Geologic Map of the Galleta Flat East 7.5' Quadrangle, Cochise County, Arizona

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Introduction

The Galleta Flat East 7.5’ Quadrangle is located in northwestern Cochise County in southeastern Arizona, north of the town of Benson. The San Pedro River flows south to north across the quadrangle and has been in a downcutting phase during the Quaternary. Lower Quaternary and upper Pliocene strata, which are exposed in bluffs and low hills flanking the river, were deposited in fluvial and lacustrine-margin to playa environments (Smith, 1994; Youberg et al., 2003). Bedrock exposed near the northern end of the Quadrangle consists of early Proterozoic Johnny Lyon Granodiorite and Pinal Schist (Cooper and Silver, 1964; Drewes, 1974).

Quaternary map units

Piedmont Alluvium

Quaternary piedmont deposits derived from the Rincon and Whetstone mountains to the west and Little Dragoon and Winchester mountains to the east of the San Pedro River cover most of the Galleta Flat East quadrangle. This alluvium was deposited by larger tributary streams that head in the mountains and smaller streams heading in the upper piedmont. Abbreviations are “ka”, thousands of years before present, and “Ma”, millions of years before present.

Qy_c – Modern stream channel deposits — Active channel and gravel bar deposits composed of very poorly-sorted sand, pebbles, and cobbles with some boulders to moderately-sorted sand and pebbles. Channels are extremely flood prone and are subject to deep, high velocity in moderate to large flow events, and severe lateral bank erosion.

Qy_3 - 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 — Young, active alluvial fan deposits in the San Pedro River valley, at the base of piedmonts. These alluvial fans are active and extremely prone to flooding.

Qy_2 - Late Holocene alluvium — Young deposits in low terraces and small channels that are part of the modern drainage system. Channels are flood prone and may be subject to deep, high velocity flows in large flow events.

Qy_1 – Older Holocene alluvium — Older Holocene terraces found at scattered locations along incised drainages throughout the study area, and isolated alluvial fans at the base of the piedmont. Qy_1 surfaces are higher and less subject to inundation than adjacent Qy_2 surfaces.

Qys – Fine-grained Holocene alluvium derived from the St. David Formation — Thin (< 2m) to discontinuous fine-grain Holocene alluvium overlying basin fill deposits (units Ts, QTcs). Qys deposits are typically fine-grained active alluvial fans at the base of basin fill outcrops along the edges of the peidmonts.

Qi_3 - Late Pleistocene alluvial fan and terrace deposits — 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_2 - Middle to late Pleistocene alluvial fan and terrace deposits — Moderately to highly dissected relict alluvial fans with strong soil development found throughout the map area. Qi_2 deposits are of variable thickness, up to 3m, over basin fill deposits which are exposed in wash banks.

Qi_1 - Early to middle Pleistocene alluvial fan and terrace deposits – Qi_1 deposits are deeply dissected relict alluvial fans that vary from rounded ridges to well-preserved fan surfaces. Qi_1 deposits are of variable thickness, up to 4m, over basin fill deposits which are exposed in roadcuts and wash banks.

Qo - Early Pleistocene alluvial fan deposits - Deeply dissected relict alluvial fans found only on the upper piedmonts. Qo deposits consists of deeply dissected, rounded ridges with no to weakly preserved surfaces.

Quaternary- Tertiary Basin Fill Units

The Quaternary-Tertiary basin fill units were first mapped by Gray (1965) who proposed the name Saint David Formation. Subsequent studies by Johnson and others (1975), Lindsay and others (1990), Slate and others (1996), and Smith (1994, 2000) divided these deposits into three depositional intervals: (1) a period of fine-grained deposition in an arid, closed-basin with a seasonally-wetted playa between 4.4-3.4 Ma, (2) integration of the San Pedro drainage basin and a transition to a less arid environment with perennial streams and higher water tables between 3.4-1.6 Ma, and (3) a transition to a strong monsoon pattern with ephemeral flow and tabular sheet-flood deposits between 1.6-0.6 Ma. In this mapping effort the basin fill units were mapped according to facies where possible.

QTa – Late Pliocene to early Pleistocene fan gravel – Coarse gravelly deposits that erosionally overlie basin-fill sediments and form the upper parts of high, broad to very rounded ridges. QTa deposits are composed of very poorly sorted angular to sub angular sand, pebbles, cobbles, and boulders common in alluvial fan deposits. High standing rounded ridges are composed of carbonate-cemented fanglomerate cap which armors the underlying, less indurated basin-fill sediment. Exposures of QTa deposits are generally poor, and are commonly the highest standing deposits in the proximal piedmont.

QTbf – Late Pliocene-Early Pleistocene relict basin floor deposits – QTbf forms extensive surfaces at the top of basin fill piedmont fans in the southwest corner of the quadrangle. QTbf may represent a relict basin floor that formed at or near the end of the basin filling period. The surface of QTbf is fine-grained, mainly silts and sands, with some minor Holocene alluvium. QTbf deposits range from carbonate-cemented sandstones and conglomerates with traces of re-worked tephra to limestone deposits up to 1m thick. The limestone deposits may be relict marsh deposits.

QTc – Pliocene-Pleistocene conglomerate – 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). Interpreted as alluvial fan deposits shed into San Pedro River Valley from flanking bedrock hills and mountains.

QTcs – Pliocene-Pleistocene conglomerate and sandstone – 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. This unit interfingers with units QTc near its top and Ts near its base.

Ts – Pliocene red sandstone, silty sandstone, and siltstone – Massive to bedded, reddish brown (5YR to 10YR) sandstone, siltstone, and mudstone that forms low-relief outcrops. Outcrops are commonly mantled in dried mud with polygonal fractures that possibly formed by expansion of clay minerals. This unit correlates to the lower Saint David Formation of Gray (1965), and Smith (1994).

San Pedro River Alluvium

Sediment deposited by the San Pedro River in the middle of the map area. Deposits are a mix of gravel, cobble, sand and finer material; they exhibit mixed lithologies and a higher degree of clast rounding, reflecting the large drainage area of this watershed. Virtually all of the area covered by Holocene river deposits has been altered by intense agricultural so there is greater uncertainty regarding the locations of unit contacts than in piedmont areas. Pleistocene river terrace deposits are thin, up to 3m thick, over strath basin fill deposits, typically unit Ts.

$Qy_c r$ - 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 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.

$Qy_3 r$ – Historical river terrace deposits — Terrace deposits occupying elevations from 1 to 2 meters above Qycr deposits and inset below the pre-incision historical floodplain. These surfaces are generally planar but exhibit bar and swale microtopography. Although little to 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.

Qy_2r – 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 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.

Qi_3r - Late Pleistocene river terrace deposits — River terrace deposits found on ridge ends along the San Pedro River. Qi_3r deposits are thin (< 2 m) over strath basin fill deposits, typically unit Ts, and composed of rounded to well-rounded gravels, cobbles, and finer-grained sediment.

Qi_2r - Middle to late Pleistocene river terrace deposits — River terrace deposits found on scattered hilltops along the San Pedro River over strath basin fill deposits, typically unit Ts. Qi_2r surfaces are 1-2m above Qi_3r terraces.

Qi_1r - Early to middle Pleistocene river terrace deposits — River terrace deposits found on scattered hilltops along the San Pedro River over strath basin fill deposits, typically of unit Ts. Qi_1r terraces are the highest river terraces in the map area. They are 2-3m above Qi_2r terraces.

Qir - Pliocene river deposits — Qir is composed of a moderately thick sequence of coarse, poorly-sorted San Pedro River deposits and consolidated, moderately to well-sorted, channel conglomerates that underlie Pleistocene river terrace deposits. channel conglomerates exhibit trough cross-bedding with a north-south trend. This unit sits directly on the lowest basin fill unit (map unit Ts).

Other Units

d - Disturbed areas – stock tanks and ditches

Qtc – Quaternary hillslope talus and colluvium – Colluvial deposits that form at the base of bedrock slopes. These deposits tend to be composed of angular to subangular cobbles and boulders derived from adjacent bedrock.

Bedrock Map Units

md - Mafic dike (Proterozoic to Tertiary) – Dark, typically fine-grained dikes containing abundant plagioclase and hornblende and/or pyroxene. One dike, located in the northwest quarter of section 30, in the northwest corner of the map area (UTME 561837, UTMN 3552304, NAD 83, zone 12), appears in thin section to be >99% pyroxene. There is some uncertainty in the identification as pyroxene, however. In thin section the pyroxene(?) appears as anhedral, colorless to very weakly pleochroic, with maximum second-order blue birefringence. It is unclear if the rock sample on the thin section is at the standard 30 micron thickness because there is no quartz that can be used to calibrate the thickness. Lack of pleochroism in hornblende could be due to excessive grinding resulting in a thin section that is too thin. However, it is thought that this rock is, in fact, a fairly fresh pyroxenite (sample 1-3-06-2).

Xgj - Johnny Lyon granodiorite (Paleoproterozoic) - Equigranular to weakly porphyritic, medium to fine grained granodiorite or granite. In areas where deformation and alteration are minimal, biotite phenocrysts are up to 4 mm diameter, and feldspar (probably K-feldspar) is up to 12 mm diameter. Weakly to moderately porphyritic character is obscured by alteration in most areas. In sparse areas of minimal alteration the granodiorite consists of approximately 60%, whitish feldspar, mostly in grains <2 mm diameter, 30%, <2 mm quartz, 4-8%, 1-2 mm biotite, and 2-3%, 1-4 mm oxidized hornblende. Quartz and feldspar form aggregates typically 1-5 mm diameter, locally to 10 mm. Unit contains sparse quartz veins.

Most of the granite in the Narrows and on the flanks of the San Pedro Valley near the northern edge of the Galleta Flat East Quadrangle is not severely fractured, although locally the unit is highly fractured. It was not obvious from mapping in the Narrows, just north of the Galleta Flat East 7.5' Quadrangle on the adjacent Wildhorse Mountain 7.5' Quadrangle, that this area should have any more subsurface hydrologic transmissivity than other areas of granite outcrop on the flanks of the valley, although such elevated transmissivity is suspected based on hydrologic data (Haney and Lombard, 2005).

The name Johnny Lyon granodiorite, first used by Silver (1955) and later formally adopted by the U.S. Geological Survey (Cooper and Silver, 1964), refers to the widely exposed granite directly north and northeast of the Galleta Flat East 7.5' Quadrangle (Cooper and Silver, 1964; Drewes, 1974). The name is used here for exposures near the north edge of the Galleta Flat East 7.5' Quadrangle that are mostly contiguous with the Johnny Lyon granodiorite in these adjacent areas. The granite was dated at 1643 ± 5 Ma by Eisele and Isachsen (2001).

Xlg – Leucocratic granite associated with Johnny Lyon granodiorite (Paleoproterozoic)

Xp - Pinal Schist (Paleoproterozoic) – Fine-grained quartzo-feldspathic schist with faint to clear, 1-10 mm thick, light and dark laminations. Dark laminations have abundant 20-200 micrometer magnetite forming 2-3% of rock. Near intrusive contacts with younger Johnny Lyon granodiorite, white mica is up to 10 mm diameter. In some areas this unit is a heterogeneous, fine-grained, quartz-feldspar-epidote rock with <3%, <2 mm biotite.

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