GEOLOGIC MAP OF THE HUACHUCA CITY 7½' QUADRANGLE, COCHISE COUNTY, ARIZONA

Philip A. Pearthree and Ann Youberg

Arizona Geological Survey Digital Geologic Map 36 (DGM-36), version 2.0

April 2009

1:24,000 scale

Citation for this map:
Pearthree, P.A., and Youberg, A., 2009, Geologic Map of the Huachuca City 7½' Quadrangle, Cochise County, Arizona: Arizona Geological Survey Digital Geologic Map 36 (DGM-36), version 2.0, 1 sheet, layout scale 1:24,000.

(also available in Adobe pdf format on CD-ROM)

Not to be reproduced for commercial purposes

Research supported by the U.S. Geological Survey, National Cooperative Geologic Mapping Program, under USGS award #02HQAG0016. 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 the U.S. government. The Arizona Department of Water Resources provided funding for map revisions depicted in DGM-36, version 2.0.

Acknowledgements:
Genevieve Pearthree was the cartographer for DGM-36, version 2.0.

Map Unit Descriptions

Other units

Plowed areas - Historically or actively plowed fields, irrigated pastures, and other lightly disturbed ground.

d — **Disturbed ground** - Profoundly disturbed areas, including aggregate excavations and intensively developed trailer parks that completely obscure the underlying geologic units.

Babocomari River alluvium

Qyr' — **Active river channel deposits** - Deposits are dominantly unconsolidated, very poorly sorted sandy to cobbly beds exhibiting bar and swale microtopography but can range from fine silty beds to coarse gravelly bars in meandering reaches based on position within the channel. Clasts are typically well-rounded but may be angular to sub-angular. Qycr deposits are typically unvegetated to lightly vegetated and exhibit no soil development. Qycr deposits are entrenched from 30 cm to 10 meters or more below adjacent early historical floodplain deposits depending on location, geomorphic relationship, and local channel conditions. Although much of the Babocomari River was a perennial stream historically, some sections are dry or marshy at the surface during much of the year. These deposits are the first to become submerged during flow events and can be subject to deep, high velocity flow and lateral bank erosion. In some areas of the Babocomari River channel deposits are very thin to discontinuous exposing underlying bedrock. Extent of channel deposit and exposed bedrock varies and shifts with significant flooding.

Qyr — **Historical river terrace deposits** - Terrace deposits that occupy elevations from 1 to 2 meters above Qycr deposits and are inset below the pre-incision historical floodplain. These surfaces are generally planar but exhibit bar and swale microtopography. Although no soil development is present, dense grasses and small mesquite trees abound. Sediments composing these deposits are poorly sorted silt, sand, pebbles and cobbles. Pebbles and cobbles are well-rounded to sub-angular. Trough crossbedding, ripple marks, and stacked channel deposits viewable in cross-section indicate deposition in a low to moderate energy braided stream environment. These deposits are prone to flooding during extreme flow events, and undercutting and rapid erosion of Qy3r surfaces is possible during lower flow events.

Qyyr — **Latest Holocene to historical river deposits** - Deposits associated with the floodplain that existed prior to the early historical entrenchment of the Babocomari River (Hereford, 1993; Huckleberry, 1996; Wood, 1997). Qy2r deposits are associated with broadly planar surfaces that locally retain the shape of historical river meanders. Qy2r surfaces are up to 7 meters above modern Qycr deposits and are the most extensive river terraces in the valley. Qy2r sediments were deposited when the San Pedro and Babocomari Rivers were widespread, shallowly-flowing river systems and are dominated by fine grained floodplain deposits. Dense mesquite bosque and tall grass is typically present on these surfaces except where historic plowing or grazing has taken place. These surfaces appear predominantly fine grained at the surface due in part to the input of organic matter and windblown dust deposition but are composed of interfingering coarse sandy to pebbly braided channel and fine sand to silty river floodplain deposits. Where Qy2r deposits are moderately to deeply incised they are not subject to inundation by river floods, but they may be flood-prone in areas with less channel incision. Qy2r deposits are subject to catastrophic bank failure due to undercutting and lateral erosion during flow events. Distal piedmont fan deposits (Qy2 ,Qyaf, and Qys) onlap onto Qy2r deposits although an interfingering relationship likely exits in the subsurface.

Qy1r — **Late to early Holocene river terrace deposits** - Deposits associated with slightly higher terraces that represent either higher elements of the early historical floodplain or remnants of older Holocene aggradation periods. These fine-grained terrace deposits commonly have been disturbed by plowing or cattle grazing. When undisturbed, Qy1r deposits are densely vegetated by mature mesquite trees (mesquite bosque) and tall grasses. Soil development is moderate and surface color ranges from 10 to 7.5 YR 4/4. Due to the dense vegetation, input of organic matter at the surface often results in a thin (< 10 cm) organic soil horizon. A light dusting (incipient stage I) calcium carbonate accumulation is evident on the undersides of some buried clasts. Qy1r surfaces are up to 7 m above the active channel in highly incised locales and typically are less than 1.5 m higher than adjacent Qy2r surfaces. Along the Babocomari River Qy1r terraces are found along the valley margins. These terraces typically are covered with fine-grained floodplain deposits, but relict gravel bars and lenses are common.

Qi3r — **Late Pleistocene river terrace deposits** - Unit Qi3r consists of remnant river terrace deposits. These terraces are typically 5 to 10 m above the active channel, and in a few areas it is clear that this unit encompasses two terraces separated by a few meters of elevation. Qi3r deposits consist of cobbles, gravels and finer-grained sediment. Qi3r surfaces commonly have loose, open lags of cobbles and gravels; surface clasts exhibit weak rock varnish. Qi3r surfaces appear light orange on color aerial photos, reflecting slight reddening of surface clasts and the surface soil horizon. Qi3r soils are moderately developed, with orange to reddish brown sandy loam to clay loam argillic horizons and stage II calcium carbonate accumulation.

Qi2r — **Middle to late Pleistocene river terrace deposits** - Higher intermediate terraces about 10 to 15 m above the Holocene floodplain of the Babocomari River. Terrace surfaces typically are fairly smooth to sloping remnants perched on eroded St. David Formation deposits. Terrace deposits are a mix of river sand, gravel, silt, and clay, but surfaces typically are covered with relict gravel deposits. Soil development is moderate because surfaces are not extensive, consisting primarily of weak clay accumulation and 5 YR reddening and stage II to III calcic horizons.

Qi1r — **Early to middle Pleistocene river terrace deposits** - Unit Qi1r consists of higher remnant river terrace deposits. These terraces are typically about 30 m above the active channel. Qi1r deposits consist of cobbles, gravels and finer-grained sediment. Qi1r surfaces commonly have loose, open to moderately packed cobbles and gravel surface lags; surface clasts exhibit moderate rock varnish. Qi1r surfaces appear in orange color aerial photos, reflecting reddening of surface clasts and the surface soil horizon. Soils typically contain reddened, clay argillic horizons, with obvious clay skins and subangular to angular blocky structure. Underlying soil carbonate development is typically stage III, with abundant carbonate through at least 1 m of the soil profile.

Piedmont alluvium and surficial deposits

Qyc — **Modern stream channel deposits** - Unit Qyc consists of deposits in active channels of the larger tributary drainages. Channel deposits are mapped where they are extensive enough to represent at 1:24,000 scale. They were outlined using the 1997 digital orthophotos for the Huachuca City quadrangle. Deposits are composed primarily of sand, pebbles, cobbles; and small boulders. Locally channels are incised as much as 2 to 3 meters below adjacent Holocene terraces (unit Qy), but in other areas there is no incision. Channels consist of single, relatively large channels and smaller branching channels in areas of channel expansions. Local relief within channels varies from minimal to more than 1 meter between low-flow channels and adjacent gravel bars.

Qy3 — **Latest Holocene alluvium** - Recently active piedmont alluvium located primarily along active drainages including floodplain, low-lying terrace, and intermittent tributary channels. Qy3 deposits are composed of unconsolidated to very weakly consolidated sandy to pebbly deposits and exhibit greater vegetation than Qyc deposits. These deposits generally exhibit bar and swale microtopography and are susceptible to inundation during moderate to extreme flow conditions when channel flow exceeds capacity. Soil development is generally absent or incipient on Qy3 deposits which exhibit pale buff to light brown (10 YR) surface coloration.

Qy2 — **Late Holocene alluvium** - Young deposits in floodplains, low terraces and small channels that are part of the modern drainage system. Along the larger drainages, unit Qy2 sediment is generally poorly to very poorly sorted silt, sand, pebbles, and small cobbles; floodplain and terrace surfaces typically are mantled with sand and finer sediment. On lower piedmont areas and in smaller tributary washes young deposits consist predominantly of moderately sorted sand and silt, with some pebbles and cobbles in channels. Soils are pale brown in color (10 YR), and soil development is very weak, consisting of slight carbonate accumulation. Channels generally are incised less than 1 m below adjacent terraces, but locally incision may be as much as 2 m. Channel morphologies generally consist of a single-thread high flow channel or multi-threaded low flow channels with gravel bars adjacent to low flow channels. Channels are flood prone and may be subject to deep, high velocity flows in large flow events. Potential lateral bank erosion is severe, and flood flows may significantly change channel morphology and flow paths. Local relief varies from fairly smooth channel bottoms to undulating bar-and- swale topography that is characteristic of coarser deposits. Terraces have planar surfaces, but small channels are common.

Qy1 — **Older Holocene alluvium** - Qy1 deposits consist of terraces along tributary drainages and broad, low-relief, undulating fan deposits that exhibit shallow widespread braided drainage patterns and sit higher in the landscape than younger Holocene alluvium. Overall relief between broad fan crests and incised drainages on gently rolling Qy1 deposits typically does not exceed 1.5 meters. Numerous shallow braided channels drain widespread portions of Qy1 surfaces. Qy1 deposits exhibit incipient calcium carbonate accumulation (stage I) and soil development characterized by medium brown (10-7.5 YR) coloration where unincised.

Qys — **Fine-grained Holocene alluvium derived from the St. David Formation** - Thin, fine-grain Holocene alluvial deposits mantling valley bottoms. Sediment is mainly clay, silt and sand, with occasional deposits of open, unvarnished, fine gravel. Soil development is minimal. Where it has developed soil is typically a brown (7.5YR) sandy loam with substantial disseminated carbonate but no visible carbonate accumulation.

Qyi — **Holocene to late Pleistocene alluvial fan and terrace deposits** - Mixed fine-grained Holocene (Qy) and Pleistocene (Qi2 or Qi3) alluvium. In some areas, surficial deposits are primarily Holocene, but these deposits are quite thin and some Pleistocene deposits are exposed along channels. In other areas, surficial deposits are primarily Pleistocene but there are Holocene deposits in topographically low areas.

Qy — **Holocene alluvium undifferentiated** - Unit Qy consists of young deposits in undivided small channels, floodplains, low terraces, and alluvial fans on the upper piedmont. Deposits vary widely in particle size. Qy deposits on the upper piedmont and along major tributaries are very coarse, including boulders, cobbles, pebbles, sand, and minor silt and clay. Farther downslope, Qy deposits are fine, consisting mainly of sand and silt, with minor fine gravel and clay. Small channels generally are incised less than 1 m below adjacent Qy terraces and fans. Channel morphologies generally consist of a single-thread channel or multi-threaded channels, with local distributary channel systems. Local relief on Qy deposits varies from fairly smooth channel bottoms to the undulating bar-and-swale topography that is characteristic of coarser deposits. Terrace surfaces typically are planar, but small channels are also common on terraces. Soil development associated with Qy deposits is weak to moderate. Soil clay accumulation is minimal, and calcic horizon development is typically stage I (see Machette, 1985, for description of stages of calcium carbonate accumulation in soils). Terrace and fan surfaces are brown, and on aerial photos they generally appear darker than surrounding areas, whereas sandy to gravelly channels appear light-colored on aerial photos.

Qi3 — **Late Pleistocene alluvial fan and terrace deposits** - Unit Qi3 consists of deposits associated with moderately dissected terraces and small relict alluvial fans found on the upper, middle and lower piedmont. It also includes some deposits on toeslopes of dissected ridges in the Babocomari Valley. Moderately well developed, moderately incised tributary drainage networks are typical on Qi3 surfaces. Active channels are less than 5 meters below Qi3 surfaces. Qi3 fans and terraces are lower in elevation than adjacent Qi2 and older surfaces, but elevation differences are minimal in some places. Qi3 deposits generally consist of pebbles, cobbles, and finer-grained sediment. Qi3 surfaces commonly have loose, open lags of pebbles and cobbles; surface clasts exhibit weak rock varnish. Qi3 surfaces appear orange on color aerial photos, reflecting slight reddening of surface clasts and the surface soil horizon. Qi3 soils are moderately strongly developed, with orange to reddish brown clay loam to light clay argillic horizons and stage II calcium carbonate accumulation.

Qi2 — **Middle to late Pleistocene alluvial fan and terrace deposits** - Unit Qi2 consists of moderately dissected relict alluvial fans and terraces with strong soil development found throughout the map area. Qi2 surfaces are drained by well-developed, moderately to deeply incised tributary channel networks; channels are typically several meters to as much as 10 m below adjacent Qi2 surfaces. Qi2 deposits typically consist of sand, pebbles and cobbles. Qi2 surfaces are characterized by scattered cobble to boulder lags with moderate to strong varnish. Well-preserved, planar Qi2 surfaces are smooth with scattered pebble and cobble lags; surface color is reddish brown and rock varnish on surface clasts is typically orange or dark brown. More eroded, rounded Qi2 deposits are less clay-rich and have some carbonate litter on the surface. Well-preserved Qi2 surfaces have a distinctive bright red color on color aerial photos, reflecting reddening of the surface soil and surface clasts. Soils typically contain red clay argillic horizons, with obvious clay skins and sub-angular to angular blocky structure. Underlying soil carbonate development is typically stage II to III, with abundant carbonate to depths of at least 1.5 m in the soil profile, but indurated petrocalcic horizons were not observed.

Qi1 — **Early to middle Pleistocene alluvial fan and terrace deposits** - Unit Qi1 consists of deposits associated with deeply dissected relict alluvial fans with variable soil development. Qi1 surfaces are drained by well-developed, deeply incised tributary channel networks. Surfaces vary from well rounded with few planar remnants of the original deposition surfaces to quite well-preserved, planar fan remnants. Qi1 surfaces are typically 5 to 20 meters above adjacent active channels. Qi1 deposits are not well-exposed, but probably consist primarily of pebbles, cobbles, sand, silt and clay. Where Qi1 surfaces are fairly well preserved, they are smooth with pebble and cobble lags; rock varnish on surface clasts is typically orange to red. Soil carbonate development is variable, but typically is stage III. Where surfaces are well preserved, soils typically contain dark red, clay loam argillic horizons, with obvious clay skins and sub-angular blocky structure. More eroded Qi1 surfaces are characterized by loose cobble lags with moderate to strong varnish, ridge-and-valley topography, and carbonate litter on the side slopes. On aerial photos, ridge crests on Qi1 surfaces typically are dark reddish brown, reflecting reddening of the surface soil and surface clasts, and eroded slopes are gray to white.

Qo — **Early Pleistocene alluvial fan deposits** - Unit Qo consists of deeply incised and degraded alluvial fan deposits with strong calcic horizon development. Qo deposits are composed of matrix supported carbonate cemented conglomerate with cobbles of limestone, sandstone and fine-grained volcanic rock. Qo deposits are eroded and dissected by deeply incised channels locally, but their margins are buried by younger deposits. The surface is covered with carbonate fragments and cobbles that have pendants of secondary carbonate. Calcic horizons are extremely well developed, with massively cemented stage V to VI secondary carbonate. Qo represents the oldest preserved alluvial fan complex in the mapped area; although the base of the Qo deposits is not exposed, they probably rest on top of the proximal fan facies of the St. David Formation.

Qof — **Early Pleistocene fine-grained basin-floor alluvium** - Unit Qof consists of very old relict basin floor deposits forming a minimally dissected surface that dips gently to the northeast in the northeastern part of the map area. The Qof surface is brown in color, with abundant carbonate litter derived from the underlying petrocalcic horizon. Surface deposits are primarily sand and silt, with little or no gravel. Exposures around the margins of the plateau reveal the existence of a ~1 to 2 m thick carbonate cemented layer that is probably a petrocalcic horizon. Small, incised swales evidently convey surface runoff across this surface, and deposits ranging in age from Holocene to middle Pleistocene appear to lap onto the Qof surface from the Whetstone-Mustang piedmont. Qof deposits in this area sit immediately above basin-fill deposits, probably the middle St. David Formation (Shipman and Ferguson, 2003).

QTsd — **Pliocene to early Pleistocene St. David Formation** - Unit QTsd consists primarily of hillslope deposits formed on fine, highly eroded basin-fill deposits. QTsd surfaces typically are alternating eroded ridges and valleys, with ridgecrests typically 10 to 30 meters above adjacent active channels. Surfaces are drained by deeply incised tributary channel networks and even the highest surfaces atop ridges are rounded. QTsd deposits typically are covered by hillslope colluvium and are poorly exposed, but where exposed they consist of tan to reddish sand and gravel in parts of the Huachuca piedmont and red and green mudstones, siltstones and marl, with some gypsiferous beds in the Babocomari Valley. Some beds are moderately indurated, but generally QTsd deposits are weakly indurated. On aerial photos, QTsd surfaces are generally gray to white, but include some dark reddish brown areas where clay is more abundant. QTsd surfaces support creosote, mesquite, ocotillo, and cholla.

Bedrock units

Kbl? — **Limestone of the Cretaceous Bisbee Group (?)** - A sequence of thin- to mediumbedded, gently northwest-dipping gray limestone, locally finely laminated. Some chert concretions and quartz veins, and locally abundant dark shell hash. Nearby limestone outcrops mapped in the Mustang Mountains include Colina Limestone and Horquilla Limestone of the Naco Group and Bisbee limestone (Hayes and Raup, 1968); characteristics of limited outcrop seem to fit Bisbee limestone best.

MN
10½°
2006 MAGNETIC NORTH DECLINATION

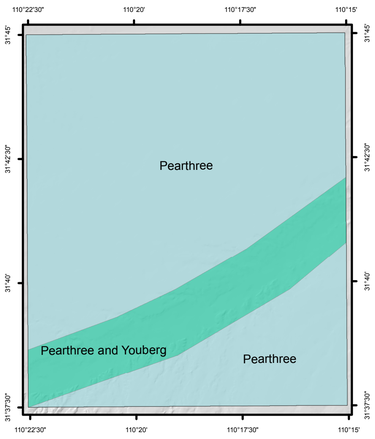
SCALE 1:24,000

1 0.5 0 1 Miles
1 0.5 0 1 Kilometers
0 1000 2000 3000 4000 5000 Feet
Contour Interval 25 feet

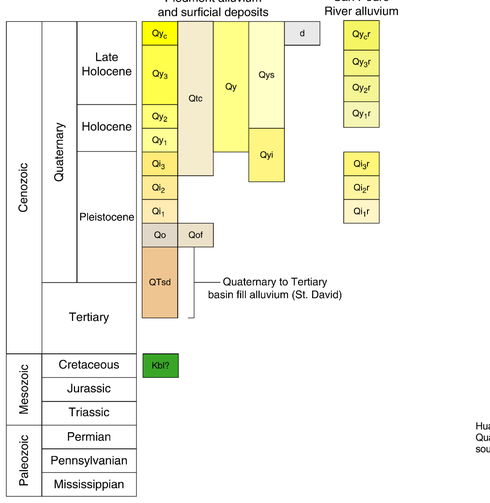
Arizona Geological Survey
416 W. Congress Street, Suite 100
Tucson, AZ 85701
(520) 770-3500
www.azgs.az.gov

Topographic base from USGS 1:24,000 scale quadrangle series. North American Datum of 1983 (NAD83). Projection and 1,000-meter grid: Universal Transverse Mercator, zone 12.

Mapping Responsibility



Unit Correlation



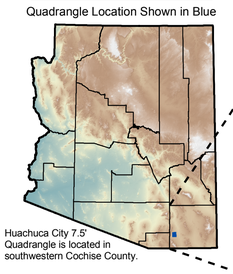
Map Symbols

Contacts

accurate contact
approximate contact
concealed contact

Location Index Map

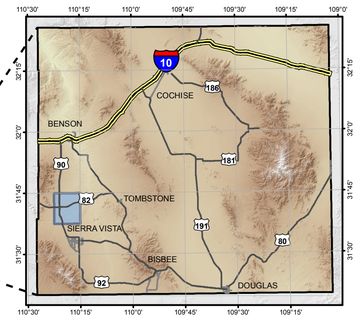
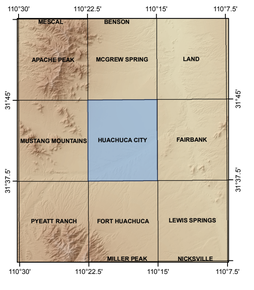
Quadrangle Location Shown in Blue



Huachuca City 7.5' Quadrangle is located in southwestern Cochise County.

Cochise County

Mapped Area Shown in Blue



Adjoining 7.5' Quadrangles