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

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Arizona Geological Survey Digital Geologic Map 34 (DGM-34), 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** - Areas where human activity has obscured the underlying geology. Typically these are borrow pits.

San Pedro 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 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 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 moderate to extreme flow events and can be subject to deep, high velocity flow and lateral bank erosion. Extent of channel deposit and exposed bedrock varies and shifts with significant flooding.

Qy3r — **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.

Qy2r — **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 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.

Qi3r — **Late Pleistocene river terrace deposits** - River terrace deposits found on scattered hilltops along the San Pedro River. Qi3r deposits are thin, (<2 m) and composed of rounded to well-rounded pebbles, cobbles, and finer-grained sediment. Qi3r soils are moderately developed, with orange to reddish brown clay loam to light clay argillic horizons.

Qi2r — **Middle to late Pleistocene river terrace deposits** - River terrace deposits found on scattered hilltops along the San Pedro River. Qi2r surfaces are slightly higher than Qi3r surfaces. Qi2r deposits are thin, (< 2 m) and composed of rounded to well-rounded boulders, cobbles, and pebbles, with finer-grained sediments. Qi2r soils contain reddened, clay argillic horizons, with obvious clay skins and subangular blocky structure.

Piedmont alluvium and surficial deposits

Qyc — **Modern stream channel deposits** - Active channel deposits composed of moderately-sorted sand and pebbles with some cobbles in the lower piedmont areas to very poorly-sorted sand, pebbles, and cobbles with some boulders in the upper piedmont areas. Channels are generally incised less than 1 m below adjacent Holocene terraces and alluvial fans, 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. Channels are extremely flood prone and are subject to deep, high velocity flows in moderate to large flow events, and severe lateral bank erosion.

Qy3 — **Latest Holocene alluvium** - Recently active piedmont alluvium located primarily along active drainages including floodplain, low-lying terrace, and overflow channels. Qy3 deposits are composed of unconsolidated to very weakly consolidated silty to cobbly 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.

Qyaf — **Late Holocene alluvium, active fan deposits** - Qyaf deposits consist of recently-active to 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.

Qy2 — **Late Holocene alluvium** - Young deposits in low terraces, alluvial fans, and small channels that are part of the modern drainage system. Includes Qyc and Qy3 where not mapped separately. In upper piedmont areas, channel sediment is generally poorly to very poorly-sorted sand and pebbles, but may include cobbles and boulders; terrace and fan surfaces typically are mantled with sand and finer sediment. On lower piedmont areas, young deposits consist predominantly of moderately sorted sand and silt, with some pebbles and cobbles in channels. Channels generally are incised less than 1 m below adjacent terraces and fans, but locally incision may be as much as 2 m. Channels are flood prone and may be subject to deep, high velocity flows in moderate to large flow events. Potential lateral bank erosion is severe. 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. Flood flows may significantly change channel morphology and flow paths. Downstream-branching distributary channel patterns - small, discontinuous, well-defined channels alternating with broad expansion reaches where channels are very small and poorly defined - are associated with young alluvial fans generally found along the base of the piedmont. 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. Soil development associated with Qy2 deposits is weak. Qy2 deposits range from unaltered fluvial sediments to weakly developed soil.

Qy1 — **Older Holocene alluvium** - Middle to older Holocene terrace deposits are found at scattered locations along incised drainages throughout the Whetstone piedmont. Qy1 surfaces are higher and less subject to inundation than adjacent Qy2 surfaces, and are generally planar. Local surface relief may be up to 1 m where gravel bars are present, but is typically much less. Qy1 surfaces are 1 to 2 m above adjacent active channels. Surfaces typically are sandy but locally have unvarnished open fine gravel lags. Qy1 soils typically are weakly developed, with some soil structure but little clay and no calcium carbonate accumulation. Yellow brown (10YR) soil color is similar to original fluvial deposits.

Qys — **Fine-grained Holocene alluvium derived from the St. David Formation** - Unit Qys consists of thin to moderate (< 3 m), fine-grain Holocene alluvium derived from, and overlying, the St. David Formation (Tsd). It is composed mostly of silts and clays with color reflecting that of the parent material. Qys is typically found in fans at the base of Tsd outcrops along the edges of the piedmont.

Qy — **Undifferentiated Holocene alluvium** - Includes Qyc, Qy2, and Qy1 deposits. On the upper piedmonts, unit Qy consists of smaller incised drainages where, at this scale, it was not possible to map surfaces separately. At the lower margin of the piedmont, unit Qy consists of young alluvial fans deposited by piedmont tributary streams interbedded with San Pedro River floodplain deposts (unit Qyr).

Qyi — **Holocene to late Pleistocene alluvial fan and terrace deposits** - Abandoned stream terraces and fans on the upper piedmont, isolated from the active channels by 1 to 3 m. Unit Qyi consists of thin (<1 m) young alluvium, derived mainly from granite, over beveled Qi2 and Qi1 surfaces. The older units are exposed in patches on ridges and in cut banks of washes. Qyi surfaces are smooth to broadly rounded and are yellow brown (10YR 4/6) to brown (7.5Y 4/4). Qyi soils have weak subangular blocky structure with no to moderate clay accumulation and no carbonate accumulation to stage I+ (see Machette, 1985, for description of stages of calcium carbonate accumulation in soils).

Qi3 — **Late Pleistocene alluvial fan and terrace deposits** - Moderately dissected relict terraces and alluvial fans which commonly flank active channel valley walls near the mountain front. Qi3 deposits are derived mainly from granite and consist of pebbles and finer-grained sediment. Qi3 soils are moderately developed, orange to reddish brown (7.5YR) with light to moderate clay accumulation and no carbonate accumulation to stage I+. Qi3 has a weak desert pavement with no interlocking of the clasts.

Qi2 — **Middle to late Pleistocene alluvial fan and terrace deposits** - Moderately to deeply dissected relict alluvial fans and terraces. Qi2 surfaces are drained by well-developed, moderately to deeply incised tributary channel networks; channels are typically several meters below adjacent Qi2 surfaces. Well preserved, planar Qi2 surfaces are smooth with scattered pebble lags. More eroded, rounded Qi2 surfaces are characterized by scattered cobble lags with moderate to strong varnish and broad ridge-like topography. Qi2 deposits are composed of grüss with isolated conglomerate lenses composed of metasediments, limestones, and granite cobbles. Soils typically contain reddened (5YR-2.5YR) clay argillic horizons, with obvious clay skins and subangular blocky structure. Carbonate accumulation is stage II to III and occurs mainly along root zones. Unit Qi2 covers much of the Whetstone piedmont.

Qi1 — **Early to middle Pleistocene alluvial fan and terrace deposits** - Deeply dissected relict alluvial fans found only on the upper piedmont. Qi1 surfaces form broadly rounded ridges that are higher than adjacent Qi2 surfaces. Qi1 soils are strongly developed with a distinct dark red (5-2.5 YR), heavy clay argillic horizon and subangular blocky to prismatic structure. Carbonate accumulations are 1-2 m thick and range from stage III - V.

QTa — **Late Pliocene to early Pleistocene fan gravel** - coarse, moderately to well-consolidated gravelly deposits capping high ridges.

Quaternary to Tertiary Basin Fill alluvium

QTc — **Pliocene-Pleistocene conglomerate** - massive to crudely stratified, poorly bedded conglomerate interpreted as alluvial fan deposits shed into San Pedro River Valley from flanking bedrock hills and mountains.

QTcs — **Pliocene to Pleistocene conglomerate and sandstone** - tan to reddish, coarse, poorly sorted, tabular to massive sandstone, conglomeratic sandstone and conglomerate.

Tsd — **St. David Formation, undifferentiated (Pliocene)** - Undivided lower and middle St. David Formation.

Tsdm — **Middle member of the St. David Formation** - Middle St. David Formation consists of red and green mudstone, marl, tuff, lacustrine limestones, and fine to medium grained sandstones. The contact between the middle and lower St. David units is subtle and approximate. This unit is equivalent to units QTsp and QTsl in the St. David quandrangle.

Tsdl — **Lower member of the St. David Formation** - Lower St. David Formation consists of red mudstones and fine grained sandstones with nodular and fibrous gypsum located in the mudstones. This unit is equivalent to unit Ts in the Galleta Flat East quadrangle and unti Tsp in the St David quadrangle.

Bedrock units

KJs — **Bisbee Group, undifferentiated (Cretaceous to Jurassic)** - A heterogeneous sequence of greenish-gray to purple, thin- to mediumbedded, argillaceous, feldspathic quartz sandstone, siltstone, mudstone and minor thin-bedded limestone (Skotnicki, 2001a and b). Hematite pseudomorphs after pyrite (2-8 mm) are common in the sandstones which are typically cross-stratified, and locally calcareous. Limestone beds, typically <20 cm thick, are laminated (locally with syndepositional folds) micrite with <2% silt to fine-grained quartz and feldspar sand grains and sparse gypsum pseudomorphs. Sparse medium- to thickbedded pebble-cobble conglomerate beds are also present containing clasts of pink quartzite, chert, and limestone.

Ygm — **Muscovite leucogranite (Mesoproterozoic)** - Medium-grained, equigranular, but locally coarse-grained with sparse potassium feldspar, porphyritic leucogranite containing 5-20% muscovite.

Yg — **Granite (Mesoproterozoic)** - Medium- to coarse-grained, potassium feldspar porphyritic (up to 3 cm) granite with between 5-12% biotite.

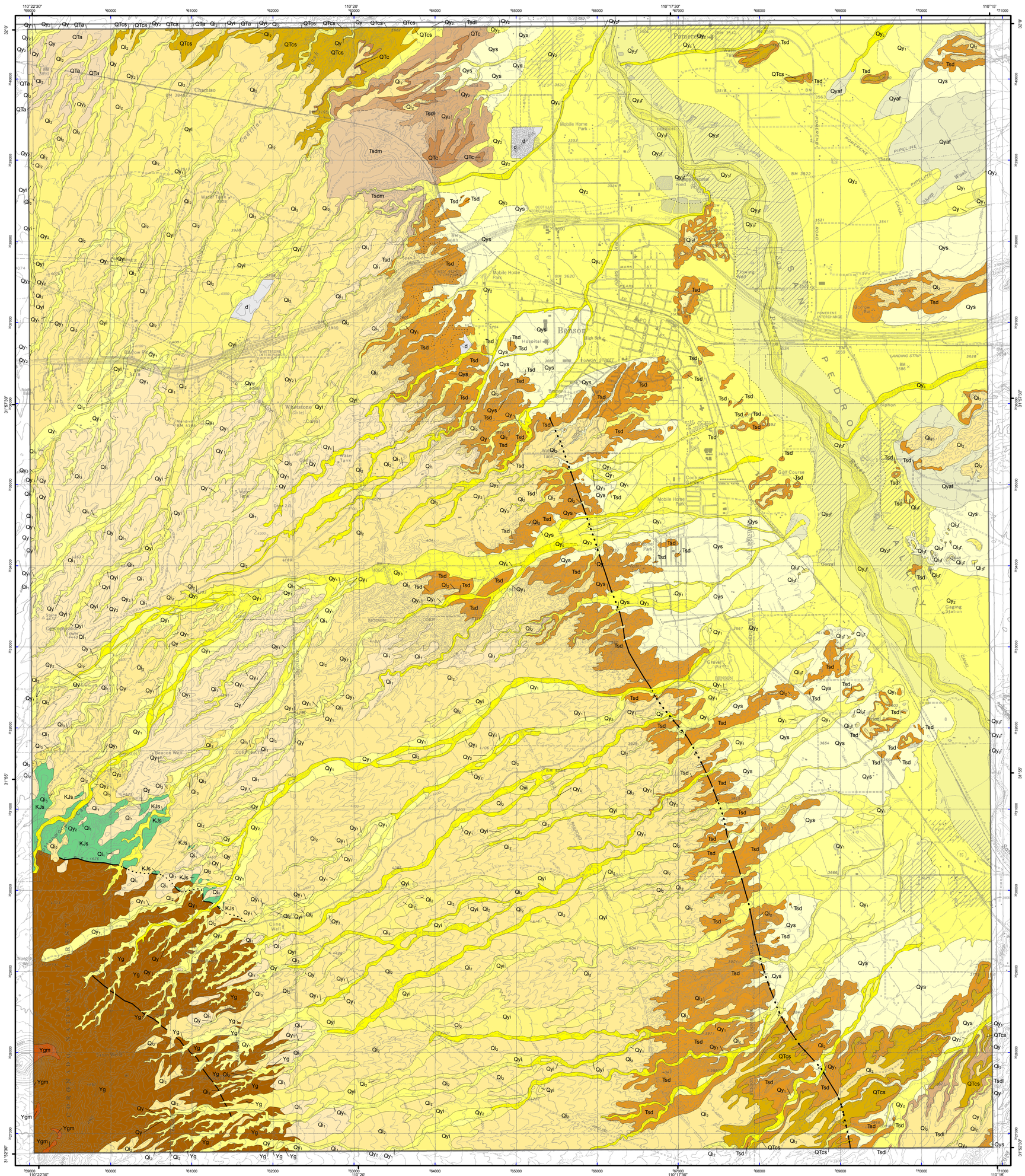
Map Symbols

Faults

- fault, accurate
- fault, concealed
- fault, concealed, hypothetical

Contacts

- accurate contact
- approximate contact
- scratch contact
- concealed contact



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

MN
10½°
2006 MAGNETIC NORTH DECLINATION

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.

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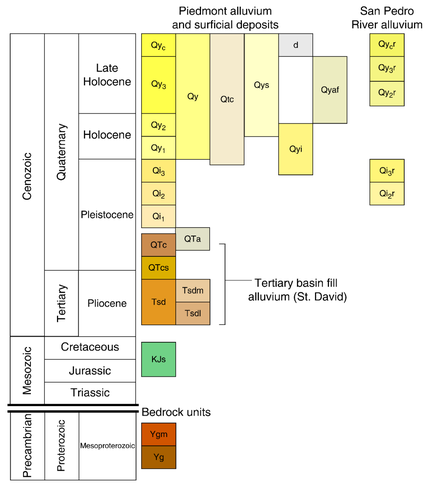
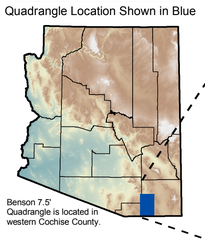
Unit Correlation



Location Index Map

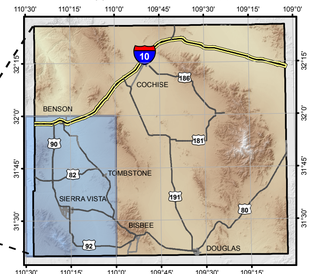
Quadrangle Location Shown in Blue



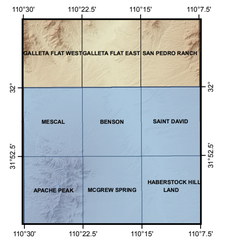
Benson 7.5' Quadrangle is located in western Cochise County.

Cochise County

Mapped Area Shown in Blue



Adjoining 7.5' Quadrangles



Mapping Responsibility