SRP2310

Geologic Map of the San Pedro River, Babocomari River and Aravaipa Creek Corridors, Southeastern Arizona

by
Joseph P. Cook, David E. Haddad
and Philip A. Pearthree

December 2008

Sheet 1 of 6

Funding for this project was provided by the Arizona Department of Water Resources

USGS 24k quadrangle series topographic base maps.
North American Datum of 1983. Projection and 1000-meter grid ticks (blue): Universal Transverse Mercator, zone 12.

1:24,000 Scale

Arizona Geological Survey
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Figure 1

Figure 2

December 2009 Subflow Delineation by Leonard Rice Engineers, Inc. for the Salt River Project on sheets 1-6, Cook et al, 2008

- Lateral extent of both surface exposure and subsurface Holocene floodplain alluvium interpreted from sheets 1-6, Cook et al, 2008, aerial photography, topographic map analysis, drillers logs and field observation.
- Subflow Zone (SFHA)- derived by adding 100 foot and 200 foot setbacks to the lateral extent of Holocene floodplain alluvium

Boundaries of Holocene River Alluvium

Thin, Solid Line
Clearly defined, accurately located contacts between Holocene river alluvium and bounding geologic units such as bedrock hillslopes, abruptly incised channels or alluvial terraces, and distinct edges of small, steep alluvial fans and talus slopes. Line location accurate to within 50 feet.

Thin, Dashed Line
Subtle or gradational contacts between Holocene river alluvium and bounding geologic units. These boundaries are often associated with very low relief distal alluvial fan onlap onto Holocene river alluvium and are often located in historically plowed fields. Line location accurate to within 100 feet.

Thin, Dotted Line
Approximately located boundary between Holocene river alluvium and bounding geologic units. Dotted line boundaries are reserved for areas which are significantly disturbed by anthropogenic activity. Placement of dotted line boundaries is based on a combination of field verification and historical aerial photo and topographic data interpretation. Line location accurate to within 500 feet depending on level of disturbance (plowed vs. paved, original topography maintained/obliterated etc.)

1105 Waypoint Location, showing station identification

Other Geologic Lines

- **Thin, Solid Line** Accurate contact
- **Thin, Dashed Line** Approximate contact
- **Thin, Dotted Line** Concealed contact
- **Hashed Line** Gradational Contact
- **Solid, Bold Line** Accurate Fault
- **Dashed, Bold Line** Approximate Fault
- **Dotted, Bold Line** Concealed Fault

Statewide Location Map

Location of each sheet shown in black

Sheet 1
Sheet 2
Sheet 3
Sheet 4
Sheet 5
Sheet 6

Figures on this Sheet

Figure locations shown in red

Figure 1
Figure 2

Map Unit Descriptions

Other units

- **d** — **Disturbed ground** - heavily disturbed ground due to agriculture, extensive excavation, or construction of earth dams
- **Plowed areas** - historically or actively plowed fields, irrigated pastures, and other lightly disturbed ground
- **Qtc** — **Quaternary hillslope talus and colluvium** - weakly bedded hillslope deposits mantling the middle and lower slopes of bedrock hills

River alluvium

- **Qyaf** — **Active river channel deposits** - unconsolidated, very poorly sorted sandy to cobbly beds in active river channels
- **Qyaf** — **Flood channel and low terrace deposits** - unconsolidated sand, gravel and silt deposits on bars, low terraces and flood channels
- **Qyaf** — **Historical river terrace deposits** - unconsolidated sand, gravel and silt deposits on low terraces inset below the abandoned early historical floodplain
- **Qyaf** — **Latest Holocene to historical river terrace deposits** - silt, clay, sand and minor gravel deposits underlying the early historical floodplain
- **Qyaf** — **Late to early Holocene river terrace deposits** - silt, clay, sand and minor gravel terrace deposits slightly above the early historical floodplain
- **Qlaf** — **Late Pleistocene river terrace deposits** - gravelly, sandy river terrace deposits up to 25 m above the active river channel
- **Qlaf** — **Middle to late Pleistocene river terrace deposits** - older, higher gravelly, sandy river terrace deposits
- **Qlaf** — **Early to middle Pleistocene river terrace deposits** - oldest, highest preserved gravelly, sandy river terrace deposits
- **Qla** — **Pleistocene river terrace deposits, undifferentiated**

Piedmont alluvium and surficial deposits

- **Qy** — **Modern stream channel deposits** - active channel deposits composed of very poorly-sorted sand, pebbles, and cobbles with some boulders to moderately-sorted sand and pebbles
- **Qyf** — **Latest Holocene alluvium** - unconsolidated, very poorly sorted silty to cobbly low terrace and overflow channel deposits
- **Qyaf** — **Late Holocene alluvium, active fan deposits** - active portions of young fan deposits exhibiting distributary drainage patterns
- **Qyf** — **Late Holocene alluvium** - planar terrace deposits located along incised drainages, broad low-relief distal fan deposits onlapping onto Holocene river alluvium, and infrequently active tributary drainage deposits
- **Qyf** — **Older Holocene alluvium** - broad, low-relief, undulating fan deposits ehxibiting widespread, shallow braided drainage patterns
- **Qys** — **Holocene fine-grained deposits** - unconsolidated fine grained alluvium derived from basin fill deposits
- **Qy** — **Holocene alluvial deposits, undifferentiated**
- **Qyl** — **Holocene and Pleistocene alluvium** - mixed fine-grained Holocene (Qy) and Pleistocene (Ql2 or Ql3) alluvium
- **Ql** — **Late Pleistocene alluvial fan and terrace deposits** - weakly consolidated sandy gravel deposits with moderate soil development
- **Ql** — **Middle to late Pleistocene alluvial fan and terrace deposits** - weakly consolidated sandy gravel deposits with strong soil development
- **Ql** — **Early to middle Pleistocene alluvial fan and terrace deposits** - high, moderately consolidated gravelly deposits with strong soil development
- **Ql** — **Pleistocene alluvial deposits, undifferentiated**
- **Qo** — **Early Pleistocene alluvial fan deposits** - highest standing Pleistocene alluvial surface in the landscape composed of moderately consolidated gravelly deposits with variable soil development
- **Qc-g** — **Early Pleistocene cobble conglomerate** - cobble conglomerate cemented by calcium carbonate

Tertiary basin fill alluvium

- **QTsd** — **Pliocene to early Pleistocene Saint David Formation** - fine-grained, highly eroded basin-fill deposits

Bedrock

- **Tg** — **Conglomerate (Cenozoic)** - Tan, thin- to medium-bedded, pebble-cobble, sandy matrix conglomerate and pebbly sandstone
- **Kai** — **Fine-grained andesite dikes (Cretaceous)** - Andesite dikes containing <5%, <1mm plagioclase phenocrysts in very fine-grained matrix
- **Kg** — **Quartz monzonite of Bronco Hill (Upper Cretaceous)** - Medium-grained, slightly plagioclase-porphyritic, 10% biotite-hornblende, quartz monzonite to quartz monzodiorite
- **Kfd** — **Porphyry of Fairbank (Upper Cretaceous)** - Phenocryst-rich porphyry
- **Kgs** — **Quartz monzonite of Government Draw (Upper Cretaceous)** - Medium-grained, slightly plagioclase-porphyritic, 10% biotite-hornblende, quartz monzonite
- **Ku** — **Uncle Sam Tuff (Upper Cretaceous)** - Phenocryst-rich ash-flow tuff
- **Kda** — **Coarse-grained andesite (Cretaceous)** - volcanic complex dominated by coarse-grained, phenocryst-rich andesitic lava and probable hypabyssal bodies containing 15-30% 1-4 mm plagioclase phenocrysts
- **Kr** — **Rhyolite (Cretaceous)** - Rhyolite containing 5-10% 1-2.5mm quartz and feldspar phenocrysts
- **Krt** — **Nonwelded ash-flow tuff (Cretaceous)** - Felsic, nonwelded, thin- to thick-bedded lithic lapilli-rich ash-flow tuff and ash-fall tuff
- **Kam** — **Medium-grained andesite dikes (Cretaceous)** - North to northwest-striking, generally steeply dipping andesite dikes
- **Kt** — **Tuff of Charleston (Cretaceous)** - Rhyolite ash-flow tuff
- **Ktx** — **Tuff of Charleston megabreccia (Cretaceous)** - Zones of the tuff of Charleston containing greater than 25% lithic blocks ranging in size from lapilli to greater than 50m
- **Kra** — **Aphyric rhyolite (Cretaceous)** - Aphyric to very phenocryst-poor rhyolite lava with probable zones of hypabyssal rock, and tuff breccia
- **Kap** — **Andesite porphyry (Cretaceous)** - distinctive, hypabyssal andesite porphyry containing 10-25%, 1-3mm, euhedral plagioclase phenocrysts in a fine-grained crystalline matrix
- **Ka** — **Andesite (Cretaceous)** - Amalgamated, andesite lava flows intruded by a myriad of dikes
- **Ks** — **Bisbee Group (Lower Cretaceous)** - Complexly intertonguing sequences of thin- to thick-bedded, cross-stratified and plane-bedded, quartz sandstone, feldspathic quartz sandstone, and lithic-feldspathic quartz sandstone, gray-green to red siltstone, mudstone, silty mudstone and shale

SRH1040

Geologic Map of the San Pedro River, Babocomari River and Aravaipa Creek Corridors, Southeastern Arizona

by
Joseph P. Cook, Erica R. Bigio,
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and Philip A Pearthree

December 2008

Sheet 6 of 6

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USGS 24k quadrangle series topographic base maps.
North American Datum of 1983. Projection and 1000-meter grid ticks (blue): Universal Transverse Mercator, zone 12.

Figure 14

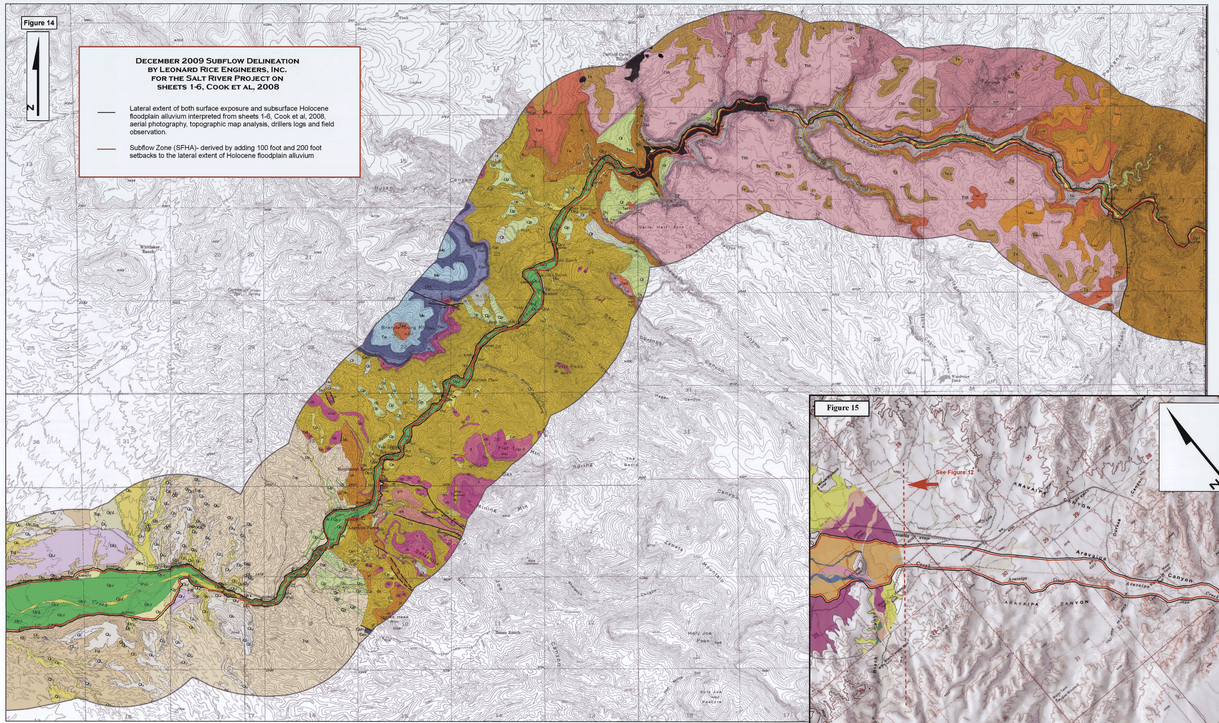

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Figure 15

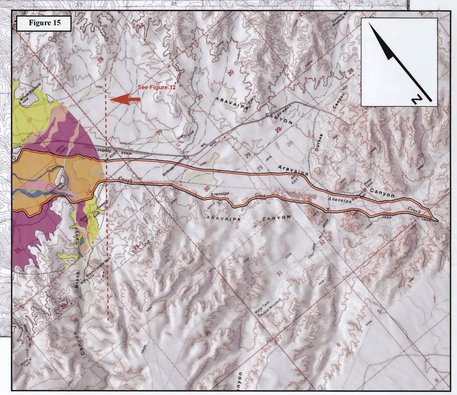
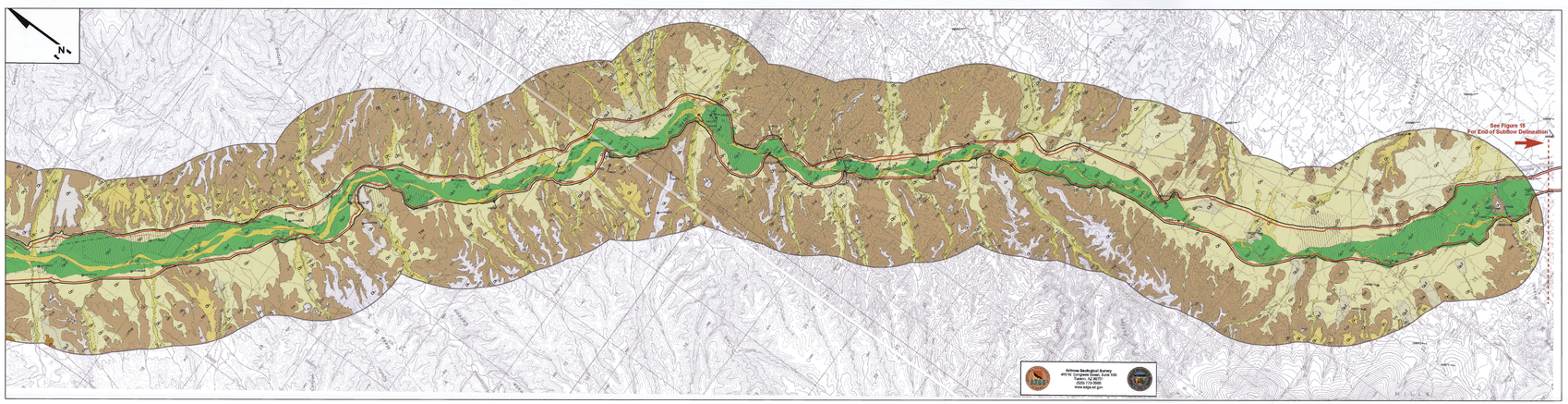


Figure 13



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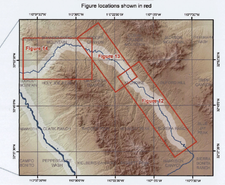

Map Unit Descriptions

Other units

- **Disturbed ground** - heavily disturbed ground due to agriculture, extensive excavation, or construction of earth dams
- **Paved areas** - moderately or actively grazed fields, irrigated pastures, and other lightly developed areas
- **Undeveloped Millville talus and colluvium** - unconsolidated to weakly consolidated very poorly sorted angular rock debris deposited at the base of bedrock slopes

River alluvium

- **Active river channel deposits** - unconsolidated, very poorly sorted sandy to cobbly bedrock in active river channels
- **Flood channel and low terrace deposits** - unconsolidated sand, gravel and silt deposits on bars, low terraces and flood channels
- **Historical river terrace deposits** - unconsolidated sand, gravel and silt deposits on river terraces from the approximately Historical floodplain
- **Latest Holocene to Holocene river terrace deposits** - silt, clay, sand and minor gravel deposits underlying the early Historical floodplain
- **Late to early Holocene river terrace deposits** - silt, clay, sand and minor gravel terrace deposits slightly above the early Historical floodplain
- **Late Pleistocene river terrace deposits** - gravelly, sandy river terrace deposits up to 25 m above the active river channel
- **Middle to late Pleistocene river terrace deposits** - older, higher gravelly, sandy river terrace deposits
- **Early to middle Pleistocene river terrace deposits** - oldest, highest preserved gravelly, sandy river terrace deposits

Piedmont alluvium and colluvial deposits

- **Modern stream channel deposits** - active channel deposits composed of very poorly sorted sand, pebbles, and cobbles with some boulders to moderately sorted sand and pebbles
- **Latest Holocene alluvium** - unconsolidated, very poorly sorted silty to cobbly fan terraces and overflow channel deposits
- **Late Holocene alluvium, active fan deposits** - active portions of young fan deposits exhibiting overflowing or braided channels
- **Late Holocene fan terrace deposits** - fan terrace deposits beveled along crosscut drainages, lacking overflow channels, but preserving only measures and volume, and infrequently active crosscut drainage deposits
- **Mid-Holocene alluvium** - broad, "non-active", not-active fan deposits exhibiting extensively eroded drainage patterns
- **Holocene fine-grained deposits** - unconsolidated alluvium derived predominantly from basalt YD deposits
- **Soils** - soils deposits consisting of large angular blocks to silt-sized particles, locally cemented with calcium
- **Surficial deposits, undivided** - includes fine-grained colluvium and alluvium, talus, and some playa/marsh and basaltal gravels
- **Colluvium deposits** - comes largely of Datura Volcanics, locally cemented with calcite
- **Pediment gravel veneer** - subangular pebbles and cobbles, includes some pedimento and Tertiary Basalt gravels
- **Late Pleistocene alluvial fan and terrace deposits** - weakly consolidated sand and gravel deposits with moderate soil development
- **Middle to late Pleistocene alluvial fan and terrace deposits** - weakly consolidated sandy gravel deposits with strong soil development
- **Early to middle Pleistocene alluvial fan and terrace deposits** - high, moderately consolidated gravelly deposits with strong soil development

Tertiary basin fill alluvium

- **Late Miocene to Pliocene Gulkana deposits, alluvial fan facies** - sandy to gravelly, moderately to strongly indurated alluvial fan deposits
- **Late Miocene to Pliocene deposits** - moderately to strongly indurated conglomerate and sandstone (basin fill deposits)

Bedrock

- **Apache Conglomerate Member** - cliff-forming conglomerate and conglomeratic tuff
- **Hell Hole Conglomerate** - red-brown tuff conglomerate composed mainly of volcanic debris, includes the mass of tuff and lava
- **Hells Half Acre Tuff member** - air fall, ultra, nonwelded to slightly welded ash flow, and reworked rhyolite tuffs
- **Hells Half Acre Rhyolite-obsidian** - flow banded obsidian to rhyolite flow brecciae
- **Virgus Canyon upper Andesite** - fine-grained, aphyric andesite entrada with small phenocrysts of plagioclase
- **Virgus Canyon Conglomerate** - pebble and cobble darkred from lower andesite of Virgus Canyon
- **Virgus Canyon lower Andesite** - coarsely porphyritic (Turney Trail) andesite
- **Arovaipa Member, nonwelded zone** - slope forming ashy tuff
- **Arovaipa Member, welded zones** - partly welded, welded, and lower nonwelded tuff
- **Bear Springs Canyon Conglomerate** - sourced from older members of the Galiuro Volcanics, andesite, and rhyolite
- **Bear Springs Canyon Tuff** - rhyolite ash-flow tuff
- **Conglomerate of Depression Canyon** - composed of older rocks, including older members of the Galiuro Volcanics
- **Depression Canyon Andesite** - massive, flow banded, to aggloromeratic, gray, brown, and olive andesite
- **Holy Joe Member** - quartz latite ash flow tuff
- **Willcox(?) Conglomerate** - composed of pedestal and colluvium of Precambrian and Paleozoic rocks
- **Rhyolite tuff bed within Willcox(?) Conglomerate** - white rhyolite tuff bed (5-25 ft thick) in Aravaipa Canyon
- **Horse Mountain Volcanics** - silica bed, tuff, andesite tuff, obsidian, and rhyolite
- **Bocaboma Limestone** - massive, cliff-forming, thick-bedded, mostly coarsegrained limestone
- **Martin Formation** - slope-forming shale unit with interbedded limestone beds
- **Abrigo Formation, upper member** - cliff-forming, mostly poorly sorted, cross-bedded, dolomitic and gypsiferous sandstone
- **Abrigo Formation, middle member** - cliff-forming mostly poorly sorted sandstone and argillaceous sandstone
- **Abrigo Formation, lower member** - thin-bedded, slope-forming mudstone, siltstone, and sandy mudstone
- **Dolomite** - dolomite
- **Troy Quartzite, upper unit** - sandstone, quartzite, and granule to small pebble conglomerate
- **Troy Quartzite, lower unit** - conglomerate and sandstone
- **Dripping Springs Quartzite** - feldspathic to arkosic quartzite and siltstone
- **Pioneer** - massive to slightly foliated, fine-grained porphyritic rock
- **Granitic rocks, undivided** - granodiorite or leucogranite quartz monzonite
- **Pinal schist** - Fines, tuffs, and flow breccias of andesitic composition

1:24,000 SCALE

1 0.5 0 1 Miles
1 0.5 0 1 Kilometers
1 1000 2000 3000 4000 5000 Feet

USGS 24k quadrangle series topographic base maps
North American Datum of 1983. Projection and 1000-meter grid ticks (blue): Universal Transverse Mercator, zone 12.

Boundaries of Holocene River Alluvium

Thin, Solid Line
Clearly defined, accurately located contacts between Holocene river alluvium and bounding geologic units such as bedrock hillslopes, abruptly incised channels or alluvial terraces, and distinct edges of alluvial fans, colluvial fans and talus slopes. Line location accurate to within 50 feet.

Thin, Dashed Line
Subtle or gradational contacts between Holocene river alluvium and bounding geologic units. These boundaries are often associated with very low relief distal alluvial fan or/slap orlitz Holocene river alluvium and are often located in historically plowed fields. Line location accurate to within 100 feet.

Thin, Dotted Line
Approximately located boundary between Holocene river alluvium and bounding geologic units. Dotted line boundaries are reserved for areas which are significantly disturbed by anthropogenic activity. Placement of dotted line boundaries is based on a combination of aerial photo interpretation, topographic map analysis, and field interpretation. Line location accurate to within 500 feet depending on level of disturbance (plowed vs. paved, original topography maintained/obliterated etc.)

Viewpoint Location, showing station identification

Other Geologic Lines

- Thin, Solid Line — Accurate contact
- Thin, Dashed Line — Approximate contact
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SRP11H5 Ø Ø/Ø

SRP2312

Geologic Map of the San Pedro River, Babocomari River and Aravaipa Creek Corridors, Southeastern Arizona

by
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Sheet 2 of 6

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Statewide Location Map

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Map Unit Descriptions

Other units

- **Qd** — **Disturbed ground** - heavily disturbed ground due to agriculture, extensive excavation, or construction of earth dams
- **Pioneed areas** - historically or actively plowed fields, irrigated pastures, and other lightly disturbed ground
- **Qtr** — **Quaternary hillslope talus and colluvium** - weakly bedded hillslope deposits mantling the middle and lower slopes of bedrock hills

River alluvium

- **Qaf** — **Active river channel deposits** - unconsolidated, very poorly sorted sandy to cobbly beds in active river channels
- **Qfc** — **Flood channel and low terrace deposits** - unconsolidated sand, gravel and silt deposits on bars, low terraces and flood channels
- **Qhf** — **Historical river terrace deposits** - unconsolidated sand, gravel and silt deposits on low terraces (river) below the abandoned early historical floodplain
- **Qlf** — **Latest Holocene to historical river terrace deposits** - silt, clay, sand and minor gravel deposits underlying the early historical floodplain
- **Qmf** — **Late to early Holocene river terrace deposits** - silt, clay, sand and minor gravel terrace deposits slightly above the early historical floodplain
- **Qu** — **Late Pleistocene river terrace deposits** - gravelly, sandy river terrace deposits up to 25 m above the active river channel
- **Qd** — **Middle to late Pleistocene river terrace deposits** - older, higher gravelly, sandy river terrace deposits
- **Qm** — **Early to middle Pleistocene river terrace deposits** - oldest, highest preserved gravelly, sandy river terrace deposits
- **Qtf** — **Early Pleistocene river terrace deposits** - very high remnant river terrace deposits located 30 to 40 m above the active channel-emanating from Babocomari Mesa

Piedmont alluvium and surficial deposits

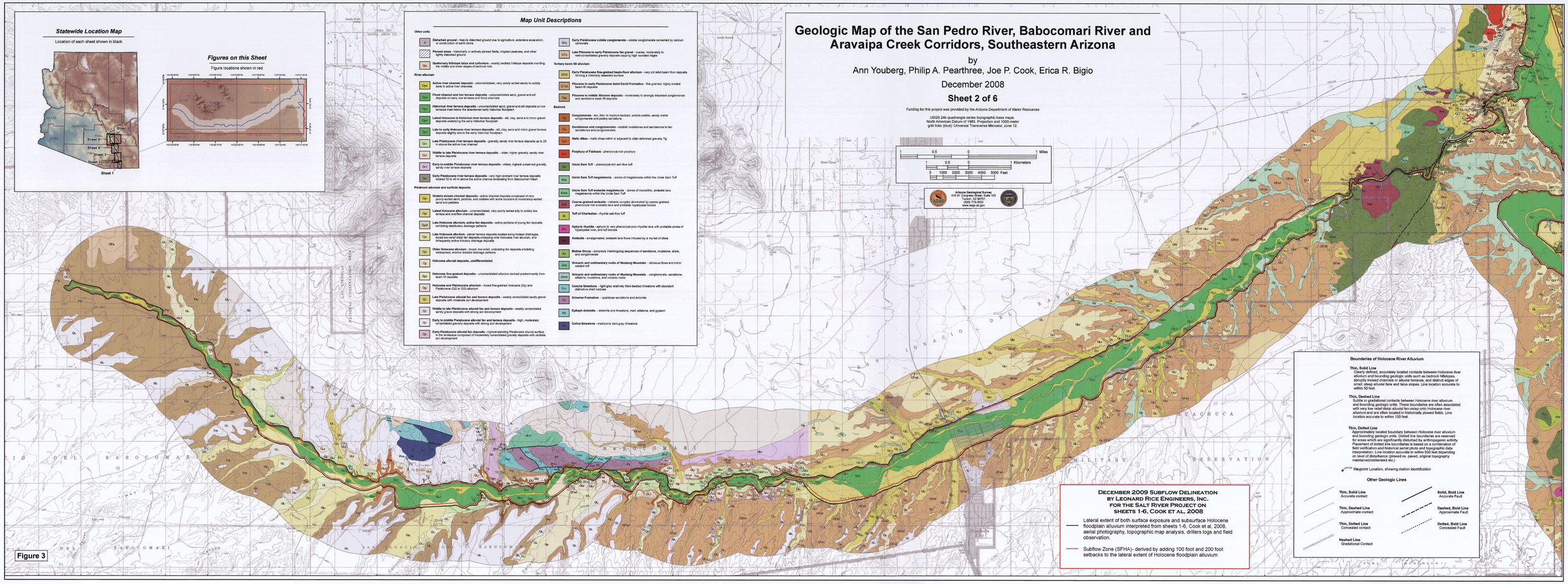
- **Qc** — **Modern stream channel deposits** - active channel deposits composed of very poorly-sorted sand, pebbles, and cobbles with some boulders to moderately-sorted sand and pebbles
- **Qlf** — **Latest Holocene alluvium** - unconsolidated, very poorly sorted silty to cobbly low terrace and overflow channel deposits
- **Qaf** — **Late Holocene alluvium, active fan deposits** - active portions of young fan deposits excluding distributary drainage patterns
- **Qp** — **Late Holocene alluvium** - planar terrace deposits located along incised drainages, broad low-relief distal fan deposits onlapping onto Holocene river alluvium, and infrequently active tributary drainage deposits
- **Qd** — **Older Holocene alluvium** - broad, low-relief, undulating fan deposits exhibiting widespread, shallow braided drainage patterns
- **Qh** — **Holocene alluvial deposits, undifferentiated**
- **Qfc** — **Holocene fine-grained deposits** - unconsolidated alluvium derived predominantly from basin fill deposits
- **Qfd** — **Holocene and Pleistocene alluvium** - mixed fine-grained Holocene (Qa) and Pleistocene (Qd or Qd) alluvium
- **Qt** — **Late Pleistocene alluvial fan and terrace deposits** - weakly consolidated sandy gravel deposits with moderate soil development
- **Qt** — **Middle to late Pleistocene alluvial fan and terrace deposits** - weakly consolidated sandy gravel deposits with strong soil development
- **Qt** — **Early to middle Pleistocene alluvial fan and terrace deposits** - high, moderately consolidated gravelly deposits with strong soil development
- **Qtc** — **Early Pleistocene alluvial fan deposits** - highest standing Pleistocene alluvial surface in the landscape composed of moderately consolidated gravelly deposits with variable soil development
- **Qcg** — **Early Pleistocene cobble conglomerate** - cobble conglomerate cemented by calcium carbonate
- **QTd** — **Late Pliocene to early Pleistocene fan gravel** - coarse, moderately to well-consolidated gravelly deposits capping high rounded ridges

Tertiary basin fill alluvium

- **QTbf** — **Early Pleistocene fine-grained basin-floor alluvium** - very old relict basin floor deposits forming a minimally dissected surface
- **QTsd** — **Pliocene to early Pleistocene Saint David Formation** - fine-grained, highly eroded basin-fill deposits
- **Tsg** — **Pliocene to middle Miocene deposits** - moderately to strongly indurated conglomerate and sandstone basin fill deposits

Bedrock

- **Tc** — **Conglomerate** - tan, thin- to medium-bedded, pebble-cobble, sandy matrix conglomerate and paddy sandstone
- **Tss** — **Sandstones and conglomerates** - reddish mudstones and sandstones to tan sandstones and conglomerates
- **Tgd** — **Mafic dikes** - mafic dikes within or adjacent to older deformed gravels, Tg
- **Kpp** — **Porphyry of Fairbank** - phenocryst-rich porphyry
- **Kt** — **Uncle Sam Tuff** - phenocryst-rich ash-flow tuff
- **Kgb** — **Uncle Sam Tuff megabreccia** - zones of megabreccia within the Uncle Sam Tuff
- **Kunb** — **Uncle Sam Tuff andesite megabreccia** - zones of monolithic andesite lava megabreccia within the Uncle Sam Tuff
- **Kcg** — **Coarse-grained andesite** - volcanic complex dominated by coarse-grained, phenocryst-rich andesitic lava and probable hypabyssal bodies
- **Kt** — **Tuff of Charleston** - rhyolite ash-flow tuff
- **Krh** — **Aphyric rhyolite** - aphyric to very phenocryst-poor rhyolite lava with probable zones of hypabyssal rock, and tuff breccia
- **Ka** — **Andesite** - amalgamated, andesite lava flows intruded by a myriad of dikes
- **Kb** — **Bisbee Group** - complexly interfingering sequences of sandstone, mudstone, shale, and conglomerate
- **JPm** — **Volcanic and sedimentary rocks of Mustang Mountain** - siliceous flows and minor welded tuff
- **JPMm** — **Volcanic and sedimentary rocks of Mustang Mountain** - conglomerate, sandstone, siltstone, mudstone, and volcanic rocks
- **Pmc** — **Concha limestone** - light-gray relatively thick-bedded limestone with abundant distinctive chert nodules
- **Ps** — **Scherrer Formation** - quartzose sandstone and dolomite
- **Pe** — **Epitaph dolomite** - dolomite and limestone, marl, siltstone, and gypsum
- **Pm** — **Colina limestone** - medium-to dark-gray limestone



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SFHYDUD

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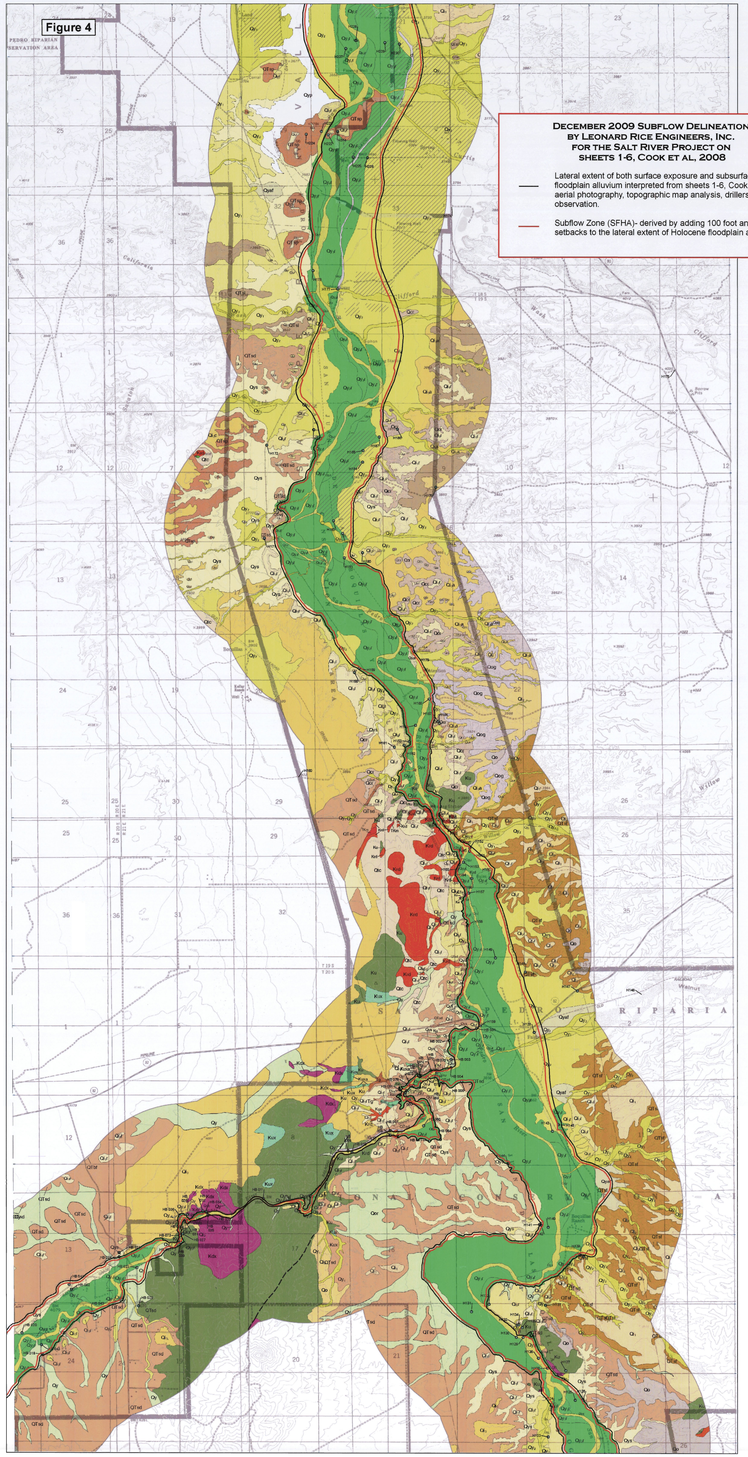
North American Datum of 1983. Projection and 1000-meter grid ticks (blue): Universal Transverse Mercator, zone 12.

Figure 4


PEDRO RIPARIAN
RESERVATION AREA
SAN PEDRO
RIPARIA
Qu
Qyf
Qmf
Qhf
Qlf
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Qmr
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QTsr
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Kus

Geologic Map of the San Pedro River, Babocomari River and Aravaipa Creek Corridors, Southeastern Arizona

by
Joseph P. Cook, David E. Haddad, Andrew L. Kowler and Philip A. Pearthree

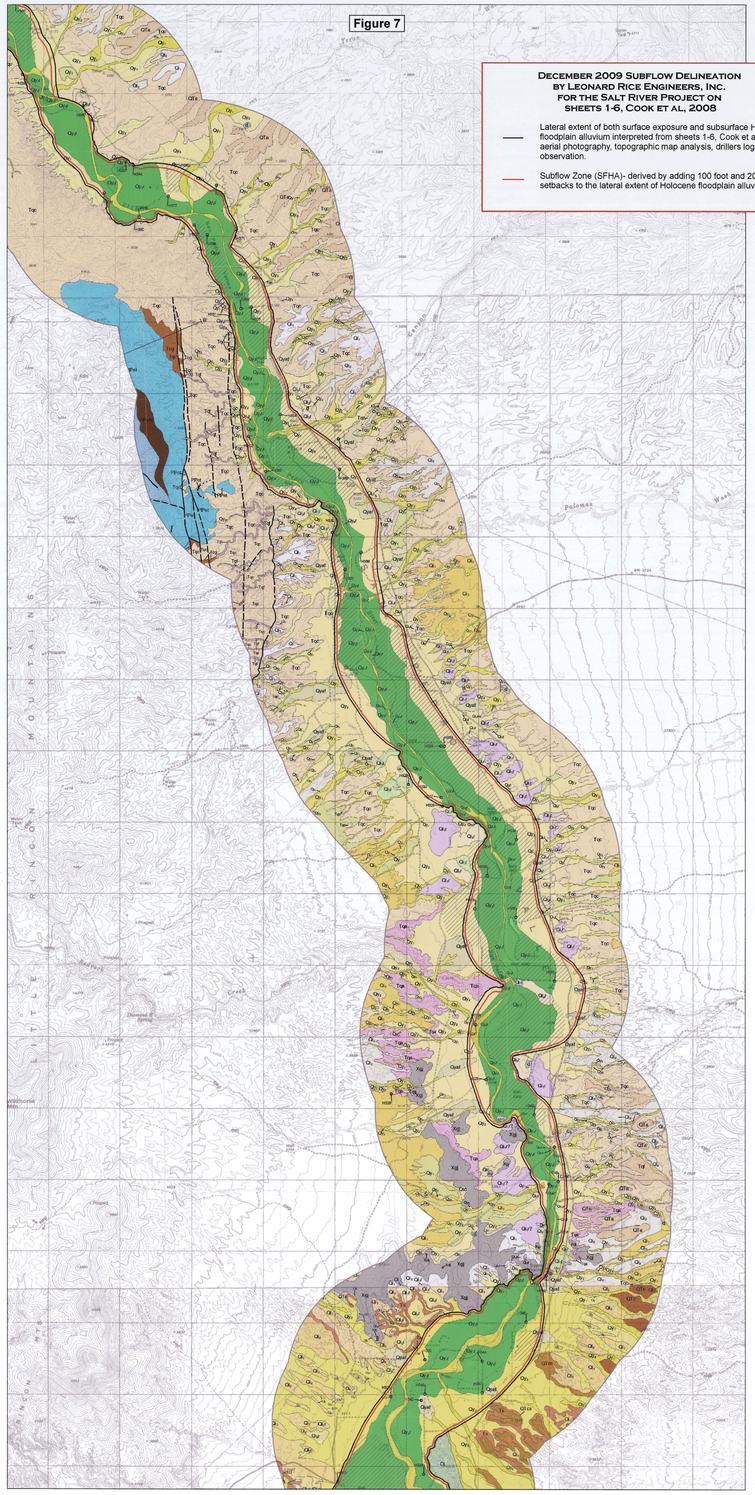
December 2008

Sheet 4 of 6

Funding for this project was provided by the Arizona Department of Water Resources

USGS 24k quadrangle series topographic base maps
North American Datum of 1983. Projection and 1000-meter grid ticks (blue): Universal Transverse Mercator, zone 12.

Figure 7

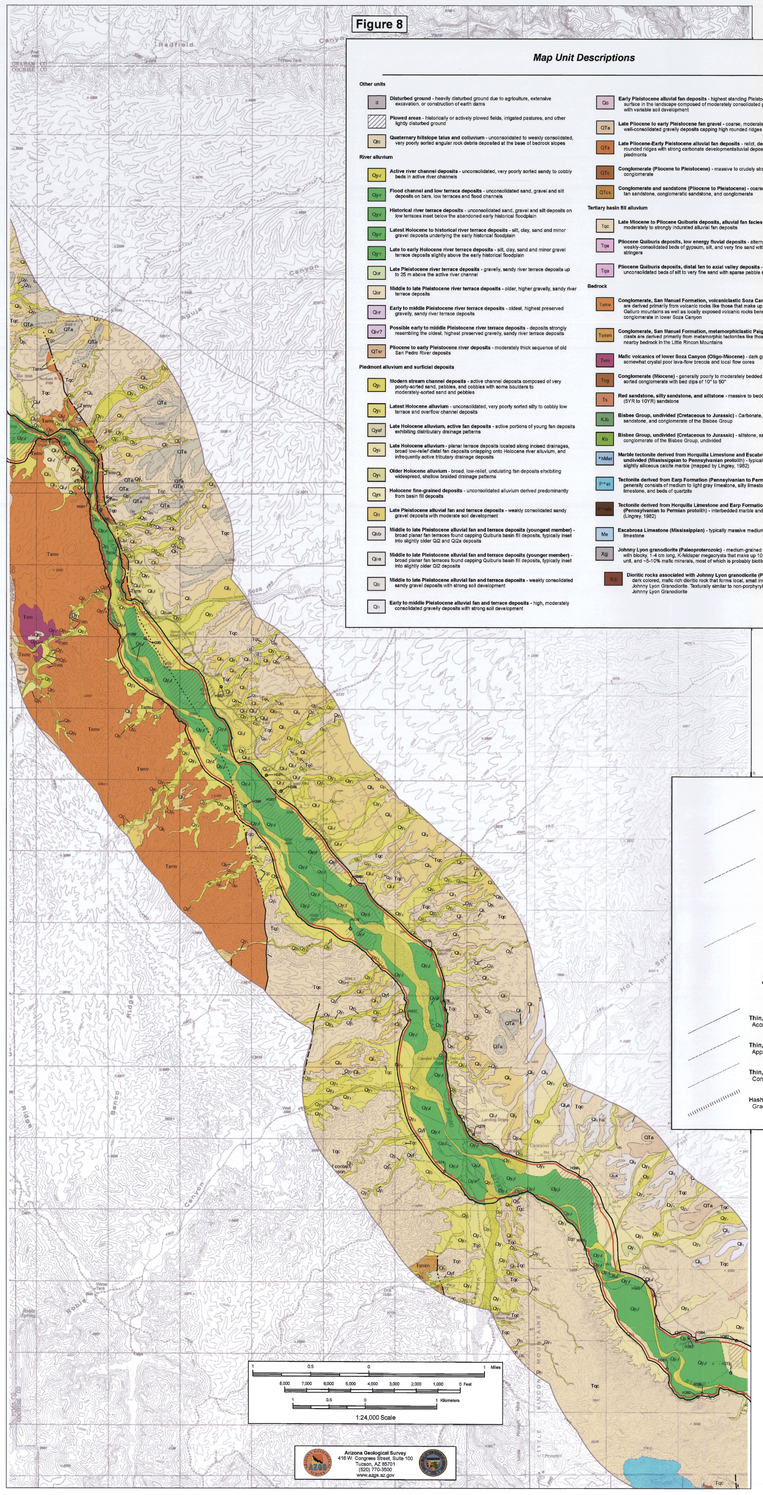


December 2009 Subflow Delineation by Leonard Rice Engineers, Inc. for the Salt River Project on sheets 1-6, Cook et al., 2008

Lateral extent of both surface exposure and subsurface Holocene floodplain alluvium interpreted from sheets 1-6, Cook et al, 2008, aerial photography, topographic map analysis, drillers logs and field observation.

Subflow Zone (SFHA)- derived by adding 100 foot and 200 foot setbacks to the lateral extent of Holocene floodplain alluvium

Figure 8



Map Unit Descriptions

Other units

- **if** — **Disturbed ground** - heavily disturbed ground due to agriculture, extensive excavation, or construction of earth dams
- **Pf** — **Plowed areas** - historically or actively plowed fields, irrigated pastures, and other lightly disturbed ground
- **Qto** — **Quaternary hillslope talus and colluvium** - unconsolidated to weakly consolidated, very poorly sorted angular rock debris deposited at the base of bedrock slopes

River alluvium

- **Qyr** — **Active river channel deposits** - unconsolidated, very poorly sorted sandy to cobbly beds in active river channels
- **Qyf** — **Flood channel and low terrace deposits** - unconsolidated sand, gravel and silt deposits on bars, low terraces and flood channels
- **Qyr1** — **Historical river terrace deposits** - unconsolidated sand, gravel and silt deposits on low terraces inset below the abandoned early historical floodplain
- **Qy1** — **Latest Holocene to historical river terrace deposits** - silt, clay, sand and minor gravel deposits underlying the early historical floodplain
- **Qy2** — **Late to early Holocene river terrace deposits** - silt, clay, sand and minor gravel terrace deposits slightly above the early historical floodplain
- **Qyr** — **Late Pleistocene river terrace deposits** - gravelly, sandy river terrace deposits up to 25 m above the active river channel
- **Qtr** — **Middle to late Pleistocene river terrace deposits** - older, higher gravelly, sandy river terrace deposits
- **Qtr1** — **Early to middle Pleistocene river terrace deposits** - oldest, highest preserved gravelly, sandy river terrace deposits
- **Qtr1?** — **Possible early to middle Pleistocene river terrace deposits** - deposits strongly resembling the oldest, highest preserved gravelly, sandy river terrace deposits
- **QTsr** — **Pliocene to early Pleistocene river deposits** - moderately thick sequence of old San Pedro River deposits

Piedmont alluvium and surficial deposits

- **Qy** — **Modern stream channel deposits** - active channel deposits composed of very poorly-sorted sand, pebbles, and cobbles with some boulders to moderately-sorted sand and pebbles
- **Qyi** — **Latest Holocene alluvium** - unconsolidated, very poorly sorted silty to cobbly low terrace and overflow channel deposits
- **Qyaf** — **Late Holocene alluvium, active fan deposits** - active portions of young fan deposits exhibiting distributary drainage patterns
- **Qyi** — **Late Holocene alluvium** - planar terrace deposits located along incised drainages, broad low-relief distal fan deposits cntapping onto Holocene river alluvium, and infrequently active tributary drainage deposits
- **Qyi** — **Older Holocene alluvium** - broad, low-relief, undulating fan deposits exhibiting widespread, shallow braided drainage patterns
- **Qyn** — **Holocene fine-grained deposits** - unconsolidated alluvium derived predominantly from basin fill deposits
- **Qs** — **Late Pleistocene alluvial fan and terrace deposits** - weakly consolidated sandy gravel deposits with moderate soil development
- **Qs/o** — **Middle to late Pleistocene alluvial fan and terrace deposits (youngest member)** - broad planar fan terraces found stepping Quituna basin fill deposits, typically inset into slightly older Qs2 and Qs2a deposits
- **Qs/a** — **Middle to late Pleistocene alluvial fan and terrace deposits (younger member)** - broad planar fan terraces found stepping Quituna basin fill deposits, typically inset into slightly older Qs2 deposits
- **Qs2** — **Middle to late Pleistocene alluvial fan and terrace deposits** - weakly consolidated sandy gravel deposits with strong soil development
- **Qt** — **Early to middle Pleistocene alluvial fan and terrace deposits** - high, moderately consolidated gravelly deposits with strong soil development
- **Qs** — **Early Pleistocene alluvial fan deposits** - highest standing Pleistocene alluvial surface in the landscape composed of moderately consolidated gravelly deposits with variable soil development
- **QTa** — **Late Pliocene to early Pleistocene fan gravel** - coarse, moderately to well-consolidated gravelly deposits capping high mounded ridges
- **QTa** — **Late Pliocene-Early Pleistocene alluvial fan deposits** - relict, deeply dissected mounded ridges with strong carbonate developmentalforial deposits found on upper piedmonts
- **QTc** — **Conglomerate (Pliocene to Pleistocene)** - massive to crudely stratified conglomerate
- **QTcs** — **Conglomerate and sandstone (Pliocene to Pleistocene)** - coarse, poorly sorted, tan sandstone, conglomeratic sandstone, and conglomerate

Tertiary basin fill alluvium

- **Tsc** — **Late Miocene to Pliocene Quiburis deposits, alluvial fan facies** - sandy to gravelly, moderately to strongly indurated alluvial fan deposits
- **Tsp** — **Pliocene Quiburis deposits, low energy fluvial deposits** - alternating thin weakly-consolidated beds of gypsum, silt, and very fine sand with sparse pebble stringers
- **Tsp** — **Pliocene Quiburis deposits, distal fan to axial valley deposits** - alternating thin unconsolidated beds of silt to very fine sand with sparse pebble stringers

Bedrock

- **Tsmc** — **Conglomerate, San Manuel Formation, volcaniclastic Soza Canyon facies** - clasts are derived primarily from volcanic rocks like those that make up most of the Galiuro mountains as well as locally exposed volcanic rocks beneath the conglomerate in lower Soza Canyon
- **Tsmm** — **Conglomerate, San Manuel Formation, metamorphiclastic Paige Canyon facies** - clasts are derived primarily from metamorphic textonites like those that form nearby bedrock in the Little Rincon Mountains
- **Tsm** — **Mafic volcanics of lower Soza Canyon (Oligo-Miocene)** - dark gray to black, somewhat crystal poor lava-flow breccia and local flow cores
- **Tcg** — **Conglomerate (Miocene)** - generally poorly to moderately bedded and poorly sorted conglomerate with bed dips of 10° to 50°
- **Ts** — **Red sandstone, silty sandstone, and siltstone** - massive to bedded, reddish brown (5YR to 10YR) sandstone
- **Klb** — **Bisbee Group, undivided (Cretaceous to Jurassic)** - Carbonate, siltstone, sandstone, and conglomerate of the Bisbee Group
- **Klc** — **Bisbee Group, undivided (Cretaceous to Jurassic)** - siltstone, sandstone, and conglomerate of the Bisbee Group, undivided
- **Ymm** — **Marble tectonite derived from Horquilla Limestone and Escabrosa Limestone, undivided (Mississippian to Pennsylvanian protolith)** - typically calcite marble and slightly alliaceus calcite marble (mapped by Lingrey, 1982)
- **PPm** — **Tectonite derived from Earp Formation (Pennsylvanian to Permian protolith)** - generally consists of medium to light gray limestone, silty limestone, sandy limestone, and beds of quartzite
- **Ym** — **Tectonite derived from Horquilla Limestone and Earp Formation, undivided (Pennsylvanian to Permian protolith)** - interbedded marble and salo-alkalic gneiss (Lingrey, 1982)
- **Me** — **Escabrosa Limestone (Mississippian)** - typically massive medium to pale gray limestone
- **Xg** — **Johnny Lyon granodiorite (Paleoproterozoic)** - medium grained biotite granodiorite with blocky, 1-4 cm long, K-feldspar megacrysts that make up 10-25% of the rock unit, and ~5-10% mafic minerals, most of which is probably biotite
- **Xd** — **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

Boundaries of Holocene River Alluvium

Thin, Solid Line
Clearly defined, accurately located contacts between Holocene river alluvium and bounding geologic units such as bedrock hillslopes, abruptly incised channels or alluvial terraces, and distinct edges of small, steep alluvial fans and talus slopes. Line location accurate to within 50 feet.

Thin, Dashed Line
Subtle or gradational contacts between Holocene river alluvium and bounding geologic units. These boundaries are often associated with very low relief distal alluvial fan onlap onto Holocene river alluvium and are often located in historically plowed fields. Line location accurate to within 100 feet.

Thin, Dotted Line
Approximately located boundary between Holocene river alluvium and bounding geologic units. Dotted line boundaries are reserved for areas which are significantly disturbed by anthropogenic activity. Placement of dotted line boundaries is based on a combination of field verification and historical aerial photo and topographic data interpretation. Line location accurate to within 500 feet depending on level of disturbance (plowed vs. paved, original topography maintained/obliterated etc.)

Waypoint Location, showing station identification

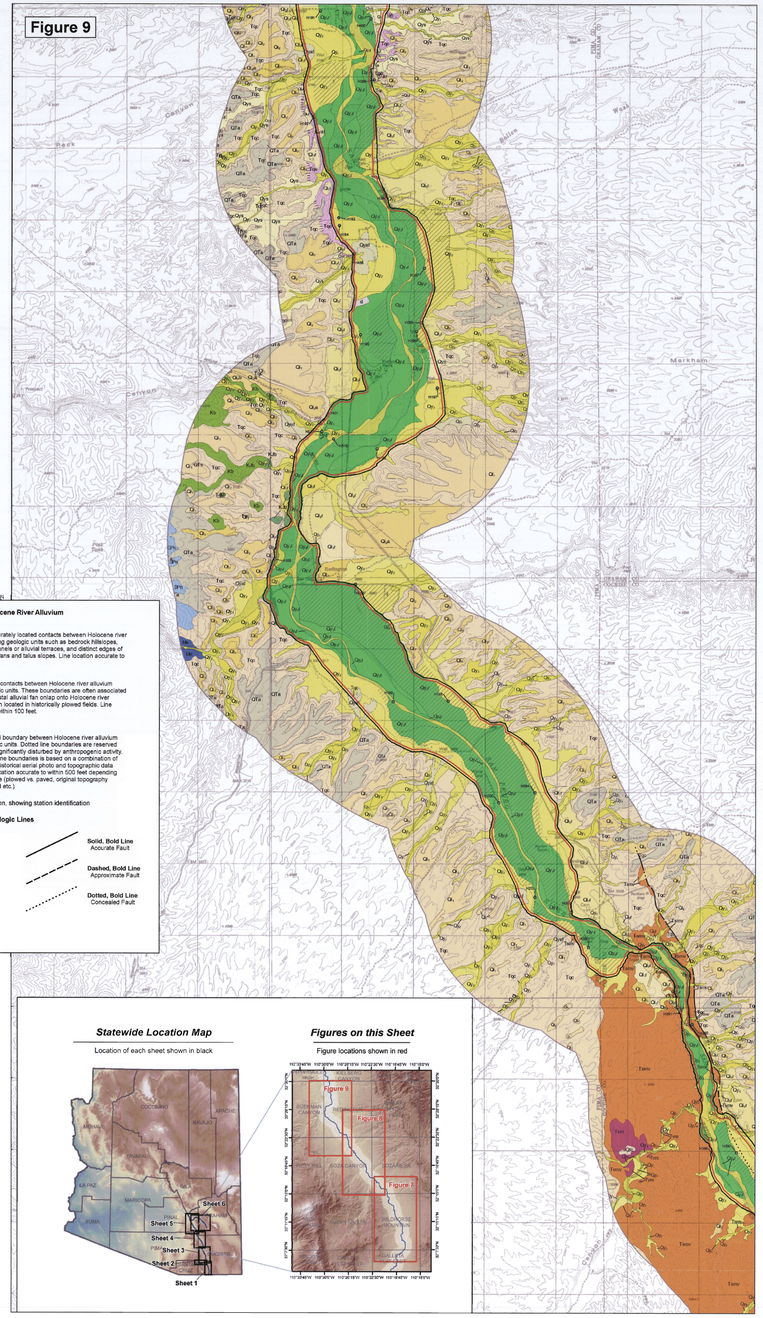
Other Geologic Lines

- **Thin, Solid Line** — Accurate contact
- **Thin, Dashed Line** — Approximate contact
- **Thin, Dotted Line** — Concealed contact
- **Hashed Line** — Gradational Contact
- **Solid, Bold Line** — Accurate Fault
- **Dashed, Bold Line** — Approximate Fault
- **Dotted, Bold Line** — Concealed Fault

1:24,000 Scale

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

Figure 9



Statewide Location Map

Location of each sheet shown in black

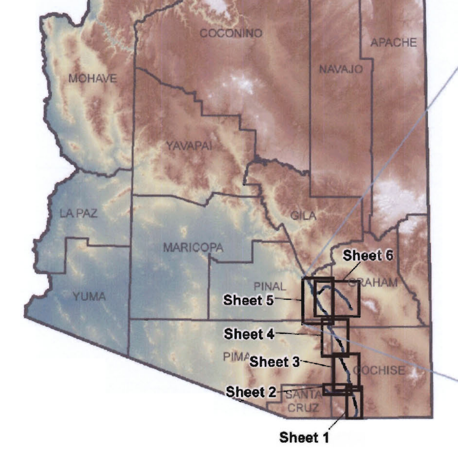
Figures on this Sheet

Figure locations shown in red

SPH1940

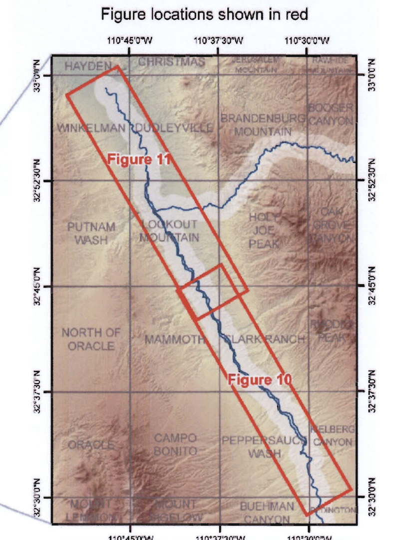
Statewide Location Map

Location of each sheet shown in black



Figures on this Sheet

Figure locations shown in red



Geologic Map of the San Pedro River, Babocomari River and Aravaipa Creek Corridors, Southeastern Arizona

by
Joseph P. Cook, Bryan J. MacFarlane,
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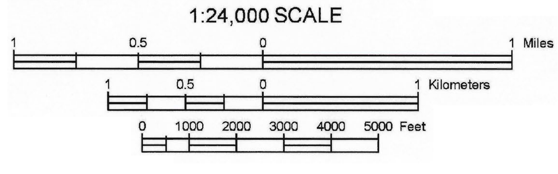
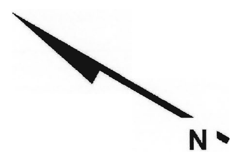
September 2008

Sheet 5 of 6

Funding for this project was provided by the
Arizona Department of Water Resources

USGS 24k quadrangle series topographic base maps.
North American Datum of 1983. Projection and 1000-meter
grid ticks (blue): Universal Transverse Mercator, zone 12.





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Map Unit Descriptions

Other units

- d — **Disturbed ground** - heavily disturbed ground due to agriculture, extensive excavation, or construction of earth dams.
- (hatched) — **Plowed areas** - historically or actively plowed fields, irrigated pastures, and other lightly disturbed ground.
- Qtc — **Quaternary hillslope talus and colluvium** - unconsolidated to weakly consolidated, very poorly sorted angular rock debris deposited at the base of bedrock slopes

River alluvium

- Qyr — **Active river channel deposits** - unconsolidated, very poorly sorted sandy to cobbly beds in active river channels
- Qyr — **Flood channel and low terrace deposits** - unconsolidated sand, gravel and silt deposits on bars, low terraces and flood channels
- Qyr — **Historical river terrace deposits** - unconsolidated sand, gravel and silt deposits on low terraces inset below the abandoned early historical floodplain
- Qyr — **Latest Holocene to historical river terrace deposits** - silt, clay, sand and minor gravel deposits underlying the early historical floodplain
- Qyr — **Late to early Holocene river terrace deposits** - silt, clay, sand and minor gravel terrace deposits slightly above the early historical floodplain
- Qlr — **Late Pleistocene river terrace deposits** - gravelly, sandy river terrace deposits up to 25 m above the active river channel
- Qlr — **Middle to late Pleistocene river terrace deposits** - older, higher gravelly, sandy river terrace deposits
- Qhr — **Early to middle Pleistocene river terrace deposits** - oldest, highest preserved gravelly, sandy river terrace deposits
- Qr — **Pleistocene river terrace deposits, undifferentiated**

Piedmont alluvium and surficial deposits

- Qy — **Modern stream channel deposits** - active channel deposits composed of very poorly-sorted sand, pebbles, and cobbles with some boulders to moderately-sorted sand and pebbles
- Qy — **Latest Holocene alluvium** - unconsolidated, very poorly sorted silty to cobbly low terrace and overflow channel deposits
- Qyaf — **Late Holocene alluvium, active fan deposits** - active portions of young fan deposits exhibiting distributary drainage patterns
- Qy — **Late Holocene alluvium** - planar terrace deposits located along incised drainages, broad low-relief distal fan deposits onlapping onto Holocene river alluvium, and infrequently active tributary drainage deposits
- Qy — **Older Holocene alluvium** - broad, low-relief, undulating fan deposits exhibiting widespread, shallow braided drainage patterns
- Qyf — **Early to late Holocene (?) alluvial fan** - inactive fan deposits at the mouth of Tucson Wash
- Qys — **Holocene fine-grained deposits** - unconsolidated fine grained alluvium derived from basin fill deposits
- Qs — **Surficial deposits, undivided** - includes fine-grained colluvium and alluvium, talus, and some pediment and terrace gravels
- Ql — **Late Pleistocene alluvial fan and terrace deposits** - weakly consolidated sandy gravel deposits with moderate soil development
- Qlz — **Middle to late Pleistocene alluvial fan and terrace deposits** - weakly consolidated sandy gravel deposits with strong soil development
- Qi — **Early to middle Pleistocene alluvial fan and terrace deposits** - high, moderately consolidated gravelly deposits with strong soil development
- Qiu — **Pleistocene alluvial terrace - undivided** - coarse clastic alluvial fan and terrace deposits with slightly to moderately reddened soils
- Qo — **Early Pleistocene alluvial fan deposits** - highest standing Pleistocene alluvial surface in the landscape composed of moderately consolidated gravelly deposits with variable soil development
- QTa — **Late Pliocene to early Pleistocene fan gravel** - coarse, moderately to well-consolidated gravelly deposits capping high rounded ridges
- Tqp — **Late Miocene to Pliocene Quiburis deposits, playa facies** - silty, moderately to strongly indurated alluvial playa deposits
- Tqr — **Late Pliocene (?) Quiburis deposits, fluvial facies** - sandstone and conglomerate, fluvial deposits
- Tqs — **Pliocene Quiburis deposits, sandy fan toe facies** - sandy fan-toe, lake-margin, and delta-front sandflat facies
- Tqse — **Pliocene Quiburis deposits, delta front subfacies** - sandstone, locally pebbly, with multiple thin mudstone interbeds

Bedrock

- Tgv — **Galluro Volcanics** - lateral equivalent of Cloudburst Formation
- Trx — **Rhyolite intrusion and intrusive breccia** - at the south edge of the map area, this unit consists of crystal-poor, massive to flow-banded rhyolite and clast-supported brecciated rhyolite
- Ta — **Basaltic andesite lava (Oligocene to lower Miocene)** - Lava flows and autobreccia with 1-10%, generally <5 mm pyroxene and up to 10%, <6 mm, plagioclase phenocrysts. Matrix commonly contains abundant <0.1 mm plagioclase needles and equant magnetite.
- Mzs — **Clastic sedimentary rocks** - sandstone and siltstone with basal conglomerate and chert-fragment breccia
- Me — **Escabrosa Limestone** - massive, cliff-forming, thick-bedded, mostly coarsegrained limestone
- Dm — **Martin Formation** - slope-forming shale unit with interbedded limestone beds
- _a — **Abrigo Formation** - Thin- to thick-bedded, cross bedded, dolomitic sandstone with local dolomite, siltstone, sandstone, and intraformational conglomerate. Dark chocolate-brown calcareous sandstone is characteristic of this unit in easternmost exposures.
- _b — **Bolsa Quartzite** - Fine- to locally medium-grained sandstone, plane bedded to cross bedded. Sandstone varies from chocolate brown to orangish tan to white. Sandstone is coarse to granule within basal several meters. Includes locally abundant, cylindrical trace fossils (burrows?), <1 cm diameter.
- (black) — **Diabase** - Dark greenish gray to olive gray, medium grained diabase forming sills and dikes in all Proterozoic rock units.
- Yt — **Troy Quartzite** - Thin-bedded sandstone and granule to small pebble conglomerate.

Tertiary basin fill alluvium

- Tqc — **Late Miocene to Pliocene Quiburis deposits, alluvial fan facies** - sandy to gravelly, moderately to strongly indurated alluvial fan deposits
- Tql — **Pliocene Quiburis deposits, playa-lacustrine facies** - fine-grained, laminated playa and lacustrine deposits
- Tqe — **Pliocene Quiburis deposits, low energy fluvial deposits** - alternating thin weakly-consolidated beds of gypsum, silt, and very fine sand with sparse pebble stringers
- Tqm — **Pliocene Quiburis deposits, prodelta mudstone facies** - massive prodelta mudstone deposited as foredelta facies of "Eskiminzin Delta"
- Ym — **Mescal Limestone** - Thick to thin bedded, brown to gray dolomite and silty to cherty dolomite, less abundant laminated limestone, and brown dolomitic sandstone locally at base (Krieger, 1968). Asbestos veins are locally present near intrusive contact with diabase.
- Yds — **Dripping Spring Quartzite** - Feldspathic, arkosic, and quartzose sandstone and less abundant siltstone. Sands are typically fine to medium grained and appear feldspathic with red K-feldspar grains. Sandstone is locally cross bedded.
- Ydsb — **Barnes Conglomerate Member, Dripping Spring Quartzite** - Up to 4 m of pebble and cobble conglomerate, with well rounded clasts up to 12 cm diameter of quartzite, vein quartz, and red jasper, in a matrix of red to gray arkosic sandstone (Krieger, 1968).
- Yp — **Pioneer Formation** - Very fine grained to coarse-grained, locally cross-bedded sandstone. Grain size generally decreases up section (Krieger, 1968).
- Yo — **Oracle Granite** - Porphyritic, medium- to coarse-grained biotite granite ("quartz monzonite" of Krieger [1968]). Microcline phenocrysts are as large as 2 x 4 cm and somewhat poikilitic, with included mafic minerals imparting a speckled appearance. K-feldspar is commonly pink to reddish, and mafic minerals are generally abundant (7-12%).
- Yoa — **Oracle Granite, alaskitic** - Equigranular, medium to coarse grained, dark orange to pale red alaskite that is gradational with the Oracle Granite (Krieger, 1968). Local porphyry, aplite, and potassic granite were included with this map unit by Krieger (1968).
- Xp — **Pinal Schist** - Faintly laminated, very fine-grained, medium to dark gray, foliated to weakly schistose sandstone to siltstone.

Boundaries of Holocene River Alluvium

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Clearly defined, accurately located contacts between Holocene river alluvium and bounding geologic units such as bedrock hillslopes, abruptly incised channels or alluvial terraces, and distinct edges of small, steep alluvial fans and talus slopes. Line location accurate to within 50 feet.

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H1105 Waypoint Location, showing station identification

Other Geologic Lines

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- Thin, Dashed Line — Approximate contact
- Thin, Dotted Line — Concealed contact
- Hashed Line — Gradational Contact
- Solid, Bold Line — Accurate Fault
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- Dotted, Bold Line — Concealed Fault

SPHY040