GEOLOGIC MAP OF THE LAND 7½' QUADRANGLE, COCHISE COUNTY, ARIZONA

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Arizona Geological Survey Digital Geologic Map 49 (DGM-49), version 2.0

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1:24,000 scale

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

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Map Unit Descriptions

Other units

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

d — **Disturbed ground** - Disturbed due to agriculture, extensive excavation, and blockage of drainages for cattle tanks.

Qtc — **Quaternary hillslope talus and colluvium** - Unconsolidated to moderately consolidated colluvium and talus hillslope deposits.

San Pedro River alluvium

Qyvf — **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 subangular. Qycr deposits are typically unvegetated to lightly vegetated and exhibit no soil development. Qycr deposits are entrenched from 30 cm to 5 meters or more below adjacent early historical floodplain deposits depending on location, geomorphic relationship, and local channel conditions. Although much of the San Pedro River was a perennial stream historically, some modern sections are dry or marshy at the surface throughout 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.

Qyvf — **Flood channel and low terrace deposits** - Deposits are found adjacent to active channels in the form of lightly vegetated in-channel bars, small planar fluvial terraces within 30 cm of river elevation, and recent erosional meanders outside the presently active channel. Terrace deposits are inset into older river alluvium and are generally narrow, rarely more than 100 meters across. Qyvf deposits are composed of poorly sorted unconsolidated sediments ranging from fine silts to gravel bars depending on location in the channel at the time of deposition. Pebbles and cobbles are well-rounded to sub-rounded. These surfaces are commonly inundated under moderate to extreme flow events and can be subject to deep, high velocity flow and lateral bank erosion. These deposits do not exhibit soil development but may exhibit a light vegetation cover of small trees, bushes, and grasses.

Qyvr — **Historical river terrace deposits** - Terrace deposits that occupy elevations from 1 to 2 meters above Qycr or Qyvf 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 subangular. 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.

Qyvr — **Latest Holocene to historical river terrace deposits** - Deposits associated with the floodplain that existed prior to the early historical entrenchment of the San Pedro 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 River was a widespread, shallowly-flowing river system and are dominated by fine grained floodplain deposits. Dense mesquite bosque and tall grass are 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 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 (Qyf , Qyaf, and Qys) onlap onto Qy2r deposits although an interfingering relationship likely exits in the subsurface.

Qiir — **Middle to late Pleistocene river terrace deposits** - Unit Qi2r consists of isolated paleoterrace deposits. This unit is the lower of two such terraces found outside of the incised river. Qi2r is composed of cobble to pebble clast supported conglomerate, subrounded to round clasts, clasts composed of granite, limestone, marl, and quartzite. This surface is approximately 2 meter thick and is degraded with beveled edges. Due to surface degradation, deposit soil was not preserved on this surface.

Qiir — **Early to middle Pleistocene river terrace deposits** - Unit Qi1r consists of the highest paleoterrace deposits. Qi1r is composed of cobble to pebble clast supported conglomerate, subrounded to rounded clasts composed of granite, limestone, marl, and quartzite. Clasts exhibit moderate rock varnish and soils typically have a reddened, clay argillic horizon, stage III secondary carbonate, and blocky peds. Qi1r surfaces are flat and beveled to rounded near their edges. Qi1r surface appear orange-brown in air photos.

Piedmont alluvium and surficial deposits

Qyr — **Modern stream channel deposits** - Unit Qyc includes only active, open channels of tributary washes on the piedmonts that can be delineated at a scale of 1:24,000. This unit is composed of moderately-sorted sand, gravel, pebbles, and some cobbles in the lower piedmont areas to poorly-sorted sand, gravel, pebbles, and cobbles in the upper piedmont areas. Channels are generally incised less than 0.5 to 1 meter below adjacent Holocene terraces. Channel morphologies generally consist of a single-threaded deep high flow channel or multi-threaded shallow low flow channels with adjacent gravel bars. The channels are flood prone and are subject to deep, high velocity flow during moderate to large flood events. Channels are subject to scouring and bar deposition while channel banks are subject to lateral erosion and undercutting. Soil development is absent in Qyc deposits and little to no vegetation exists within the active channel.

Qyr — **Latest Holocene alluvium** - Qy3 deposits comprise flat surfaces along the axial distributary drainages of recently active alluvial fans. Qy3 deposits are mudstone dominated with traces of an organic layer littering the surface. These surfaces are normally not incised and experience flooding during most precipitation events. Qy3 surfaces are vegetated by grasses, small shrubs, medium mesquites, and salt cedar near the San Pedro River. Qy3 soils are very weakly developed with an organic layer and clay loam upper surface coloration of 10 YR 7/3. Qy3 deposits were produced by recent incision of alluvial fans and subsequent deposition during the sheetflow events.

Qyaf — **Late Holocene alluvium, active fan deposits** - Qyaf deposits consist of active alluvial fan deposits in the San Pedro valley. These deposits have distributary drainage patterns and are extremely prone to flooding and channel migration. Sediments are unconsolidated and consist of very poorly sorted sand to cobbles. Vegetation includes small mesquite trees, shrubby acacia, prickly pear, and medium creosote.

Qyp — **Late Holocene spring deposits** - Unit Qyp is related to the only spring feed swamp on the mapped area. Although much of the swamp is drying the landscape is modified by the spring's presence. Qyp deposits are composed of clay loam and have a high percentage of expanding clays (smectite). Much of this surface is barren except the portions that are still wet. In the wet portion of the surface cattails and sacaton grasses crowd the landscape. In the dry portion of this surface dissection and incision have begun, with abundant vertical surface cracks developing.

Qy₂ — **Late Holocene alluvium** - Unit Qy2 is composed of very flat surfaces sloping away from the mouths of tributary valleys on the west side of the map. This unit sits slightly lower in the landscape than Qy1 deposits and is less degraded. Qy2 is composed of .5 m sheets of clay loam. Qy2 deposits often exhibit a grass dominated surface which may experience flooding during moderate storm events. No soil development is evident on Qy2 deposits although a vesicular layer is present. Qy2 deposits represent a small phase of alluvial fan development along the western side of the river valley.

Qy₁ — **Older Holocene alluvium** - Unit Qy1 consists of hummocky fan deposits found near tributary drainage outlets on the western portion of the mapped area. Qy1 deposits are composed of pebble to cobble conglomerate within a mud matrix. The surface is humnocky and shows no characteristics of erosion. No soil development is apparent and the matrix is 7.5 YR 5/3 in color. Qy1 deposits stand slightly higher than Qy2 deposits and may experience some flooding in extreme events. Qy1 deposits are interpreted to be debris flow deposits.

Qcr — **Early Pleistocene river cobble conglomerate** - Unit Qcr is exposed along the hillslopes of the incised river valley beneath identified terraces. Qcr is composed of cobble conglomerate cemented by calcium carbonate. Clast composition is dominated by volcanic and limestone marl from the Saint David Formation.

Qys — **Fine-grained Holocene alluvium derived from the Saint David Formation** - Fine-grained Holocene alluvium derived from the Saint David Formation. 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.

Qi₃a — **Late Pleistocene alluvial fan and terrace deposits A** - Unit Qi3a consists of deposits that fill the valleys incised into the Saint David Formation, Qo, and Qi2 alluvial fan complexes. Qi3a deposits are composed of mudstone with some floating cobbles within the mud matrix. These surfaces are flat with punctuated slot incised channels. Qi3a surfaces are incised up to 3m down the tributary toward the San Pedro River. Closer to the river, isolated remnants of Qi3a outcrop along the tributary valleys. Soils are weak to moderately developed with clay loam, small blocky peds, 7.5 YR 5/4, and filament carbonate. Qi3a surfaces appear as buff in air photos. Qi3a is dominated by sacaton grasses and medium size mesquite trees. Qi3a represents the valley fill that is subsequently incised due to down cutting in the San Pedro River.

Qi₃b — **Late Pleistocene alluvial fan and terrace deposits B** - Unit Qi3b consists of deposits that fill the broad shallow drainages on Qi2 surfaces. Qi3b derives its material from unit Qi1 and outflow from Tertiary granites, and is grüss dominated. These surfaces are inundated frequently during minor events and have a punctuated incision of about .5 m. Qi3b surfaces are vegetated with medium mesquite, grasses, and cholla. Qi3b has a weak to moderately developed semi hard soil composed of sandy loam with granular peds, 10 YR 5/3, and reaction with HCl. In air photos Qi3b surfaces are light brown. Qi3b represents a stage of sediment accumulation within the drainages on the Qi1 alluvial fans.

Qi₃c — **Late Pleistocene alluvial fan and terrace deposits C** - Unit Qi3c consists of weakly to moderately dissected alluvial fan deposits. Qi3c deposits are composed of clay loam mudstone. Qi3c surfaces mantle Saint David Formation usually as broad distributed fans. Qi3c surfaces are patchy and planar sloping toward the valley that is broadly dissected. Qi3c source primarily Paleozoic limestone outcrops. Qi3c soils are weak to moderately developed, 10 YR 6/4 light brown, stage I to II secondary nodular carbonate present in the profile, with columnar peds. Qi3c has no desert pavement. Qi3c represents a broad alluvial fan deposit across the moderately dissected fan surface. Qi3c is primarily vegetated by creosote and sparse acacia.

Qi₂ — **Middle to late Pleistocene alluvial fan and terrace deposits** - Qi2 deposits consist of planar fan surfaces perched higher than surrounding canyons. Qi2 deposits are cobble conglomerate with clasts composed of granite and Paleozoic limestone. Qi2 surfaces are relatively flat with some beveling near the edge of major drainages and punctuated incision near smaller drainages. The moderately developed soils found in unit Qi2 are small to medium prismatic peds, sandy clay loam texture, 7.5 YR 4/4 coloration, and stage II to III secondary carbonate. Qi2 surfaces are vegetated by small to medium mesquite and acacia trees with interspersed grasses and shrubs. These surfaces appear light orange in the air photos.

Qi₁ — **Early to middle Pleistocene alluvial fan and terrace deposits** - Qi1 deposits consist of broad flat ridges that are moderately incised and mostly located along the northeastern portion of the mapped area. Qi1 is composed of pebble to coarse grüss shed from Tertiary intrusive granites in the Dragoon Mountains. Surfaces are broad and dipping toward the valley bottom and beveled near incisions. Qi1 surfaces appear reddish brown on the air photos. Qi1 soils are well developed and composed of sandy loam with medium blocky peds, 5 YR 5/6, and contain stage II to III carbonate. These surfaces are dominated by small to medium Mesquite trees and small cacti.

Qo — **Early Pleistocene alluvial fan deposits** - Qo deposits consist of high ridges and fan surfaces along the eastern portion of the mapped area that are deeply incised alluvial fans shed off the western side of the Dragoon Mountains. Qo deposits are composed of cobble to pebble conglomerates that vary from matrix to clasts supported with a calcium carbonate matrix. Clasts are subrounded to rounded, 5 to 9" in diameter, and consist of limestone, metasedimentary rocks, and quartzite. Qo surfaces are often covered with carbonate chips and capped in places with a stage IV to V petrocalcic horizon. Qo surfaces are exposed as isolated outcrops in some places, surrounded by younger alluvial deposits. Qo surfaces are usually absent of trees and are dominated by creosote and whitethorn shrubs, with occasional ocotillo. Qo deposits represent the oldest exposed alluvial fans in the mapped area and commonly rest on top of the St. David Formation with an erosional contact.

Qof — **Early Pleistocene fine-grained basin-fill 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, uncised 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 Saint David Formation (Shipman and Ferguson, 2003).

Qog — **Early Pleistocene cobble conglomerate** - Unit Qog is exposed along the hillslopes of the incised river valley and its tributary valleys. Qog is composed of cobble conglomerate cemented by calcium carbonate. This unit has no exposed surface and is lumped into this category.

Quaternary to Tertiary Basin Fill alluvium

QTsd — **Pliocene to early Pleistocene St. David Formation** - Undifferentiated Plio-Pleistocene Saint David Formation.

QTsf — **Early Pleistocene basin fill alluvial fan deposits** - Unit QTsf is defined as a depositional facies of the Saint David Formation exposed on the western portion of the map area. QTsf deposits are composed of matrix supported cobble conglomerate with paleosols that developed on the upper boundaries of mudstone interbeds.

QTsl — **Lacustrine facies of the Saint David Formation** - Tabular limestone beds are found interbedded with red and green mudstones. Limestones are composed of structureless chalky micritic calcite. Globular calcium carbonate nodules classified as stage III to IV carbonate are found within a muddy matrix on the peripheral facies. Tuffs with fine to medium-grained sandstones are common throughout this formation.

QTsp — **Playa facies of the Saint David Formation** - Thick tabular gypsiferous layers interbedded with limestones and mudstone. Gypsum as tabular layers is found in some cases below this layer. Selenite litters the outcrop.

Bedrock units

Tg — **Conglomerate (Tertiary)** - Tan, thin- to medium-bedded, pebble-cobble, sandy matrix conglomerate and pebbly sandstone dominated by angular to sub-rounded clasts of Uncle Sam Tuff, and porphyry of Fairbank. The sandy matrix consists of quartz, feldspar, lithic grains, and 5-10% heavy and opaque minerals.

Krd — **Porphyry of Fairbank (Upper Cretaceous)** - Phenocryst-rich porphyry containing 25-40% phenocrysts of plagioclase (0.5-5.0mm), potassium feldspar (0.5-3.0mm), quartz (0.5-5mm), biotite (0.5-2.5mm), and 1-10%, 1-10cm, rounded, irregular, fine-grained dioritic inclusions. The porphyry, although containing a phenocryst assemblage essentially identical to the Uncle Sam Tuff, can be distinguished from the tuff by a slightly coarser grained, more evenly distributed porphyritic texture, and the lack of pumice and lithic lapilli. The porphyry of Fairbank displays flow-foliation along its intrusive contacts in some areas, and locally has a dark vitric matrix along intrusive contacts. Elsewhere, the matrix is crystalline, and crumbly.

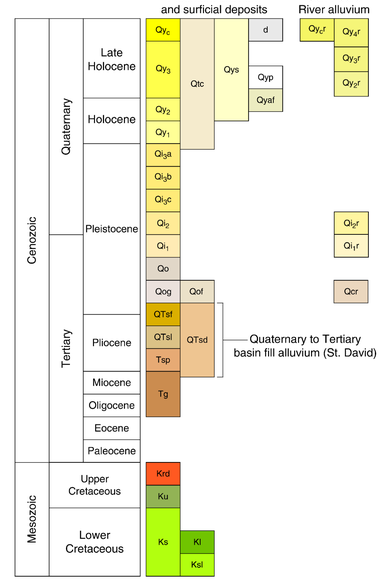
Ku — **Uncle Sam Tuff (Upper Cretaceous)** - Phenocryst-rich ash-flow tuff containing 25-40% phenocrysts of plagioclase (0.5-3.0mm), sanidine (0.5-2.0mm), quartz (0.5-5mm), biotite (0.5-2.5mm), and hornblende (0.5-2.0mm). Lithic lapilli (1-25%) consist chiefly of andesite and rhyolitic volcanics, sandstone, and argillite. Equant pumice lapilli (1-10cm), constituting between 1 and 20% of the tuff contain slightly larger, more euhedral phenocrysts that display a more evenly distributed texture than in the tuff matrix. Fine-grained, rounded, irregular dioritic inclusions (1-10%, 1-10cm) are ubiquitous. The tuff is typically dark gray with a very fine-grained crystalline to vitric matrix and is usually resistant, forming steep rounded hills and knobs. Locally the tuff includes extensive zones of megabreccia which are typically less resistant, forming slopes and low areas. Marvin et al. (1973) report a K/Ar biotite age of 73.5 + 2.8Ma for the Uncle Sam Tuff.

Ks — **Morita and Cintura formations (Lower Cretaceous)** - As noted by Gilluly (1956) and Hayes (1970), the younger siliciclastic formations of the Bisbee Group are virtually indistinguishable if the intervening Mural Limestone is not present. The two formations consist primarily of complexly intertonguing sequences of thin- to thick-bedded, cross-stratified and plane-bedded, quartz sandstone, feldspathic quartz sandstone, and lithic-feldspathic quartz sandstone interbedded with gray-green to red siltstone, mudstone, silty mudstone and shale, locally with abundant calcareous nodules and irregularly thin- to medium-bedded, discontinuous impure limestone, and limestone pebble conglomerate. Two types of sequences, ranging in thickness from 5 to 150m, are recognized, each representing approximately 50% of the map unit: 1) gray-green mudstone and lithic-feldspathic-quartz sandstone, and 2) red shale or mudstone and quartz sandstone. The gray-green mudstone and lithic-feldspathic quartz sandstone sequences are characterized by thin- to medium-bedded, moderately to moderately poorly-sorted, grayish green, argillaceous sandstone interbedded with dark colored mudstone and siltstone. The sandstone is typically massive, but may include ripple-laminated intervals. Sparse, rounded to well-rounded, clast-supported and matrix-supported, medium- to thick-bedded sandy matrix, pebble-cobble conglomerate beds are associated with lithic-feldspathic-quartz sandstone sequences. Clasts in the conglomerate consists of quartzite, argillite, vein quartz, sparse granitoid, limestone, and felsic volcanics. In general the conglomerate and sandstone of these units thin and fine upwards. The red shale and quartz sandstone sequences typically consist of moderately to well-sorted, lighter colored, less argillaceous, commonly complexly cross-stratified sandstone interbedded with reddish siltstone, mudstone and shale. Calcareous nodules, irregularly bedded impure limestone, and limestone pebble conglomerate beds (interpreted as pedogenic carbonates) are found almost exclusively associated with the red shale or mudstone. The two sequences occur in repeating cycles with the red shale and quartz sandstone units typically sharply overlying the lithic-feldspathic-quartz sandstone and dark mudstone units.

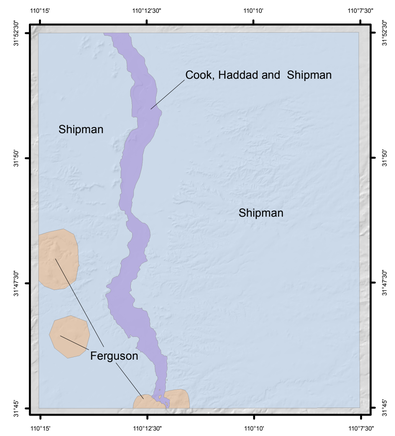
Kl — **Mural Limestone (Lower Cretaceous)** - Thin- to medium-bedded, micrite, molluscan skeletal wackstone, and algal-laminated limestone interbedded with subordinate dark shale. Sparse, medium-bedded intraclastic limestone conglomerate beds are also present. Slump folds and related soft-sediment deformation features are common.

Ksl — **Morita Formation (Lower Cretaceous)** - Medium- to thick-bedded, argillaceous, moderately to moderately poorly-sorted feldspathic quartz sandstone and gray silty mudstone. These strata are conformably overlain by the Mural Limestone indicating that this map unit (Ksl), otherwise indistinguishable from the combined Morita-Cintura formation map unit (Ks) is the Morita Formation.

Unit Correlation



Mapping Responsability



Map Symbols

Contacts

- contact, accurately located
- contact, approximately located
- concealed contact

Structure

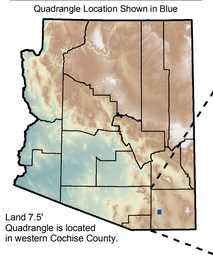
- 27 — bedding, inclined
- 19 — bedding, inclined with tops known
- 53 — fold hinge
- 66 — inclined flow foliation

Hinge surface trace

- anticline, solid where accurate, dotted where concealed
- syncline, solid where accurate, dotted where concealed

Location Index Map

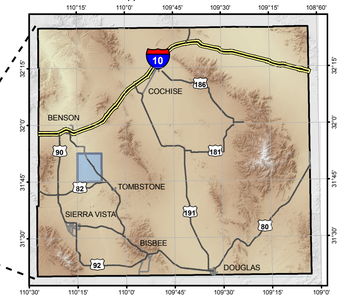
Quadrangle Location Shown in Blue



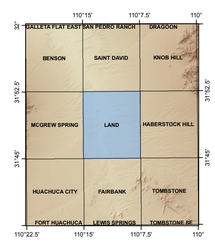
Land 7.5' Quadrangle is located in western Cochise County.

Cochise County

Mapped Area Shown in Blue



Adjoining 7.5' Quadrangles



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.

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 20 feet

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