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

By

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Open-file Digital Geologic Map OF-GM 076

Scale 1:24,000

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Description of map units—Otis Quadrangle

Sediment color was estimated by comparing dry sediment to Munsell Color Chart (Munsell Color, 1994).

Hd-disturbed areas (Holocene)— Disturbance areas consisting of quarries and (or) dump areas that obscure the local geology.

Qal-alluvium (Holocene) Brown (7.5 YR 6/4), silt to sand, well sorted**,** subangular to subrounded, dominantly quartz with rare lithics, occupies draws and river channels and associated active floodplains**.** Little to no vegetation. Overlies or is inset into nearly all older units. Thickness 0-2m.

Qaes-alluvial and eolian deposits (Pleistocene (?) to Holocene)-Brown (7.5 YR 6/4), silty clay to silt to sand, well sorted, subangular to subrounded, grains composed of 70% quartz and 30% carbonate and chert. Weak soil development in upper 1.25 m: upper 15 cm of soil is massive silty clay to clayey silt, brown (7.5 YR 5/4), slightly plastic, bioturbated, effervesces strongly, local organic film with granular soil structure; gypsiferous and calcareous concretions decrease in abundance downward to 40 cm; and prismatic structure extends down to 1.25 m. Unit locally weathers into badlands and exhibits piping. Common veneer on nearly all Quaternary deposits in the map area and commonly overlies Qagp2, Qasp2, Prlu and Prv. Thickness ≤10 m.

Qasm1-alluvial sand mainstem (Pleistocene (?) to Holocene)- Light brown (7.5 YR 6/4), silt to fine-lower sand, subrounded to subangular, well sorted, massive, quartzose and lithic grains, scattered pebbles and rare cobbles dispersed within matrix, rare calcic nodules and laminated drapes of dark red mud. Surface nearly always reworked into coppice dunes. Top of unit forms a terrace (T1) 5 m above modern Pecos River and deposit is equivalent to flume sand in Carlsbad. May overlie or be inset into Qagm2. Thickness ≤10m.

Qagp2-alluvial sand and gravel piedmont (Pleistocene)-Pink (7.5 YR 8/3), fine upper-medium lower sand, subangular to rounded, well sorted, with rare grains of coarse sand and pebbles, grains dominated by quartz with lesser lithics. Gravel is matrix-supported to clast-supported and in many cases is well consolidated by calcite cement and conglomeratic. Gravel clast size is <35 cm dia, and grains are composed of quartz, yellow and orange and gray chert, tan siltstone, gray to tan limestones and dolomites, green, pink, and maroon quartzites, and accessory minerals. Clast composition is dominated by carbonates in center of quadrangle (by canal; all locally derived dolomites). Larger clast sizes in central-eastern part of quadrangle are are white to buff carbonates, rare chert, and very rare reddish quartzite**.** Gravel beds (meter-scale thickness), where exposed, are interbedded w/minor silty sandstone beds (cms thick) and are locally contorted. Sandstones are commonly crossbedded with tangential to planar-tabular foresets < 20°, some sets very low angle, sets in medium to thick beds, pebble stringers at base of crossbed sets, poorly to well developed imbrication. Paleocurrent from imbrication and crossbedding indicate dominantly easterly flow, with subordinate southerly and northeasterly flow directions. Calcrete (≤2-3 m thick): local carbonate nodules, bioturbation and contorted bedding in upper <1 m of unit grades into massive autobrecciated carbonate-rich sand with isolated gravel clasts (~1.5 m thick) overlain by massive to vesicular autobrecciated calcrete in undulose, lenticular beds with internal laminations, pisolitic texture, local cemented sandstones

and gravels (~0.5 m thick), and overlain by massive to laminated calcrete with pisolitic texture (upper 0.5 m), and a thin capping veneer of calcrete regolith with angular clasts of calcrete and chert clasts, reverse graded. This unit dominates the Otis Quadrangle and correlates to low bluffs on west side of Pecos River. Grades to Qagm2 and Qasp2. Overlies Prlu in SW corner of quadrangle. Thickness ~≤ 100 m (from cross section).

Qasp2-alluvial sand piedmont (Pleistocene) Brown(7.5 YR 7/3)**,** silt and fine upper to medium lower sand, weakly to moderately consolidated with carbonate cement, matrix subangular to rounded, well sorted with rare grains of coarse sand and pebbles, grains dominated by quartz with lesser lithics. No gravel. Massive. Upper 40 cm is wavy tabular, generally finer than lower, slight organic stain, poorly exposed. Calcrete poorly to well developed (1-2 m thick) and is dominantly brecciated in sand and silt matrix**.** Unit is lateral fine-grained facies equivalent of Qagp2. Thickness ~≤ 70 m (from cross section).

Qagm2-alluvial gravel mainstem (Pleistocene) Pecos River gravel and sand, medium upper to coarse upper with lesser granules and pebbles (3-6 cm in dia, ave.), moderately sorted, well rounded, moderately to well cemented by calcite. Sand fraction is mostly quartz and chert. Pebbles are composed of red, tan, and gray quartzite, variegated cherts, gray limestone, yellow limestone, yellow siltstone, light grey and yellow dolomite, petrified wood, light tan and gray volcanic porphyry, bull quartz, and schist, yet dominated by locally derived carbonates and siliciclastics. Capped by calcrete (1.5 to 2 m thick), autobrecciated, laminar at top. Forms low mesas along Pecos River valley. Thickness ~≤ 70 m.

Qagdc2 alluvial gravels of Dark Canyon (Pleistocene)- Pink (7.5 YR 8/3) (matrix) and commonly medium gray(GLEY 7/10 Y) (clasts), fine sand to boulder gravel, sub-angular to rounded**,** locally-derived clasts of dolomite, limestone, siltstone, and sandstone**,** tabular to lenticular beds, crossbedded and imbricated, paleocurrent data indicate northeasterly flow. Calcrete cap (1-2 m thick). Correlates to other Qa2 deposits. Thickness >15 m.

Prc-Permian Rustler Formation, Culebra Dolomite Member (Ochoan)- cream to light gray (2.5 Y 7/1, 8/1, 8/2 and 7.5 Y2 8/1), finely crystalline, sugary dolomite and local limestone with distinctive vuggy texture, thin to medium bedded, prominently fractured, and associated with yellow(10 YR 6/6) crossbedded to ripple-laminated sandy dolomite and lesser gypsum. Contorted into local hills and depressions in southeast corner of quadrangle. Overlies Rustler clastics (Prv) with sharp contact. Thickness difficult to determine. Reported thickness of ≤ 12 m (e.g., Hill, 1999).

Prv-Permian Rustler Formation, Virginia Draw Member (Ochoan) Red siltstone to very fine sandstone, well sorted, subrounded to rounded, dominantly quartz, interbedded with green-red claystones in very thin to medium beds. Weathers into badlands. Exposed in southeast corner of map area and base of unit not exposed. Thickness ~75-100 m (from cross section).

Prlu-Permian Rustler Formation, lower, undifferentiated (Ochoan)—Irregular masses of gypsum, dolomite, and salt in large blocks scattered on surface and outcrops with chaotic bedding orientations. Unit may include blocks of strata from the underlying Salado Formation. Exposed in SE corner of map area. Thickness unknown.

Ps-Permian Salado Formation (Ochoan)—In cross section only. Halite and anhydrite with subordinate potash salts, dolmite to silty-sandy dolomite, and claystone to siltstone. Thins to north-northwest, ~300-550 m thick.

Pc-Permian Castille Formation (Ochoan)—In cross section only. Anhydrite and interbedded halite. Thins to south-southeast, ~75-120 m thick.

Pl-Permian Delaware Mountain Group, Bell Canyon Formation, Lamar Limestone Member (Ochoan- Guadalupian)—In cross section only. Limestone, siltstone, sandstone and shale. Thins to south-southeast, ~20-55 m thick.

Pd-Permian Delaware Mountain Group, undifferentiated (Guadalupian)—In cross section only. Sandstone, siltstone, and shale with subordinate limestone., >~150 m thick.

Map symbols:

Bedding contact-dashed where approximately located or where interpreted from air photo

Pleistocene bar-and-swale paleocurrent indicators--from air photo interpretation, only

Hatchures- indicate depression made by salt removal/collapse and (or) wind deflation

Oil/gas well location used in this study
(suggested type logs for subsurface stratigraphic picks are logfile numbers 19546, 21649, 40114)

Water well location used in this study

Depositional environments of Permian facies

Permian outcrops in the Otis quadrangle are confined to a small area in the southeastern corner of the map. It is difficult to characterize these units due to their poor exposure and the contorted nature of the strata. Sedimentary structures are rare and macrofossils were not found during this study. The sedimentary characteristics of the Culebra Dolomite suggest a restricted shallow shelf environment. The lower Rustler Formation (Virginia Draw Member) also likely represents a restricted low-energy environment, possibly a shoreward equivalent environment to the Culebra shelf such as a tidal flat.

Structural geology

The structural history of this quadrangle is difficult to interpret based on limited exposure of bedrock units. The cross section and map reflect gentle folding of the Permian units, although bedding orientation is not well established. Laramide reactivation of late Paleozoic structures and (or) deformation from salt tectonics are two viable scenarios to explain this deformation (Hiss, 1976c), however salt tectonics is favored because deformation does not appear to propogate downward (or upward) through the strata (see cross section). Varying bedding

orientations and convolution of all pre-Holocene deposits suggest that salt tectonics has been active as recently as Pleistocene time.

Geomorphology and landscape evolution of the Pecos River

Two hypotheses address the landscape position of the Quaternary deposits in the Otis quadrangle. The preferred hypothesis is that the deposits underlying the hills in the quadrangle (Qamg2) are the same deposit as that in the topographically lower surrounding landscape (Qaes/Qagp2). Another hypothesis is that these deposits at higher elevations are an older deposit and that the hills represent terraces preserved in the landscape. This latter hypothesis is not favored due to: insignificant differences in calcrete development; same composition of clasts (provenance); calcrete surfaces follow land surface; and no terrace risers observed. In keeping with the first hypothesis, Qamg2 and related deposits are the oldest known Quaternary deposits in the field area. They are post-Ogallala Fm and pre-modern Pecos River, and likely representthe ancestral (Pleistocene) Pecos River in a setting analogous to the modern Pecos River. Although most of the alluvial gravels in the quadrangle may be approximately the same age, they may be polygenetic.

The cross section shows a nice broad channel form, which is filled with Qa2 deposits. This swale and others like it in the quadrangle, indicate northeasterly flow from the Dark Canyon area toward the paleo-Pecos River, which was likely located where the Qagm2 gravels are (in the northeastern map area).

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