GEOLOGIC MAP OF THE GALLETA FLAT EAST 7½' QUADRANGLE, COCHISE COUNTY, ARIZONA

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Arizona Geological Survey Digital Geologic Map 56 (DGM-56), version 3.0

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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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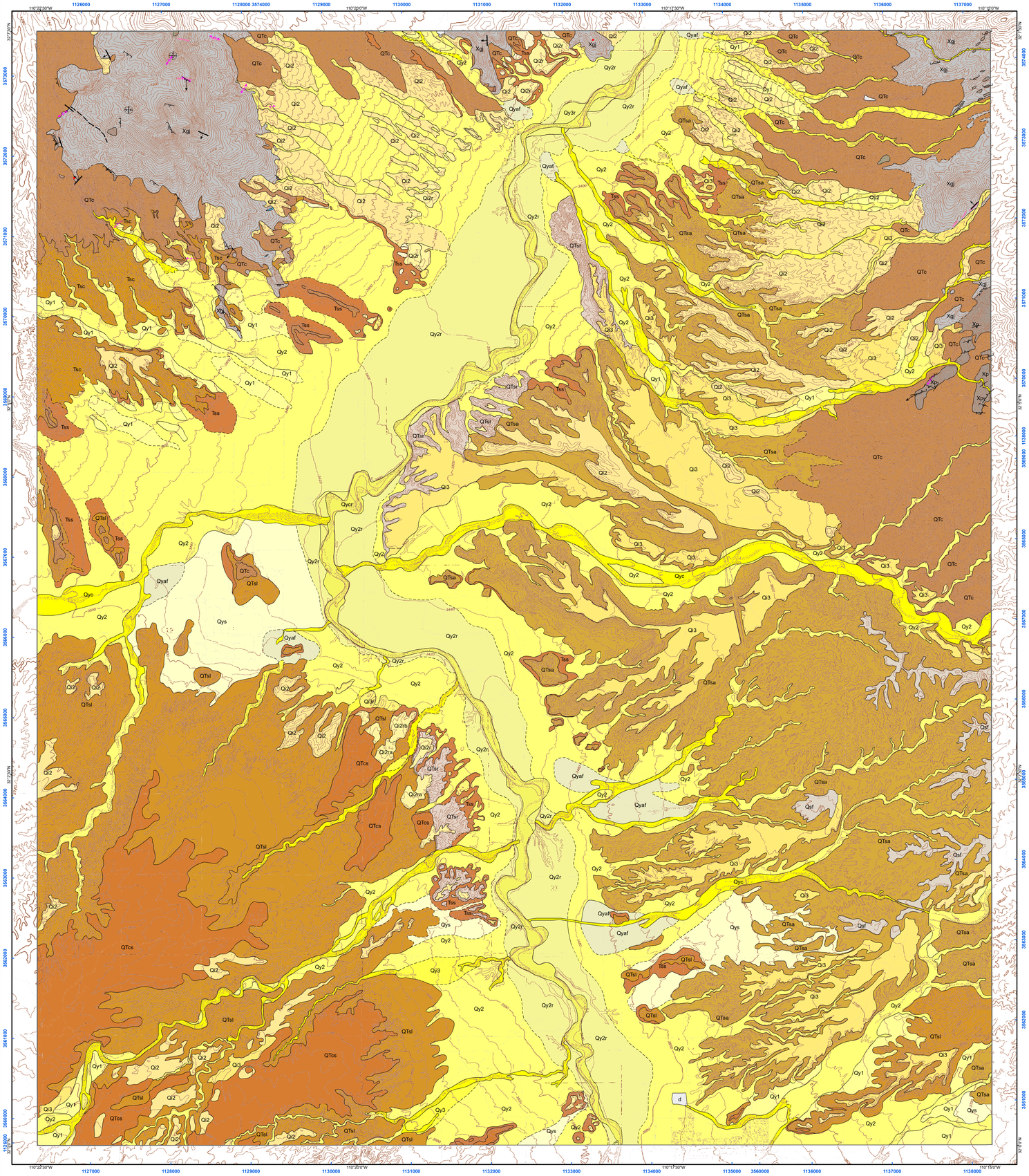


Map Unit Descriptions

San Pedro River alluvium

Qy_1f **Active river channel deposits (Modern)** - River channel deposits of the San Pedro River, composed primarily of sand and pebbles. Deposits are unconsolidated, very poorly sorted sandy to cobbly beds exhibiting bar and swale microtopography but can range from fine silty beds to coarse pebble-cobble bars based on position within the channel. Lithologically diverse clasts are typically well-rounded but may be angular to sub-angular. Qycr deposits are typically unvegetated to lightly vegetated, exhibit no soil development, 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. 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. The current entrenched channel configuration began to evolve with the development of arroyos in the late 1800s to early 1900s, and continued to evolve through this century (Hereford, 1993; Wood, 1997). 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.

Qy_1f **Very young river terrace deposits (Historical to modern)** - 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 Qy_3r surfaces is possible during lower flow events.

Qy_1f **Young river terrace deposits (Latest Holocene to historical)** - Deposits associated with the floodplain that existed prior to the early historical entrenchment of the San Pedro River (Hereford, 1993; Huckleberry, 1996; Wood, 1997). Qy_2r deposits are associated with broadly planar surfaces that locally retain the shape of historical river meanders. Qy_2r surfaces are up to 7 meters above modern Qycr deposits and are the most extensive river terraces in the valley. Qy_2r 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 Qy_2r 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. Qy_2r deposits are subject to catastrophic bank failure due to undercutting and lateral erosion during flow events. Distal piedmont fan deposits (Qy_2 ,Qyaf, and Qys) onlap onto Qy_2r deposits although an interfingering relationship likely exits in the subsurface.

Qi_3f **Young intermediate river terrace deposits (Late Pleistocene)** - Terrace deposits occupy elevations 5 to 20 m higher than and up to 500 m outside the margins of the modern San Pedro channel. These deposits consist of well-rounded pebbles to cobbles exhibiting stage I+ calcium carbonate accumulation with cross-bedded coarse sandy interbeds. Clast composition is varied and includes rock types not found in the mountains from which modern piedmont material is derived from. Qi_3r terrace surfaces are planar, often surrounded by distal piedmont alluvium, and are generally lightly vegetated except for small weeds and grasses. Commonly, Qi_3r deposits are inset into adjacent piedmont alluvial deposits but can also be inset into older river gravel terraces. Soil development is weak, possibly due to the porous nature of these deposits.

Qi_2f **Intermediate river terrace deposits (Middle Pleistocene to Late Pleistocene)** - Terrace deposits are similar to Qi_3r deposits but occupy higher positions in the landscape 15 to 35 m above the active San Pedro River channel. Terrace surfaces are slightly to moderately rounded. Clast composition is diverse. Well-rounded pebbles to cobbles with stage I-II calcium carbonate accumulation armor Qi_2r surfaces. Vegetation is sparse, consisting of small shrubs and grasses. Soil development is generally weak on Qi_2r surfaces, possibly but soil development is more evident in finer grained sections. Qi_2r surfaces are typically found as high-standing isolated mounds surrounded by distal fan alluvium or as small terraces inset into older fan or basin fill alluvium.

Qi_2rb **Intermediate river terrace deposits, younger member (Middle Pleistocene to Late Pleistocene)** -

Qi_2ra **Intermediate river terrace deposits, older member (Middle Pleistocene to Late Pleistocene)** -

Qi_1r **Older intermediate river terrace deposits (Early Pleistocene to Middle Pleistocene)** - Isolated deposits covered with well-rounded pebbles and cobbles associated with the highest river terraces along the San Pedro River.

QTsr **Ancestral San Pedro River deposits (Pliocene to Pleistocene)** - A moderately thick sequence of axial fluvial deposits of the ancestral San Pedro River composed of consolidated, moderately to well-sorted, rounded pebble-cobble conglomerate and medium- to coarse-grained sandstone. These channel conglomerates and sandstones exhibit trough cross-bedding with a north-south trend. Diverse lithology reflects the larger drainage area of the San Pedro River as compared to local tributary streams. These deposits typically underlie Qi2r terrace deposits and sit abruptly on top ofthe sandflat facies (Tss). In some areas, however, hillslopes are covered with a course rounded pebble and cobble lag limiting exposures of the finer-grained sequence beneath. Smith (1994) places QTsr in Deposition Interval II; it correlates to the middle St. David Formation of Grey (1967).

Piedmont alluvium and surficial deposits

Qy_0 **Active channel deposits (Modern)** - 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.

Qy_3 **Active alluvial deposits (Latest Holocene to modern)** - Recently active to active piedmont alluvium located primarily along active drainages including floodplain, low-lying terrace,and overflow and small channels. Includes Qyc 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.These deposits generally exhibit bar and swale microtopography and are susceptible to inundation during moderate to extreme flow conditions when channel flow exceeds capacity. Channels generally are incised less than 1 m below adjacent terraces and fans, but locally incision may be as much as 2 m. 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 is generally absent or incipient on Qy3 deposits which exhibit pale buff to light brown (10 YR) surface coloration.

Qyaf **Very young to active alluvial fan deposits (Latest Holocene to modern)** - 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. 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.

Qy_2 **Very young alluvial deposits (Late Holocene)** - 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.

Qy_1 **Young alluvial deposits (Early Holocene to Middle Holocene)** - 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 Saint David Formation (Holocene)** - Unit Qys consists of thin to moderate (< 3 m) beds of 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.

Qi_3 **Young intermediate alluvial fan and terrace deposits (Late Pleistocene)** - Slightly to moderately dissected relict alluvial fans and terraces. Qi_3 terraces along major washes tend to be strath terraces in basin fill deposits with thin (<2 m) Qi_3 deposits on top. Qi_3 soils are moderately developed with yellow brown to brown (10YR to 7.5YR) loam with argillic horizons and stage I-II carbonate accumulation. Qi_3 has a weak desert pavement with no interlocking of the clasts.

Qi_2 **Intermediate alluvial fan and terrace deposits (Middle to late Pleistocene)** - Moderately to deeply dissected relict alluvial fans and terraces. Qi_2 surfaces are drained by well-developed, moderately to deeply incised tributary channel networks; channels are typically several meters below adjacent Qi_2 surfaces. Well-preserved, planar Qi_2 surfaces are smooth with scattered pebble lags. More eroded, rounded Qi_2 surfaces are characterized by scattered cobble lags with moderate to strong varnish and broad ridge-like topography. Qi_2 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.

Quaternary to Tertiary Basin Fill alluvium

Qsf **Sandstone and sand conglomerate (Early Pleistocene to Middle Pleistocene)** - Stacked, tabular, poorly sorted silty sandy conglomerate separated by thinner (typically < 1 m) beds of finer-grained deposits with reddish paleosols or pebbly sand beds to thinly bedded (< 0.5 m), stacked distal fan deposits of sands and gravels. Smith (1994) places this unit in Deposition Interval III (ca 1.7-0.7 Ma); it correlates to the upper St. David Formation of Grey (1967). Generally, Qsf beds conformably overlie beds of the middle St. David Formation.

QTsa **Piedmont alluvial deposits (Pliocene to Early Pleistocene)** - Coarser alluvial fan and channels deposits (QTcs) and finer-grained floodplain and marsh deposits towards the basin center (QTsl) where not mapped separately. In most exposures, QTcs abruptly overlies QTsl. Smith (1994) places this unit in Deposition Interval II (ca 3.5-1.7 Ma); it correlates to the middle St. David Formation of Grey (1967).

QTcs **Conglomerate and sandstone (Pliocene to Early Pleistocene)** - This unit is dominated by coarse-grained piedmont alluvial fan deposits composed of interbedded lithologically diverse, consolidated, matrix supported, moderately to well-sorted, sub-angular to rounded, pebble-cobble conglomerate and massive to cross-bedded sandstone deposited by piedmont alluvial fans. This unit is dominated by conglomerate towards the mountains and by finer sandstones towards the basin center. Smith (1994) places this unit in Deposition Interval II (ca 3.5-1.7 Ma); it correlates to the middle St. David Formation of Grey (1967).

QTsl **Siltstone and mudstone (Pliocene to Early Pleistocene)** - This unit is dominated by fine-grained piedmont alluvial fan deposits composed of interbedded siltstone, silty sandstone, and mudstone, and tabular pond and groundwater-deposited limestone beds which sometimes includes reworked tephra. Pond limestones are generally < 1 m thick. Groundwater deposited limestones range from structureless chalky micritic calcite to globular calcium carbonate nodules (stage III to IV) within a muddy matrix on the peripheral facies. This is equivalent to the pond, marsh and floodplain facies of piedmont alluvium described by Smith (1994). Smith (1994) places this unit in Deposition Interval II (ca 3.5-1.7 Ma); it correlates to the middle St. David Formation of Grey (1967).

QTc **Conglomerate (Pliocene to Pleistocene)** - Conglomerate is massive to crudely stratified, poorly bedded to massive. Subangular clasts are typically 5-50 cm, and locally up to 1 m. Near north edge of quadrangle, clasts consist dominantly of Johnny Lyon Hills Granodiorite, with less common Pinal Schist and miscellaneous other granitoids and vein quartz. In northeast corner of quadrangle, clasts include probably Scanlon Conglomerate derived from the Pioneer Shale of the Apache Group, which is exposed to the northeast in the Johnny Lyon Hills (Cooper and Silver, 1964). This unit is interpreted as alluvial fan deposits shed into San Pedro River Valley from flanking bedrock hills and mountains. Queried where uncertain.

Tsc **Sandstone and conglomerate (Pliocene)** - Coarse, poorly sorted, tan sandstone, conglomeratic sandstone, and conglomerate. Some sandstone and conglomeratic sandstone are pinkish tan to reddish tan to reddish medium brown. Poorly to moderately defined beds are generally 20 to 100 cm thick. Most clasts are 1-20 cm diameter, locally to 50 cm. Conglomerate clasts are mostly granitic and subangular to subrounded. Conglomeratic sandstone beds commonly contain channels and channel fill pebbles and cobbles that are coarser than host. Typical channel is 1 m wide and 20 cm deep. Some beds have 2-20 mm granules and pebbles in lower 5-10 cm, with crudely graded beds. Locally, near basin axis but adjacent to bedrock outcrops, unit consists of poorly bedded and poorly sorted sandstone with spars 1-10 cm angular granite debris. QTcs interfingers with Qsf sediments in upper sections and Tss sediments near the base. This unit is described by Smith (1994) as Depositional Interval I conglomerate, and is interpreted as alluvial fan deposits shed into San Pedro River Valley from flanking bedrock hills and mountains.

Tss **Red sandstone, siltstone and mudstone (Pliocene)** - Sandflat and mudflat deposits composed of massive to bedded, reddish brown (5YR to 10YR) sandstone, siltstone, and mudstone forming low-relief outcrops that are commonly mantled in dried mud with polygonal fractures. Smith (1994) places this unit in Deposition Interval I (ca 4.4 - 3.5 Ma); it correlates to the lower St. David Formation of Grey (1967).

Other Units

d **Disturbed ground** - areas of substantial excavation or anthropogenic deposition, for example, sewage treatment facilities or gravel pits

Bedrock units

md **Mafic dike (Proterozoic to Tertiary)** - dark, typically fine-grained dikes containing abundant plagioclase and hornblende and/or pyroxene

Xgj **Johnny Lyon granodiorite (Paleoproterozoic)** - equigranular to weakly porphyritic, medium to fine grained granodiorite or granite containing sparse quartz veins

Xdj **Dioritic rocks associated with Johnny Lyon granodiorite (Paleoproterozoic)** - Dark colored, mafic rich dioritic rock that forms local, small irregular bodies in Johnny Lyon Granodiorite. Texturally similar to non-porphyritic parts of Johnny Lyon Granodiorite.

Xlg **Leucocratic granite associated with Johnny Lyon granodiorite (Paleoproterozoic)** - Leucocratic granite associated with Johnny Lyon granodiorite (Paleoproterozoic)

Xp **Pinal Schist (Paleoproterozoic)** - medium- to fine-grained sericitic schist ranging from light green to dark gray

SCALE 1:24,000

1 0.5 0 1 Miles

1 0.5 0 1 Kilometers

0 1000 2000 3000 4000 5000 Feet

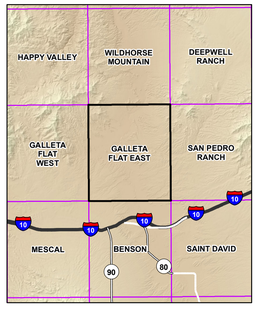
CONTOUR INTERVAL 40 FEET

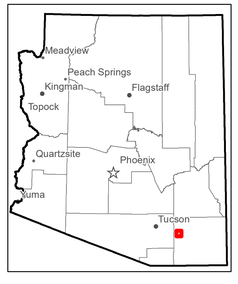
TRUE NORTH
MAGNETIC NORTH
9.3°

Approximate mean declination, 2019

Topographic base map derived from the Galleta Flat East 7.5' USGS topographic quadrangle map originally with NAD27 datum. Reprojected to UTM NAD83 datum (zone 12) using iGage All Topo Maps V9. UTM NAD 83 grid and lat-lon markers produced using ESRI ArcMap v. 10.4.

Arizona Geological Survey Digital Geologic Map DGM-56
Geologic map of the Galleta Flat East 7 1/2' Quadrangle





Location of map area

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THE UNIVERSITY OF ARIZONA

Map Symbols

Contacts

contact, accurately located

contact, approximately located

Faults

fault, approximately located

Definition of terms:

***laminated** - *indicates layering less than 1 cm thick*
***differentiated** - *indicates segregation of minerals into layers*
***shape fabric** - *indicates preferred orientation of flat or elongated minerals*

Structure Symbols

protomylonite, normal sense of shear shown with arrow where present

weak protomylonite

strong protomylonite

mylonite

close disjunct (spaced) cleavage, inclined

laminated differentiated foliation, moderate to strong shape fabric*

minor fault attitude

S-fold

inclined joint

foliation with lineation, where present

apparent dip