow-brown sandstone, conglomerate, and quartzite are common. The matrix consists of dark yellowish brown (10YR3/4) to light brown

(7.5YR6/3), unconsolidated, moderately sorted, coarse- to fine-grained sand, silty sand, silt, and sandy clay. Stage V-VI pedogenic carbonate can be found in the oldest deposits, while middle to upper Pleistocene deposits range from stage IV to III. Degree of pedogenic carbonate development can be the main distinguishing characteristic between the youngest deposits.

Qpp_5 **Youngest Quaternary piedmont alluvium (Holocene to upper Pleistocene)** — Thickness 1 to 3 m.

Qpp_4 **Younger Quaternary piedmont alluvium (Upper Pleistocene)** — Thickness 2 to 4 m.

Qpp_3 **Old Quaternary piedmont alluvium (Upper to middle Pleistocene)** — Most extensive deposit. Thickness 2 to 4 m.

$QTpp_2$ **Older piedmont alluvium (Middle Pleistocene to late Pliocene)** — Thickness 2 to 6 m.

Tpp_1 **Oldest piedmont alluvium (Late Pliocene to late Miocene(?))** — Thickness 2 to 6 m.

Rio Peñasco piedmont channel deposits (Historic to upper Pleistocene) — Numerous, thin alluvial channels, swales, and occasional coalescing depression fill deposits drain the piedmont alluvial complex. They usually consist of light brown (7.5YR6/4) to pinkish gray (7.5YR6/2), unconsolidated, poorly sorted, fine-grained sand, silt, and clay sediments. They were often mapped primarily by soil moisture increases in lower areas relative to adjacent piedmont deposits noted on photography. Eolian input often mantles the “v-shaped” contours associated with stream channels and in some areas sand sheets and dunes can fill these channels (*Qpce*). On the Rio Peñasco on the Dayton quad immediately to the south, older channels ($Qppc_1$) are mapped on Qpp_4 surfaces, similar and stratigraphically equivalent to those on Eagle Creek Qpe_3 deposits.

$Qppc_2$ **Young Quaternary piedmont channels (Holocene to upper Pleistocene)** — Thickness <1 to 2 m.

Qpce **Young Quaternary piedmont channels filled with eolian sands, occasionally forming dunes (Holocene to upper Pleistocene)** — Thickness $\leq$ 1 m.

Eagle Creek alluvial piedmont complex

Eagle Creek alluvial piedmont deposits (Upper to middle Pleistocene) — Eagle Creek (or Eagle Draw further west) heads on the easternmost flank of the southern Sacramento Mountains in San Andres Formation (*Psa*) rocks and flows east to the Pecos River. Where it leaves the Permian highlands, it has built a large piedmont alluvial complex, which coalesces with the Rio Felix to the north and the Rio Peñasco to the south. This piedmont complex grades to and onto the Pecos Valley alluvial terraces. Oldest, highest remnant surfaces are correlative to Quaternary – Tertiary piedmont deposits of the Rio Peñasco (*QTpp2*). Collectively, these are comprised of gravels that are almost exclusively limestone derived from *Psa*, supported in a matrix of light brown (7.5YR6/3), unconsolidated, moderately sorted, coarse- to fine-grained sand, silty sand, silt (largely calcareous), and sandy clay. Topographic expression between the youngest deposits are often to subtle to practically non-existent. Distinction is often based upon a stronger developed pedogenic carbonate (Qpe_3 = stage III – II+; Qpe_4 = stage II). Qpe_4 grades to Qlt_3.

Qpe_4 **Youngest Quaternary piedmont alluvium (Holocene to upper Pleistocene)** — Thickness 1 to 3 m.

Qpe_3 **Younger Quaternary piedmont alluvium (Upper Pleistocene)** — Thickness 2 to 4 m.

Qpe_2 **Older Quaternary piedmont alluvium (Upper to middle Pleistocene)** — Most extensive deposit. Thickness 2 to 4 m.

$QTpe_1$ **Oldest piedmont alluvium (Middle Pleistocene to late Pliocene)** — Thickness 2 to 6 m.

Eagle Creek piedmont channel deposits (Historic to upper Pleistocene) — Up until the mid 20th Century, prior to channelization through town, Eagle Creek flowed primarily south of the town of Artesia. These abandoned channels (2-3 m thick) are now similar to the numerous, thin alluvial channels, swales, and occasional coalescing depression fill deposits that only drain the local piedmont alluvial complex. These channels usually consist of light brown (7.5YR6/4) to pinkish gray (7.5YR6/2), unconsolidated, poorly sorted, fine-grained sand, silt, and clay sediments. They were often mapped primarily by soil moisture increases in lower areas relative to adjacent piedmont deposits noted on photography. Eolian input often mantles the "v-shaped" contours associated with stream channels and in some areas sand sheets and dunes can fill these channels (*Qece*). Older channels ($Qpec_1$) are mapped on Qpe_3 surfaces above modern Eagle Creek in the vicinity of the Eagle Creek retaining dam on the northwestern edge of the quad.

$Qpec_2$ **Young Quaternary piedmont channels (Holocene to upper Pleistocene)** — Thickness <1 to 2 m.

$Qpec_1$ **Older Quaternary piedmont channels (Upper Pleistocene)** — Thickness <1 to 2 m.

Qpce **Young Quaternary piedmont channels filled with eolian sands, occasionally forming dunes (Holocene to upper Pleistocene)** — Thickness ≤ 1 m.

Quaternary depression fill and sinkhole deposits

Qd **Quaternary depression fill, undifferentiated (middle Pleistocene to Holocene)** — Unconsolidated, well-sorted, fine-grained (fine sands to clay) complexes of alluvial, colluvial, eolian, and occasional lacustrine deposits within closed depressions. Colors variable. Depressions are created by either gradual subsidence or sudden collapse followed by gradual subsidence of underlying gypsiferous carbonate terrane. These complexes, often significantly modified by stream erosion and deposition, playa deposition, deflation, and mass wasting. Depression fills have been active since the middle Pleistocene and are usually 1-3 m thick but can reach thicknesses in excess of 30 m.

Qds **Quaternary sinkhole deposits, primarily caused by collapse (Historic to middle Pleistocene)** — Complexes of unconsolidated, well- to poorly-sorted, coarse- to fine-grained sands to clay, alluvial, colluvial, eolian, and occasional lacustrine deposits within closed depressions. Colors variable. Thickness <1 to 3 m.

PALEOZOIC

Permian Artesia Group

Pgq **Queen and Grayburg formations (Guadelupian)** — Cross section only.

Lower Permian Formations

Psa **San Andres formation** — Cross section only.

Pg **Glorieta sandstone tongue** — Cross section only.

Pye **Yeso formation, undifferentiated** — Cross section only.

Pa **Abo formation, undifferentiated** — Cross section only.

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