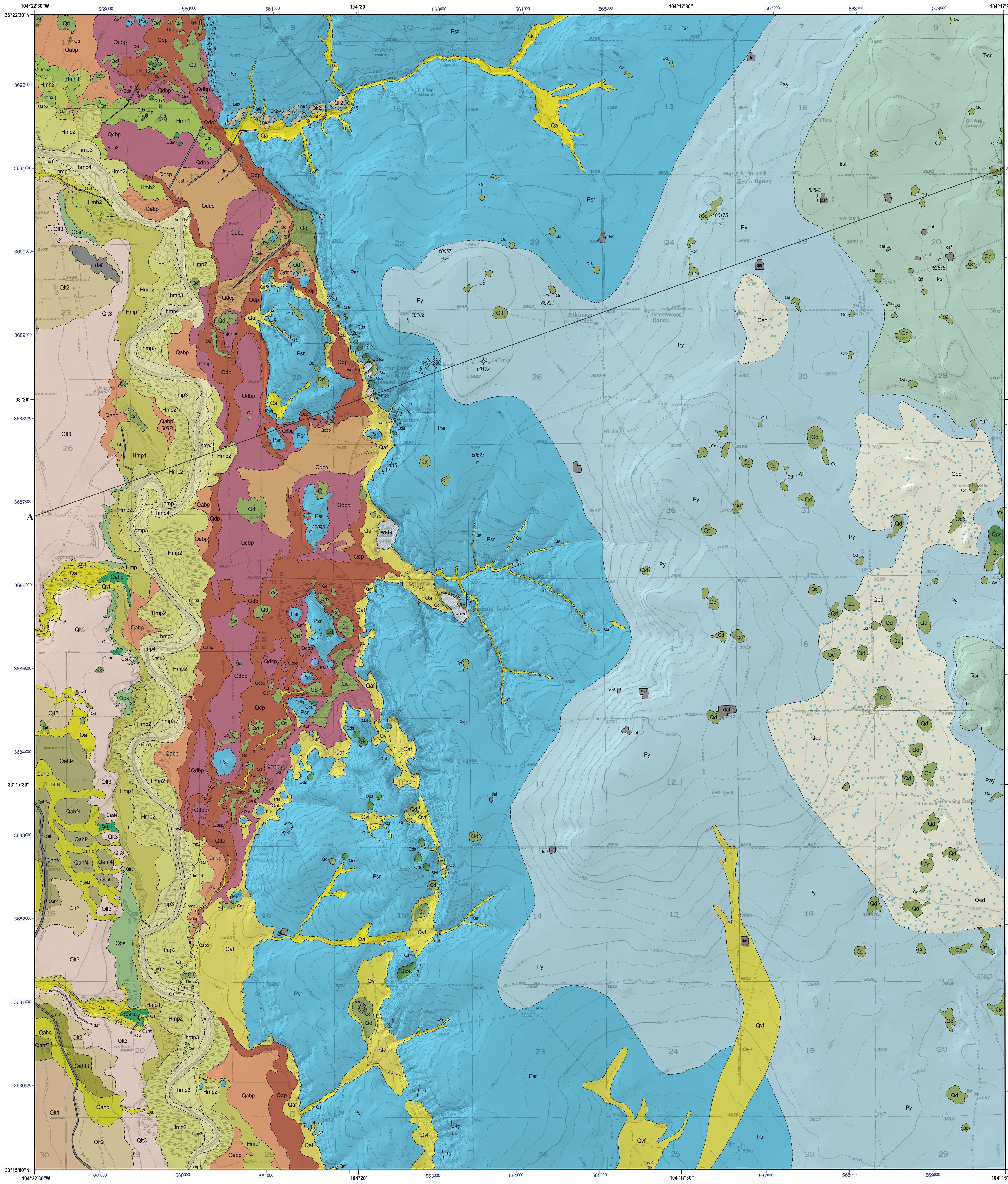


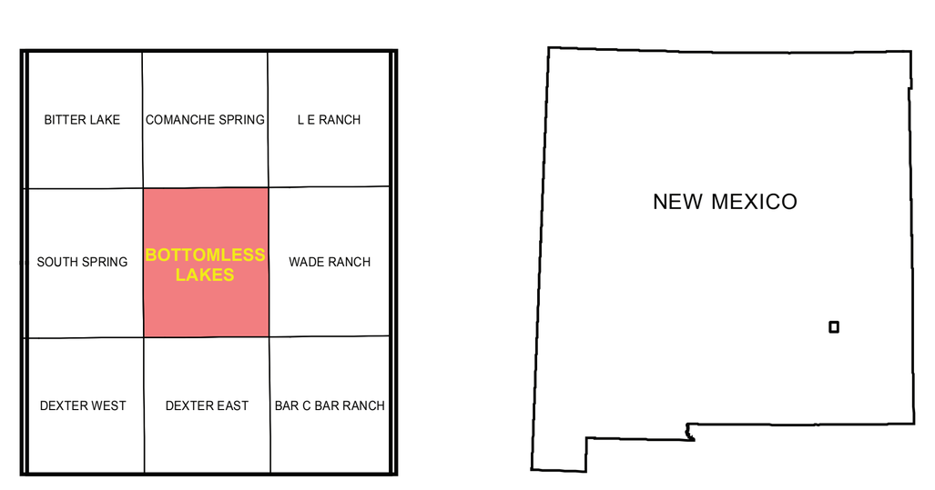
Base map from U.S. Geological Survey 1950, from photographs taken 1947, field checked in 1949-1950.
1927 North American datum, UTM projection -- zone 13N
1000-meter Universal Transverse Mercator grid, zone 13, shown in red

1:24,000

CONTOUR INTERVAL 10 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929

Magnetic Declination
March 2005
8° 45' East
At Map Center

Mapping of this quadrangle was funded by a matching-funds grant from the STATEMAP program of the National Cooperative Geologic Mapping Act, administered by the U. S. Geological Survey, and by the New Mexico Bureau of Geology and Mineral Resources, (Dr. Peter A. Scholle, *Director and State Geologist* , Dr. J. Michael Timmons, *Geologic Mapping Program Manager*).



QUADRANGLE LOCATION

Geologic map of the Bottomless Lakes quadrangle, Chaves County, New Mexico.

April 2010

by
Geoffrey Rawling and David J. McCraw

New Mexico Bureau of Geology and Mineral Resources, Socorro, NM 87801

New Mexico Bureau of Geology and Mineral Resources
Open-file Geologic Map 126

Supercedes
Preliminary geologic map of the Bottomless Lakes quadrangle, Chaves County, New Mexico
May 2006
by
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This and other STATEMAP quadrangles are available for free download in both PDF and ArcGIS formats at:

http://geoinfo.nmt.edu/publications/maps/geologic/ofgm/home.html

EXPLANATION OF MAP SYMBOLS

A——A' Location of geologic cross section.

Geologic contact. Solid where exposed or known, dashed where approximately known, queried where uncertain, dotted where concealed.

Headscarp of landslide or slump block.

Horizontal bedding.

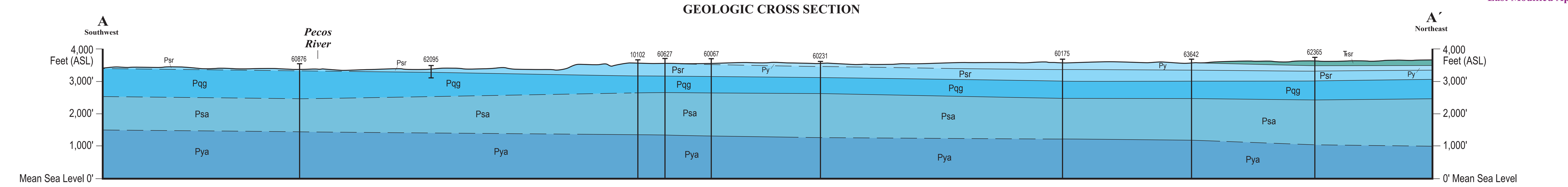
Inclined bedding showing degrees of dip; dashed where estimated visually

Strike of vertical joints.

Oil well with last five digits of API number from NM Oil Conservation Division database.

View of Lea Lake looking south-southwest showing the state park's bathhouse and swiming area in the distance. Lea Lake is both the largest and deepest of the sinkhole lakes at 2,108 m^2 (18.2 hectares) in area and 29.5 m in depth. Piping has developed in the weathered gypsum, sandstone, and siltstone of the Seven Rivers Formation in the foreground.

GEOLOGIC CROSS SECTION



DESCRIPTION OF MAP UNITS

Quaternary/Neogene

Alluvium, colluvium, eolian, and anthropogenic deposits

water — **Open water**

daf — **Disturbed areas 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 borrow or gravel pits.

Qa — **Quaternary tributary alluvium, undifferentiated (Holocene to uppermost Pleistocene)** — Brown (7.5YR4/2) (Rio Hondo fan deposits), pinkish gray (7.5YR6/2) to light reddish-brown (5YR 6/4) to reddish brown (2.5YR4/6) (Pecos floodplain and eastern Permian uplands), unconsolidated, moderately sorted, pebbly sand, silt, and clay, gypsiferous in many areas. Varies considerably in thickness from <1 m to 10-12 m. Unit equilavent to *QHa* on the preliminary geologic map of the Bottomless Lakes quadrangle (v1p-00, May 2006).

Qvf — **Quaternary valley-fill alluvium, undifferentiated (Holocene to upper Pleistocene)** — Brown (7.5YR4/2) to pale brown (10YR6/3) unconsolidated, poorly sorted, pebbly sand, silt, and clay, probably deposited by alluvial processes with subordinate sheetwash and colluvial processes. Grades into minor alluvial and colluvial fans on toes of hillslopes. Heavily vegetated and often incised by active drainages too small to map, which are floored by *Qa*. Thickness 0 to 5 (?) m.

Qaf — **Alluvial-fan deposits, undivided (Historic to uppermost Pleistocene)** — Predominantly quartzite, chert, and carbonate cobbles to gravel, often in stringers, in a light reddish-brown (5YR6/4) to reddish brown (2.5YR4/6), unconsolidated, poorly sorted, and coarse- to fine-grained gypsiferous sand to silty sand. These fans are built along the base of the Seven Rivers formation (*Psr*) eastern bluffs and interfinger with and/or spread out onto Pecos floodplain deposits. They are locally incised by small drainages floored with recent alluvium (*Qa*). Most are stabilized by vegetation and apparently not currently active. Thickness <1 m at their distal margins to 8 (?) m.

Qc — **Colluvium, undifferentiated (Holocene to uppermost Pleistocene)** — Light reddish-brown (5YR6/4) to reddish brown (2.5YR4/6), unconsolidated to poorly consolidated, poorly to moderately sorted sand and silty sand, with rubble blocks of gypsum, sandstone, siltstone, and mudstone, and minor limestone. Deposits range from less than 1 m to about 3 m in thickness.

Qed — **Eolian dune sand, undivided (Holocene to uppermost Pleistocene)** — Very pale brown (10YR8/2) to light brown (7.5YR6/4), unconsolidated, moderately to well-sorted sand, silty sand, and sandy clay. Forms extensive thin sheets and low dunes. Deposits are along the eastern margin of the quadrangle appear to be localized by the low bluff formed by outcrops of Triassic Santa Rosa formation (*T̶Rsr*). Largely stabilized by vegetation other than in blowouts. Sand sheets appear to be common throughout the quadrangle east of the bluff composed of Seven Rivers formation, but these deposits could not be consistently delineated on aerial photographs Thickness commonly <1 m to about 5 m.

Pecos River alluvial valley floor

Pecos River meander belt alluvial deposits (Historic to lower (?) Holocene) — During the Holocene, the Pecos River built four distinguishable meander belts on top of an upper Pleistocene Pecos River braided alluvial valley-fill deposit (*Qabp*), which is the basal unit of the floodplain. Consisting of channel, channel bar, and point bar deposits, undivided, these meander belt deposits are differentiated based upon aerial photographic work into two older Holocene units and two Historic units, first described on the Bitter Lake quad (McCraw, *et al*., 2007): 1) the modern meander belt was mapped from both 2005 digital 1-m resolution, color orthophotography and 1981-vintage color aerial photography produced for the U.S.D.I.-Bureau of Land Management, and 2) a 1939-1940 meander belt was mapped using vintage U.S.D.A. – Soil Conservation Service black and white aerial photography. The 1939-40 meander belt, in places, also incorporates areas where meander migration clearly continued up at least until around 1962, the issue date of the Bitter Lake topographic quadrangle (before photo-revision). All aerial photography was georeferenced and plotted onto the 2005 orthophotography using ArcGIS. The historic units are differentiated from the Holocene units by using a lower case "h" on the unit labels.

hmp4 — **Modern meander belt deposits (Historic)** — Very pale brown (10YR7/4) to reddish brown (2.5YR4/6), unconsolidated, moderately to well-sorted, occasionally pebbly, coarse- to fine-grained sand in the modern channel and adjacent bar crests, grading to silty sand and sandy clay with distance from the channel. Modern meander amplitudes are only approximately 0.2-0.6 km in width. This has greatly reduced both channel and overbank deposition, thus the majority of modern meander belt deposits are <1 m thick, but reach about 1.5 m thick in a few places. Unit occupies areas mapped as *Qfly* on the preliminary geologic map of the Bottomless Lakes quadrangle (v1p-00, May 2006).

hmp3 — **1939-1940 meander belt deposits (Historic)** — Very pale brown (10YR7/4) to reddish brown (2.5YR4/6), unconsolidated, moderately to well sorted, coarse- to fine-grained gypsiferous sand in the Historic channel and adjacent bar crests, grading to silty sand and sandy clay with distance from these older channels. Throughout the upper Holocene, extensive point bar development, with some minor channel bar development has taken place. This has resulted in a series of sweeping meanders, with meander amplitudes >1 km in width common, the largest reaching about 1.8 km in width. In terms of estimating thicknesses of this meander belt, the Holocene meander belts, and the braided Pleistocene deposits, we consider a valley-fill thickness map based upon interpretations of data from numerous wells throughout the Roswell artesian basin by Lyford (1973). This map depicts the valley fill thickness dropping from approximately 30 m on the western valley margin to < 1 m to the east. Based upon this fact that the meander belts are built on a wedge of Pleistocene braided alluvial valley fill, present at the surface aside hmp2 and buried with a ~30-m base alongside the western bluffs, the thickness of hmp1 ranges from <1 m to 3-10 m where it overlies Holocene meander belts, and up to15 m where it buries *Qabp*. Unit occupies areas mapped as *Qfly* on first version of the Bottomless Lakes preliminary geologic map (v1p-00, May 2006).

Hmp2 — **Younger Holocene meander belt deposits (Historic to upper Holocene)** — Very pale brown (10YR7/4) to reddish brown (2.5YR4/6), unconsolidated, moderately to well sorted, occasionally pebbly, coarse- to fine-grained sand, silty sand, and sandy clay. Meander geometries are similar to hmp1, and while much of this is obscured by more recent meander belt deposition and/or agriculture, amplitudes are estimated to average about 1 km in width with one amplitude of about 2 km in width. Thickness 3-10 m. Unit occupied areas mapped as *Qfly* on the preliminary geologic map of the Bottomless Lakes quadrangle (v1p-00, May 2006).

Hmp1 — **Older Holocene meander belt deposits (upper Holocene to lower (?) Holocene)** — Very pale brown (10YR 7/4) to reddish brown (2.5YR4/6), unconsolidated, well sorted, fine-grained, gypsiferous sand, silty sand, and sandy clay. Meander geometries are significantly smaller with meander amplitudes averaging only 0.5 km in width. It appears that this meander belt was first to develop, switching the river from flowing in a braided, coarser-grained *Qabp* floodplain into a small meandering stream, which probably co-existed with active *Qabp* channels throughout much of the lower Holocene. Thickness <1 to 3 m. Unit occupies areas mapped as *Qfly* and *Qflo* on the preliminary geologic map of the Bottomless Lakes quadrangle (v1p-00, May 2006).

Qdp — **Pecos River channel alluvium occupying coalescing depressions (middle Holocene to uppermost Pleistocene)** — Light reddish-brown (5YR 6/4) to reddish brown (2.5YR4/6), unconsolidated, well sorted, fine-grained, gypsiferous sand, silty sand, and clay thinly draped over the floor of depressions developed primarily in gypsum. Forms the lowest inset fluvial deposit of the Pecos floodplain. The timing of the collapse or subsidence of the depressions is unknown, but their capture of the Pecos River is constrained to lower Holocene – uppermost Pleistocene prior to *Hmp1* development and probably in the waning phases of active *Qabp* deposition. This is clear because the tributary Rio Hondo built two lower to middle Holocene meander belts (*Hmh1* and *Hmh2*) across *Qabp*. *Hmh1* and *Hmh2* are clearly distinguished from any meandering Pecos River deposit by differing lithologies, sediment chararacteristics, and especially meander geometries (Rio Hondo meanders are an order of magnitude smaller than those of the Pecos), and are clearly visible in aerial photos completely crossing the Pecos floodplain to the eastern margin, where it joined the Pecos in its *Qdp* channel. While *Qdp* flows could have occurred concurrently in the depression channel(s) and parts of *Hmp1*, it was not until an avulsion occurred upstream during the middle Holocene, which caused *Hmp1* to build out across *Hmh1* and *Hmh2* in the vicinity of the historic meander belts, thereby cutting these lower belts off and causing the Rio Hondo to develop *Hmh3* to the south and west. Pecos River alluvium is very thin in these channels (<1 to 2 m thick) and very little bank or bar formation occurred while *Qdp* was active. Thickness 3-10 m. Unit occupies areas mapped as *QHps* and *Qafs* on the preliminary geologic map of the Bottomless Lakes quadrangle (v1p-00, May 2006).

View to north-northwest of three coalescing collapse depressions with braided Pecos River alluvium in between. This alluvial channel is early Holocene - latest Pleistocene in age when the collapses captured the Pecos River, causing it to flow directly below the Seven Rivers bluffs. The hill on the skyline, Comanche Hill, is the location from which the panorama below was photographed.

Qdbp — **Pecos River channel braided alluvium associated with coalescing depressions (middle Holocene to uppermost Pleistocene)** — Light reddish-brown (5YR6/4) to reddish brown (2.5YR4/6), unconsolidated, poorly to moderately sorted, pebbly coarse- to fine-grained sand, silty sand, sandy clay, and clay. Braided channels and bars are common on the surface. Deposits primarily extend between *Qdp* depressions formed during flood events. Thickness 3-10 m. Unit occupies areas mapped as *QHps* and *Qafs* on the preliminary geologic map of the Bottomless Lakes quadrangle (v1p-00, May 2006).

Qcbp — **Pecos River crevasse-splay alluvium debouching from Pecos River depression channel alluvium (middle Holocene to uppermost Pleistocene)** — Light reddish-brown (5YR6/4) to reddish brown (2.5YR4/6), unconsolidated, poorly to moderately sorted, pebbly coarse- to fine-grained sand, silty sand, sandy clay, and clay. Braided channels, bars, and crevasse splay lobes are common. Deposits formed during flood events when *Qdp* depressions and *Qdbp* channels were breached and when the Pecos River abandoned the eastern depression course and built *Hmp1* and *Hmp2*. The extensive *Qcbp* deposits south and west of Comanche Draw are capped by Commanche Draw *Qa* alluvium. Thickness 3-10 m. Unit occupies areas mapped as *Qafs* on the preliminary geologic map of the Bottomless Lakes quadrangle (v1p-00, May 2006).

Qabp — **Pecos River braided alluvial deposits (lower Holocene to upper Pleistocene)** — Light reddish-brown (5YR6/4) to reddish brown (2.5YR4/6), unconsolidated, poorly to moderately sorted, pebbly coarse- to fine-grained sand, silty sand, sandy clay, and clay. Braided channels and bars typify the surface of *Qabp*. As discussed above, the thickness of *Qabp* is greatest on the western margin of the floodplain, although buried, varies from 10 - 20 m. Large areas of *Qabp* are found on the floodplain surface in the center and eastern margins of the valley, here the thickness varies from 3 m to <1 m. Unit primarily occupies areas mapped as *Qflo* and *Qafs* on the preliminary geologic map of the Bottomless Lakes quadrangle (v1p-00, May 2006).

Qbs — **Floodplain alluvial backswamp deposits (Historic to upper Pleistocene)** — Light gray (2.5Y7/1) to very dark gray (7.5YR3/1), unconsolidated, well-sorted, gypsiferous silty sand, sandy clay, and clay in low-lying, poorly drained areas below the bluffs of the Lakewood terrace. These areas commonly only receive fine-grained, slack-water flood deposition. Thicknesses range from 3-15 (?) m. Unit occupies areas mapped as *Qflo* on the preliminary geologic map of the Bottomless Lakes quadrangle (v1p-00, May 2006).

Rio Hondo alluvium

Rio Hondo meander belt alluvial deposits (Holocene) — Gravels of limestone, sandstone, and igneous rocks in brown (10YR5/3) to dark yellowish brown (10YR3/4), unconsolidated, moderately sorted, coarse- to fine- grained sand, silty sand, silt (largely calcareous), and sandy clay. At the onset of the Holocene, both the Pecos River and the Rio Hondo began meandering, building meanderbelts. The earliest two Rio Hondo meanderbelts built across the entire Pecos River floodplain (*Qabp* deposits) during the early to middle Holocene, due to the fact that the Pecos River occupied collapsed karstic depressions along the eastern margin at this time (*Qdp and Qbdp* deposits) (McCraw, *et al.*, 2007). Responding to an avulsion of the Pecos River in the middle Holocene on the Bitter Lake quad, the Rio Hondo abandoned these meanderbelts and was forced to turn south along the western edge of the floodplain, building a third, modern (*Hmh3)* meanderbelt on the Bitter Lake quad. While meander geometries are essentially identical between all three Hondo meander belts, *Hmh1* certainly exhibited the widest lateral migration (although not necessarily widest meander amplitude). Units occupy areas mapped as *Qflo* on the preliminary geologic map of the Bottomless Lakes quadrangle (v1p-00, May 2006).

Hmh2 — **Young meander belt deposits (middle Holocene)** — As described above, the two oldest Hondo meander belts (*Hmh1* and *Hmh2*) built up on top of both upper Pleistocene Rio Hondo braided alluvium (*Qabh*) and upper Pleistocene Pecos braided alluvium (*Qabp, Qdbp*),with *Hmh2* often building on top of *Hmh1*. Thickness 1-3 m.

Hmh1 — **Older Holocene meander belt deposits (middle Holocene to lower (?) Holocene)** — Thickness 1-3 m.

Rio Hondo alluvial fan complex deposits

Rio Hondo alluvial fan lobe deposits (upper Pleistocene to lower Pleistocene) — During most of the Pleistocene, the Rio Hondo debouched from the western uplands into the Pecos valley south of its current location. It flowed from approximately latitude 33° 17' 30" N, roughly due east through what is now known as Rocky Arroyo onto the valley floor, three quads west of the Bottomless Lakes quad. From here, it built a very large alluvial fan complex out over Pleistocene Pecos River terraces. It prograded east until a stream capture occurred within the western uplands, sometime in the upper Pleistocene. This capture, located at the current site of the dry Twin Rivers reservoir, on the Hondo Reservoir 7.5-minute quad, turned the Rio Hondo northeast into its present channel and cut off fluvial and sediment input to the distal reaches of its fan complex in both the South Spring and Bottomless Lakes quads (McCraw, 2008).

On the South Spring quad, four distinct fan lobes are mapped, prograding east to northeast (*Qahf1-4*). The distal reaches of the two youngest fan lobes (*Qahf4* and *Qahf3*) reach the westernmost part of the Bottomless Lakes quad. These are comprised of sands and a few gravels with a distinct petrographic Rio Hondo signature. While limestone, sandstone, and chert, could've originated anywhere within the Sacramento Mountains and along its eastern flanks, the porphyritic igneous, mafic igneous, and rhyolitic gravels common throughout these deposits could only have originated from Sierra Blanca, the headwaters of the Rio Hondo. These gravels are supported by a matrix of brown (10YR5/3) to dark yellowish brown (10YR3/4), unconsolidated, moderately sorted, coarse- to fine- grained sand, silty sand, silt (largely calcareous), and sandy clay. Pedogenic carbonate varies from stage II to I, west to east and northeast for these youngest fan lobes. These units were incorrectly mapped collectively as the Orchard Park alluvial terrace (*Qopt*) on the preliminary geologic map of the Bottomless Lakes quadrangle (v1p-00, May 2006).

Qahf4 — **Youngest Rio Hondo alluvial fan lobe deposits (upper Pleistocene)** — Thickness 1 to 3 m.

Qahf3 — **Younger Rio Hondo alluvial fan lobe deposits (upper Pleistocene)** — Thickness 1 to 4 m.

Qahc, Qahd — **Rio Hondo alluvial fan channel deposits (Holocene to upper Pleistocene)** — The Rio Hondo alluvial fan complex contains numerous alluvial channel deposits, ranging from old, abandoned channels to historic ephemeral streams (formerly perennial – artesian spring-fed). Only the youngest (equilavent to *Qahc3* on the South Spring quad) were mapped on the Bottomless Lakes quad. These channel sediments are usually comprised of brown (10YR5/3) to dark yellowish brown (10YR3/4), unconsolidated, moderately sorted, coarse- to fine-grained sand, often containing clay drapes, with occasional gravels of limestone, sandstone, and igneous rocks and are slightly inset into alluvial fan lobe deposits. At their distalmost ends, the often form a "deltaic" distributary fan complex (*Qahd*). These units were incorrectly mapped as the Orchard Park alluvial terrace (*Qopt*) on the preliminary geologic map of the Bottomless Lakes quadrangle (v1p-00, May 2006).

Alluvial terrace deposits

Lakewood terrace alluvial deposits (upper to middle Pleistocene) — 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. The Lakewood terrace, with an elevation of 6 to 9 m above the floodplain, flanked the inset Pecos floodplain and extended up many of its western tributaries. We now recognize three distinct low-lying (upper to uppermost middle(?) Pleistocene) "Lakewood terraces," the highest and oldest of which would be Fiedler and Nye's original (McCraw, *et al.*, 2007; McCraw, 2008). Surface tread elevations above the floodplain for these three are: <1-1 m, 1.2-6 m, and 6-9 m, respectively. We differentiate these terraces by their location either in the Pecos valley, in the tributary valleys of the Rio Hondo and Borrendo Creek on the Bitter Lake quad west of the Pecos valley, and in the Comanche Draw valley east of the Pecos valley. All of the Pecos valley Lakewood terrace deposits vary between: 1) the west side, with light gray (2.5Y7/1) to very pale brown (10YR7/4) to reddish brown (2.5YR4/6), unconsolidated, well-sorted, medium- to fine-grained gypsiferous sand, silt, and sandy clay, and 2) the east side, made up of light reddish-brown (5YR6/4) to reddish brown (2.5YR4/6), unconsolidated, moderately sorted, pebbly, fine-grained, gypsiferous sand, silty sand, and clay. Mostly non-gypsiferous. These units were incorrectly mapped collectively as the Orchard Park alluvial terrace (*Qopt*) on the preliminary geologic map of the Bottomless Lakes quadrangle (v1p-00, May 2006).

Qlt3 — **Youngest Lakewood terrace alluvial deposits (upper Pleistocene)** — Thickness <1 to 1 m.

Qlt2 — **Young Lakewood terrace alluvial deposits (upper Pleistocene)** —Thickness 1.5 to 5 m.

Qlt1 — **Older Lakewood terrace alluvial deposits (upper to middle Pleistocene)** —Thickness ~2 to 9 m.

Depression and sinkhole deposits

Qd — **Quaternary depression fill, primarily caused by subsidence (Historic to middle Pleistocene)** — Unconsolidated, 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 gypsiferous carbonate terrane. These complexes are 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. Unit occupies areas mapped as *QHsf,* where they were mapped, on the preliminary geologic map of the Bottomless Lakes quadrangle (v1p-00, May 2006).

Qds — **Quaternary sinkhole deposits, primarily caused by collapse (Historic to middle Pleistocene)** — Eastern bluffs: boulders, slump blocks, gravel, sand, silt, and clay filling dry sinkholes derived from local collapse of Psr. Thickness unknown, probably 1-5 m for smaller sinks, quite likely several tens of meters for the larger ones (predominantly on the Commanche Spring quad to the east). Western terraces: occasional cobbles, gravel, and slumped gypsite blocks in a fine-grained sandy clay matrix. Most are submerged beneath the water table. Thickness <1 to 5 (?) m. Unit occupies areas mapped as *QHsf,* where they were mapped, on the preliminary geologic map of the Bottomless Lakes quadrangle (v1p-00, May 2006).

MESOZOIC SEDIMENTARY ROCKS

T̶Rsr — **Santa Rosa Formation (upper Triassic) —** Unit not observed in the field due to difficulty of land access; mapped with aerial photos and projections of the top of the Yates formation from well logs. The outcrop pattern is defined by a series of low hills (< 50 feet high) along the eastern margin of the quadrangle, and is in general agreement with Kelley (1971). Exposures appear to be poor, with abundant alluvial and eolian cover. Kelley (1971) described exposures approximately 20 miles to the north as composed of grayish to reddish brown thick-bedded sandstones and subordinate red, brown, and variegated mudstone. Lucas and Anderson (1993) described exposures at Mesa Diablo, seven miles to the north, as grayish-red and pale reddish-brown micaceous sandstones, siltstones and mudstones with subordinate yellowish- and greenish-gray conglomerates. Thickness: Top not exposed; probably <40 m based on cross-section.

PALEOZOIC SEDIMENTARY ROCKS

Pemian Artesia Group

Py — **Yates Formation (Guadelupian - upper Permian) —** Unit not observed in the field due to difficulty of land access and poor exposure. Unit forms a broad bench across the central portion of the quadrangle. Mapping was performed with aerial photos and projections from well logs. Surface expression (soil texture and vegetation patterns) on aerial photographs allows differentiation from both the underlying Seven Rivers Formation and overlying Santa Rosa formation, although unit is largely obscured by sand sheets and small, stabilized dunes. Generally described by Kelley (1971) as gypsum, dolomite, and fine-grained, thin-bedded sandstone. Further south in the Lake McMillan area, its described by McCraw and Land (2008) and Dehler, *et al*. (2005) as very light gray, massive to vesicular gypsum interbedded with pink dolomite, green to white and orange to red siltstone and minor sandstone. Folded into domes and basins on a meter to several decimeter scale. Thickness: Top not exposed; probably <50 m based on cross-section.

Psr — **Seven Rivers Formation (Guadelupian - upper Permian) —** White to pale gray gypsum, brick red, pale red, to orange very fine sandstone, siltstone, and mudstone, and minor limestone. Gypsum comprises up to 90% of the unit in the area of Bottomless Lakes State Park. Towards the north edge of the quadrangle, gypsum content decreases to ~ 75%, with concomitant increase in clastic interbeds. Bedding is irregular and highly variable along eastern Pecos River bluffs due to sinkhole formation, associated dissolution and collapse, and rotated slump and landslide blocks. Gypsum beds are thin- to thick- to very thick-bedded, and massive to thin-bedded to laminated internally. Red outcrop color is due to surface wash from the clastic interbeds. These clastic layers often have veins of gypsum. Bedding is irregular and highly variable where gypsum content is high. As gypsum content decreases, bedding comes thinner and more planar, with less development of collapse features and slumping. Thickness: Top not exposed; at least 75 m based on cross-section.

Pqg — **Queen and Grayburg Formations, undivided (Guadelupian - upper Permian)** — cross section only.

Panoramic view to the south-southeast of two collapse depressions and the early Holocene - lastest Pleistocene Pecos River alluvial channel taken from Comanche Hill. Warped beds of primarily Permian Seven Rivers Formation gypsum can be seen in the bluffs to the left. The trees in the far distance to the right follow early Holocene meandering Rio Hondo channels, which were deposited when the Rio Hondo flowed across the entire Pecos floodplain to reach the Pecos River.

Warped gypsum beds of Permian Seven Rivers Formation ring the 10.5 m-deep Devil's Inkwell, named for its steep sides and dark water resulting from a higher algal concentration relative to the other sinkhole lakes in the state park.

Other Pemian Sedimentary Rocks

Psa — **San Andres Formation (middle to upper Permian) —** cross section only on the Bottomless Lakes quad. Two small outcrops are mapped approximately 4.5 to 5 km west of the Pecos floodplain on the Bitter Lake quad as the Artesia Group pinches out to the west.

Pya — **Yeso Formation and Abo formation, undivided (lower to middle Permian) —** cross section only.

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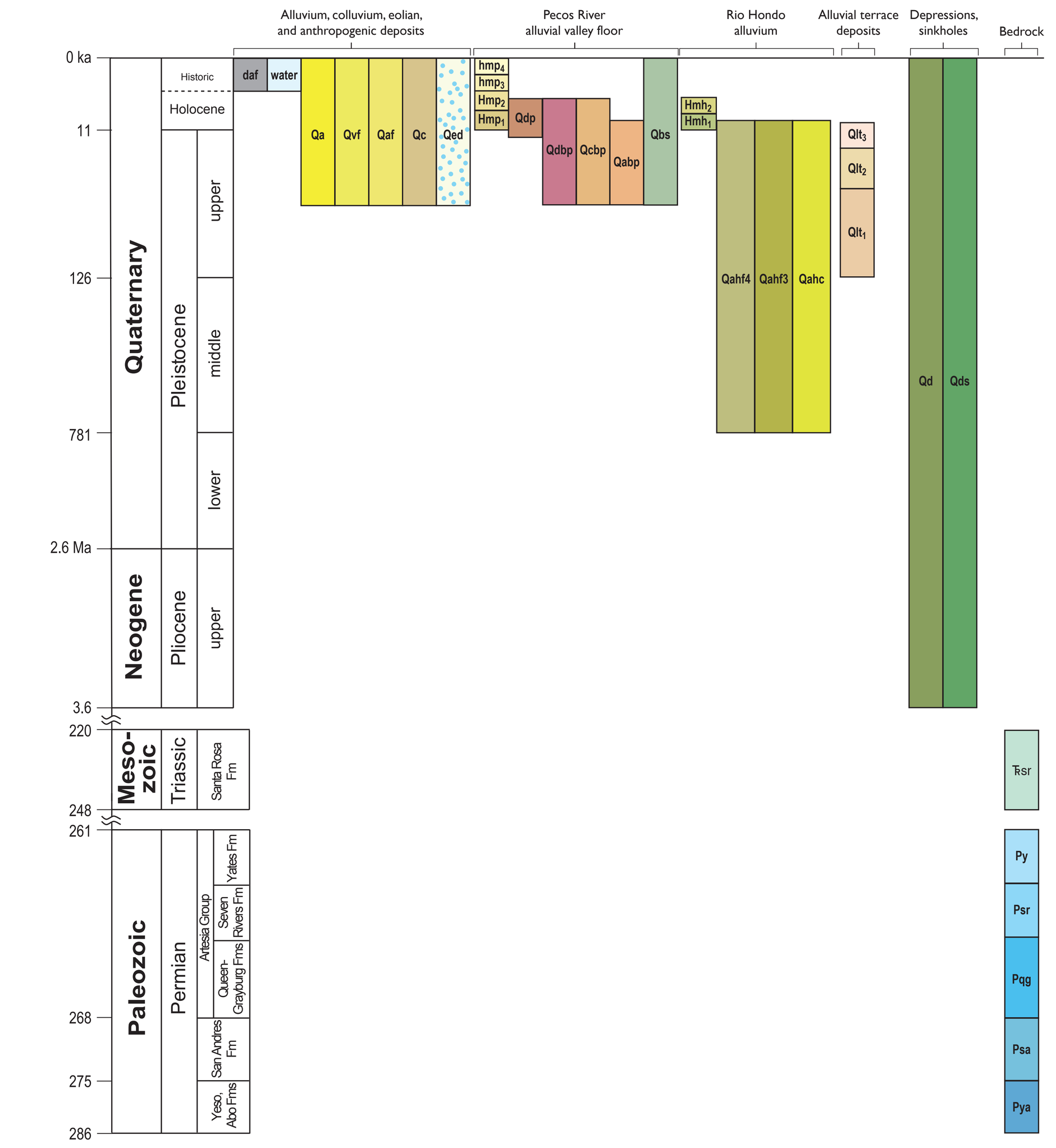
CORRELATION OF MAP UNITS



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, 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 associated with recent development may not be shown.

Cross sections are constructed based upon the interpretations of the author made from geologic mapping, and available geophysical, and subsurface (drillhole) 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 man-made structures.