GEOLOGIC MAP OF THE WHITE HILLS WEST 7 ½' QUADRANGLE, MOHAVE COUNTY, ARIZONA

Arizona Geological Survey Digital Geologic Map DGM-97, version 1.0

Scale 1:24,000

By

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Description of Map Units

Other units

d — **Disturbed ground (Holocene)** - Heavily disturbed ground due to mining, extensive excavation, construction of earth dams, and highways.

Qtc — **Quaternary talus and colluvium (Holocene)** - Unconsolidated to weakly consolidated very poorly sorted angular rock debris deposited on and at the base of bedrock slopes and mantling highly eroded bedrock hills.

Qyd — **Holocene debris flow deposits (Holocene)** - Snouts, levees, scoured debris flow channels, and debris flow-deposited fans. Qyd deposits are located on or at the base of steep bedrock slopes along the White Hills and along some channels within and near the mountain front. Unit Qyd also includes areas of erosion (debris flow scars) on hillslopes that are spatially associated with debris flow deposits. Coarse cobble and boulder lag forms linear levees parallel to steep hillslope channels or irregularly shaped piles representing debris flow snouts. Older Qyd deposits are predominantly composed of darkly varnished coarse cobble to boulder lag while younger deposits are less darkly varnished to unvarnished and retain a greater portion of finer grained (silty to pebbly) matrix.

Detrital Wash deposits

Qyr$_{1f}$ — **Active river channel deposits (Present day)** - 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 sub rounded but may be angular to sub angular. Qycr deposits are typically unvegetated and exhibit no soil development. Qycr deposits are entrenched from 30 cm to 2 meters or more below adjacent floodplain deposits depending on location, geomorphic relationship, and local channel conditions. Detrital Wash is dry at the surface throughout much of the year and only flows in response to local or upstream rainfall. These deposits are the first to become submerged during flow events and can be subject to deep, high velocity flow and lateral bank erosion. The distribution and extent of Qycr deposits can vary dramatically following heavy rainstorms especially in relatively unconfined, shallow reaches of the channel system.

Qyr$_{4f}$ — **Flood channel and low terrace deposits (Historical to present day)** - Deposits are found adjacent to active channels in the form of lightly vegetated in-channel bars, small planar fluvial terraces within 60 cm of river elevation, and recent erosional meanders outside the modern channel. Terrace deposits are inset into older river alluvium and are generally narrow, rarely exceeding 100 meters across. Qy4r deposits are composed of poorly sorted unconsolidated sediments ranging from fine silts to gravel bars depending on location in the channel at the time of deposition. Well preserved bar and swale microtopography is common. Flotsam, flood debris wrapped around shrubs and small trees, and flow patterns from the most recent flow event large enough to inundate Qy4r deposits may be present on part or all of the surface. Pebbles and cobbles are sub-rounded to sub-angular and include clast lithologies not present in local piedmont fan deposits. Qy4r surfaces may become inundated under moderate to extreme flow events and can be subject to deep, high velocity flow and lateral bank erosion. These deposits do not exhibit soil development but may exhibit a light vegetation cover of weeds, small shrubs, creosote, and desert broom. Striated bands of mesquite and acacia mark former Detrital Wash meanders.

Qyr$_{3f}$ — **Low terrace and floodplain deposits (Historical)** - Terrace deposits that occupy elevations from 3 to 6 feet above Qycr or Qy4r deposits and are inset below the pre-incision historical floodplain. Qy3r surfaces are generally planar but exhibit bar and swale microtopography. No soil development is present but medium creosote, small shrubs, and weeds sparsely inhabit the surface. Fine grained vegetation mounds or small nebkhas are present beneath many of the creosote and desert broom present on the surface. 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 observable in modern channel walls indicate deposition in a low to moderate energy braided to meandering stream environment with some episodes of rapid flood erosion and deposition.

Qyr$_{2f}$ — **Young terrace and valley floor deposits (Late Holocene to Historical)** - Broadly planar surfaces that stand up to 2-3 meters above modern Qycr deposits. Qy2r surfaces appear predominantly fine grained at the surface due in part to windblown dust deposition but are largely composed of interfingering coarse sandy to pebbly braided channel and fine silty to sandy river channel and floodplain deposits. Little to no soil development is evident in cross section however incipient calcium carbonate accumulation is present in some pebbly beds and lenses. Creosote is the dominant vegetation over the majority of the surface however stands of mesquite and acacia line the edges of Qy2r surfaces near Detrital Wash and some smaller tributary fan channels. Qy2r deposits are not subject to inundation by river floods where the active channel is moderately to deeply incised, but they may be flood-prone in areas with less channel incision. Qy2r deposits are subject to rapid erosion and bank failure due to undercutting and lateral erosion during floods and large flow events. Angular to sub angular clasts of local piedmont lithologies (Qy2, Qya, and Qys deposits) onlap onto Qy2r deposits at the upfan end of the terrace although an interfingering relationship likely exits in the subsurface.

Qyr$_{1f}$ — **Intermediate terrace deposits (Early to late Holocene)** - Deposits associated with slightly higher terraces that represent either higher elements of the early historical floodplain or remnants of older Holocene aggradation periods. Qy1r deposits are broadly planar with mild to moderate undulation in areas where internal drainage patterns have developed. Clast composition is more diverse than adjacent piedmont deposits. Vegetative cover is sparse, consisting of widely spaced small to medium (1 to 3 feet tall) creosote, small weeds, and grasses. Qy1r surfaces are generally sandy to pebbly on the surface with more heavily vegetated areas retaining more windblown silts, sometimes forming vegetation mounds. Soil development is absent to mild. A light dusting (incipient stage I) calcium carbonate accumulation is evident on the undersides of some buried clasts. Qy1r surfaces stand up to 3 meters above and up to 1 kilometer outside the modern channel. Many low relief hills of older Detrital Wash alluvium (Qir deposits) are found within and adjacent to distal reaches of Qy1r deposits. A subtle change in slope up and away from Detrital Wash and a transition to domination of local surface clast lithologies marks the boundary between Qy1r and distal fan deposits.

Qi$_5$ — **Older terrace deposits (Late Pleistocene)** - Qir deposits are the oldest Detrital Wash deposits in the mapping area. They are characterized by sandy to pebbly low relief mounds mantled by well rounded to sub rounded cobbles of diverse lithologies. Varying preservation of Qir deposits has resulted in outcrops ranging in extent from individual disconnected mounds 150 ft across to widespread remnant terraces over 1 mile in length. Qir deposits may lie over 0.5 miles away from the modern Detrital Wash channel yet they are only located 9-12 ft higher in the landscape. The long axes of elongate Qir deposits are oriented approximately parallel to the modern Detrital Wash floodplain and roughly perpendicular to tributary piedmont alluvial fan channels. Qir deposits appear slightly darker in color on air photos yet their appearance on the ground is very similar to surrounding Holocene age deposits. Little to no soil development is present although stage 1 carbonate accumulation is evidenced by thin carbonate coatings on the undersides of some clasts. Vegetative cover is sparse, dominated by small creosote, weeds, and grasses. The outermost edge of Qir deposits farthest from Detrital Wash is often overlain by fine grained distal fan deposits emanating from the White Hills to the east and Black Mountains to the west.

Piedmont Alluvium

Qy$_{1f}$ — **Deposits in active tributary channels (Latest Holocene)** - Qyc deposits are composed of unconsolidated, very poorly sorted sandy to cobbly ephemeral piedmont channel sediments. Channels may exhibit bar and swale microtopography with bars composed of coarser sediments. Qyc deposits are typically unvegetated and exhibit no soil development although small shrubs and grasses may be found on slightly elevated in-channel bars. Qyc deposits commonly become submerged during moderate to extreme flow conditions and can be subject to deep, high velocity flow and lateral bank erosion. Channels are generally incised 0.5 to 1.5 m below adjacent Holocene alluvium and may be incised into adjacent Pleistocene alluvium by 4 m or more.

Qy$_3$ — **Deposits associated with active washes and drainageways (Late Holocene)** - Recently active piedmont alluvium located primarily along active drainages including floodplain, low-lying terrace, less active tributary drainages to Qyc channels, and distal reaches of active fan channels that have aggraded and transitioned to distributary flow and infiltration. Qy3 deposits are composed of unconsolidated to very weakly consolidated unvarnished sandy to pebbly deposits. Qy3 drainages are often wider, lower energy, and more heavily vegetated than the Qyc channels they drain into. These deposits may 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.

Qys — **Very young fine-grained deposits in sheetflood areas (Latest Holocene)** - Unconsolidated very fine silty to sandy splay alluvium located in distal fan environments and adjacent to flood prone alluvial fan channels. Qys deposits appear light colored (milky to light brown) on air photos and on the ground. Qys deposits are very thin (less than 10 cm thick in most cases) and mantle older alluvium. Qys alluvium is deposited in low energy environments where only the smallest sediments are able to be transported. These deposits often expand laterally downfan as weakly-incised channels become unconfined and distributary flow takes over. In overbank Qys deposits the fine grained sediments were emplaced in a flood that exceeded capacity of the incised fan channel. In these cases, Qys sediments represent the lateral limit of local flood inundation on the fan. Flotsam, rafted debris, and trash are often present in Qys overbank deposits.

Qy$_2$ — **Low terrace and floodplain deposits (Late Holocene)** - Qy2 deposits consist of piedmont terrace deposits located primarily along the flanks of incised drainages, isolated intrachannel islands, and low-relief terraces inset into Pleistocene age fan deposits. These deposits consist of predominantly fine grained unconsolidated to weakly consolidated sediments with sub-rounded to sub-angular cobble and boulder bars on the surface and beds and lenses in cross section. Where inset into older alluvium, Qy2 deposits are planar with remnant bar and swale microtopography. Soil development on Qy2 deposits is minor, characterized by incipient stage I-II calcium carbonate accumulation in the form of small filaments and medium brown (10 YR) surface coloration. Vegetation on Qy2 surfaces consists of numerous medium creosote, yucca, small shrubs, weeds, and grasses. These surfaces are subject to inundation during moderate to extreme flow conditions when channel flow exceeds capacity or due to channel migration on low-relief portions of broad distal fan deposits. Planar Qy2 terraces are typically elevated from 30 cm to 1.5 m above active channels.

Qya — **Young alluvial fan deposits (Middle to late Holocene)** - Laterally extensive, low relief, hummocky, fine grained alluvial fan deposits widespread throughout the mapping area. Qya deposits are similar in age and appearance to Qy2 deposits but are far more laterally extensive and dominate almost the entirety of the distal fan environment near Detrital Wash. Numerous small, weakly incised fan channels exist within Qya deposits but these deposits are dominantly aggradational. The surface on Qya deposits is generally fine grained, dominated by sand to silt with a sparse pebble cover and isolated cobbly bars along slightly larger channels. Qya deposits have aggraded nearly to Pleistocene deposit elevations in the middle fan environment and likely overlie Pleistocene deposits in the distal fan. Vegetation on Qya deposits consists of small to medium creosote, small shrubs, weeds, and occasional yucca. Creosote dominated vegetation mounds are common in the finer grained distal fan environment.

Qy$_1$ — **Young, inactive alluvial fan and terrace deposits (Early to late Holocene)** - Qy1 deposits consist of planar terraces along larger fan drainages inset into older alluvium, and inactive elements of young alluvial fans. They stand 1-2 m higher in the landscape than Qy2 deposits, are not part of the modern drainage system except possibly under flood conditions, and partially overlie Pleistocene deposits in some areas. Qy1 deposits are composed of sandy to pebbly swales with coarser unvarnished to very lightly varnished cobble to small boulder bars. Bar and swale microtopography is somewhat muted by incipient pavement formation, and gravel clasts are lightly varnished. Pebbles and cobbles exposed in cross section exhibit stage I-II calcium carbonate accumulation within a medium brown matrix of fine sand to silt. Vegetation on Qy1 deposits is similar to that found on Qy2 deposits; medium creosote, yucca, small shrubs, weeds, and grasses.

Qy — **Young stream deposits, undivided (Holocene)** - Holocene sand, gravel and silt deposits.

Qiy — **Partially buried Pleistocene alluvial fan deposits (Early to Late Holocene)** - Qiy deposits are characterized by relatively planar terraces with isolated medium to well varnished cobbles and boulders surrounded and partially buried by a thin (less than 30 cm thick) deposit of unvarnished younger Holocene alluvium. Qiy deposits often fill in low swales on older terraces, lie adjacent to slightly higher standing Pleistocene fan deposits, or near broad, unincised active and secondary fan channels (Qyc and Qy3 deposits). Late Pleistocene deposits (units Qi4 and Qi3) likely compose the majority of surfaces underlying Qiy deposits as Qi2 and older deposits often stand higher than adjacent Qiy deposits. Deposition of Qiy sediments ranges from overbank flood deposition (young Qiy deposits) to fan aggradation followed by channel migration and incision (older Qiy deposits). In the latter case Qiy deposits lie atop older alluvium elevated from the modern fan drainage system.

Qi$_4$ — **Young intermediate alluvial fan and terrace deposits (Latest Pleistocene)** - Qi4 fans and terraces are planar, exhibit weak varnish on surface gravel, commonly exhibit incipient pavement formation and incipient vesicular horizon development. Pebble dominated swaths on Qi4 surfaces feel crunchy underfoot due to the vesicular horizon just beneath the surface pavement-forming clasts. These surfaces are easily disturbed by medium vegetation growth and animal burrowing. Qi4 deposits occupy similar but lower elevations in the landscape relative to older Pleistocene deposits. Adjacent Holocene deposits (Qya, Qy2, and Qy3) may lie at nearly the same elevation as Qi4 deposits. In some areas younger aggradation partially buries Qi4 deposits. Vegetation on Qi4 deposits consists of small to medium creosote, small shrubs, weeds, and grasses.

Qi$_3$ — **Intermediate alluvial fan and terrace deposits (Late Pleistocene)** - Qi3 deposits are widespread throughout the mapping area in the proximal to distal piedmont environment. They exhibit medium to well varnished cobbles and boulders, occupy higher positions in the landscape than younger deposits, and exhibit moderate to locally strong pavement development in pebble to cobble dominated swales. Subdued bar and swale microtopography has been overprinted and smoothed by pavement formation and inflation, very coarse boulder dominated lobes may stand 0.5-1 meter above lower lying portions of the same-age fan surface. Qi3 deposits are commonly surrounded by and partially buried by younger deposits especially toward the middle and distal fan environment where topographic relief between Pleistocene and Holocene deposits is minimal.

Qi$_2$ — **Older intermediate alluvial fan deposits (Middle to late Pleistocene)** - Qi2 deposits are exposed throughout the mapping area from proximal to distal piedmont areas. These deposits exhibit darker varnish and better pavement than nearby Qi3 deposits, especially in basalt clast dominated deposits. Some large, long-standing stationary basalt boulders within Qi2 deposits exhibit thick metallic coatings of rock varnish. Qi2 deposits also exhibit more advanced (stage II-III) calcium carbonate accumulation than Qi3 and Qi4 deposits. Extensive Qi2 surfaces are relatively planar with higher standing coarse boulder bars rising above adjacent finer grained pebble to cobble dominated swales. Qi2 deposits typically stand 1-2 meters above adjacent channels and up to 1 meter higher in the landscape than nearby Qi3 deposits. Vegetation on Qi2 deposits consists of medium to large creosote, small shrubs, yucca, cholla, Joshua Tree, weeds, and grasses. The presence of Joshua Tree is a good indicator of Qi2 and older deposit distribution in the landscape as they do not tend to grow on younger deposits.

Qi — **Intermediate alluvium, undivided (Middle to late Pleistocene)** - undivided middle or late Pleistocene alluvial deposits.

Qi$_1$ — **Older alluvial fan deposits (Early to middle Pleistocene)** - Alluvial fan deposits forming planar to broadly rounded, light-colored surfaces. Qi1 fans are commonly 10 to 20 feet above adjacent washes. Varnish and pavement development is variable, including patches of pavement and some darkly varnished surface clasts, but more commonly are weak to moderate. Qi1 deposits exhibit abundant calcium carbonate accumulation (stage III to IV) and surfaces are commonly littered with carbonate fragments.

QTa — **Very old alluvial fan deposits (Pliocene-Quaternary)** - Deeply dissected high alluvial fan remants. Deposits are very poorly sorted, with particles ranging in size from medium boulders to clay, but consist mostly of cobbles, pebbles and sand. QTa deposits form rounded ridgecrests and are relatively thin over bedrock; in these settings, they were originally mantled bedrock pediments that have subsequently been dissected.

Bedrock Units

Tc — **Volcaniclastic conglomerate (Miocene)** - Conglomerate, pebby sandstone, and sandstone containing clasts of rhyolite, dacite, and andesite. Generally medium- to thick-bedded and mostly clast-supported, although some thick massive units are matrix-supported. Sandy matrix is generally reddish, and non-volcanic clasts are conspicuously absent.

Tb — **Basalt (Miocene)** - Basalt lava including minor interbeds of basaltic scoria, tephra, and sparse volcaniclastic rocks. Basalt lava contains 2-10% phenocrysts of olivine, pyroxene, and plagioclase.

Tbr — **Basaltic dike (Miocene)** - Mafic dikes containing sparse phenocrysts of olivine, pyroxene, and plagioclase

Tau — **Upper andesite (Miocene)** - Phenocryst-poor andesite containing <5% 1-2mm plagioclase, and pyroxene.

Tr — **Rhyolite (Miocene)** - Phenocryst-poor rhyolite lava and tuff undifferentiated.

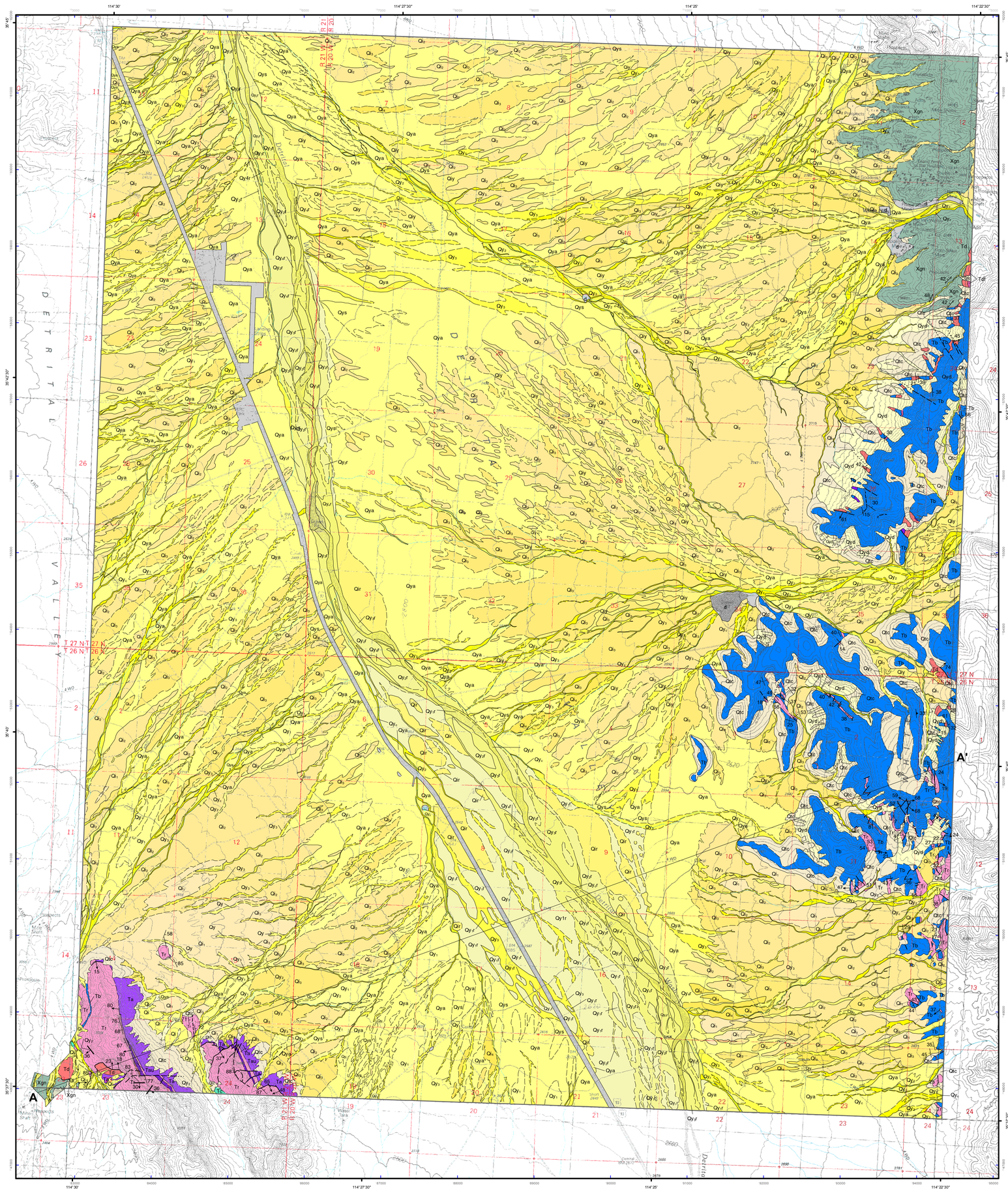
Ta — **Andesite (Miocene)** - Andesitic lava with minor undifferentiated pyroclastic and volcaniclastic interbeds. Lava contains up to 15% phenocrysts of plagioclase <4mm, and lesser <2mm pyroxene, and olivine.

Tdf — **Fine-grained dacite (Miocene)** - Dacitic lava, tuff, breccia, and volcaniclastic rocks containing sparse <2mm plagioclase, and ubiquitous hornblende phenocrysts up to 5mm.

Td — **Dacite (Miocene)** - Dacitic lava, tuff, and breccia containing 10-35% phenocrysts of plagioclase (1-8mm), biotite (<4mm), and/or hornblende (<4mm), and/or pyroxene (<2mm).

Tsa — **Andesitic lava (Miocene)** - andesitic lava with 10% 1-10mm plagioclase, 1% 1-2mm biotite, 4-5% <1mm green pyroxene, 2% 0.2-1.5mm iddingsite phenocrysts.

Xgn — **Metamorphic and plutonic rocks, undifferentiated (Early Proterozoic)** - Orthogneiss, paragneiss, and foliated granitoid intruded by leucogranitic and pegmatitic dikes. Foliation is mylonitic in some areas with well-developed stretching lineation.



Topographic base from USGS 1:24,000 Quadrangle Series; generated using iGage All Topo Pro software
Contour interval: 10 feet (low relief areas), 40 feet (high relief areas)

Projection: UTM Zone 12N
Datum: NAD83

scale 1:24,000

1000 500 0 1000 2000 3000 4000 5000 6000 7000 Feet

1 0.5 0 1 Miles

1 0.5 0 1 Kilometers

APPROXIMATE MEAN DECLINATION, 2011

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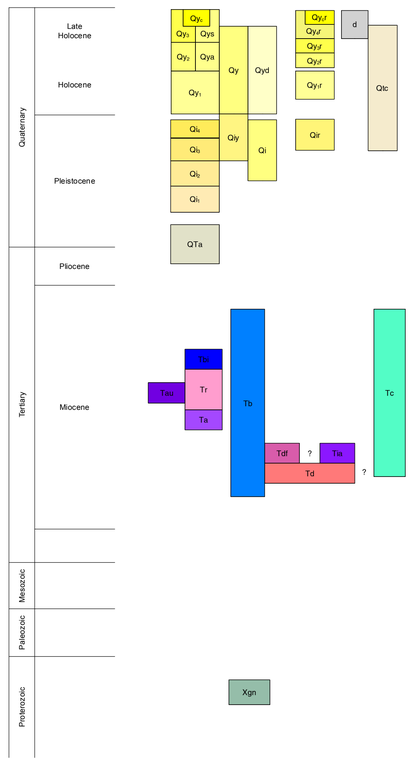
Introduction

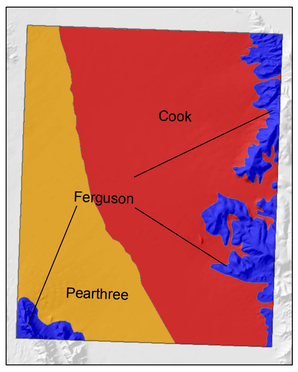
The White Hills West 7½' Quadrangle encompasses part of Detrital Valley, the western flank of the White Hills, and small part of the Black Mountains in northwestern Arizona. This map depicts the Precambrian and Cenozoic bedrock in the mountains and late Cenozoic surficial deposits in the valley. Production of this new geologic map continues the Arizona Geological Survey mapping program in northwestern Arizona that includes the Grasshopper Junction 7½' Quadrangle (Ferguson et al., 2009), Dolan Springs 7 ½' Quadrangle (Ferguson et al, 2010), Middle Water Spring Quadrangle 7 ½' Quadrangle (Johnson et al, 2012), and several 7½' quadrangles farther southwest in the Colorado River Valley. This mapping was done under the joint State - Federal STATEMAP program, as specified in the National Geologic Mapping Act of 1992, and was jointly funded by the Arizona Geological Survey and the U.S. Geological Survey under STATEMAP Program Contract award number G10AC00428. Mapping was compiled digitally using ESRI ArcGIS software.

The map area is located in Detrital Valley in the Basin and Range Province of northwestern Arizona. Most of the White Hills West Quadrangle is underlain by late Cenozoic clastic sedimentary deposits that are very thin adjacent to the White Hills and the Black Mountains, but are at least 1600 feet thick in the central part of the quadrangle (Richard et al., 2007; Mason et al., 2007). These deposits consist mostly of sandstone and conglomerate in alluvial fans that flank the valley and a fine-grained axial facies. The surface of the valley is covered by relatively thin deposits of various ages ranging from Pliocene to modern. Detrital Valley has undergone very little incision during the Quaternary, and thus most of the valley topography is relatively smooth. In general, upper piedmont areas are dominated by moderately coarse to very coarse alluvial fan deposits of various ages; late Pleistocene and younger, relatively fine-grained deposits are prevalent on the lower piedmonts and along Detrital Wash. The quadrangle contains several large alluvial fan complexes composed of Pleistocene and Holocene deposits. Extensive, complex distributary drainage systems in piedmont areas are outlined by the extent of late Holocene deposits, and broad areas are covered by young, relatively fine-grained deposits. These areas have potential flood hazards due to complex flow paths and widespread sheetflooding. Two general types of bedrock units are present in the quadrangle; Proterozoic metamorphic rocks and Miocene supracrustal volcanic and sedimentary rocks. Precambrian rocks are exposed in the southwestern and northeastern corners of the quadrangle. Middle Miocene volcanic units ranging in composition from rhyolite to basalt are exposed in the southwestern and east-central parts of the quadrangle. In the White Hills, these units are cut by several small-displacement faults and generally dip to the northeast or east. In the Black Mountains portion of the quadrangle, volcanic rocks dip to the southwest.

Unit Correlation Diagram

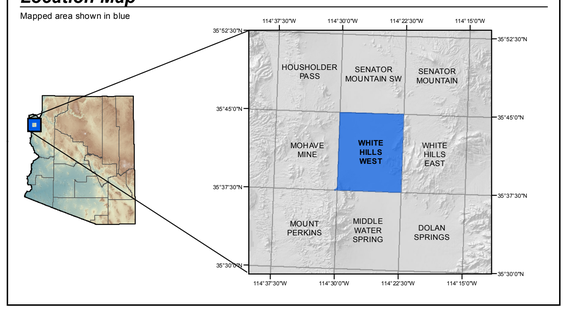


Mapping Responsibility



Location Map

Mapped area shown in blue



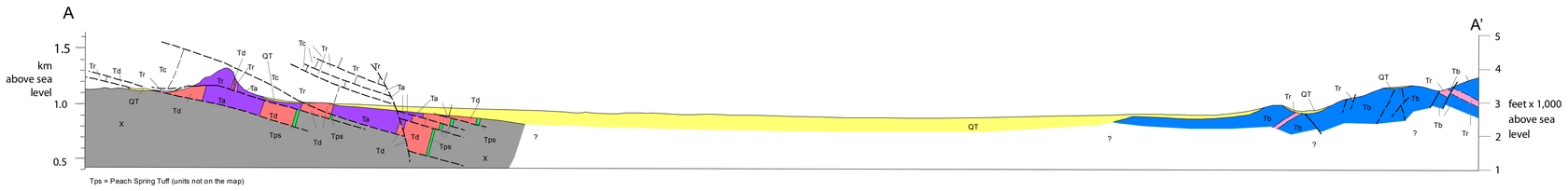
Structure Symbols

- 23 — strike and dip of bedding
- 67 — strike and dip of flow-foliation in lavas and hypabyssal rocks
- 44 — strike and dip of tectonic-metamorphic foliation
- 19 — dip of contact or dike
- 31 — strike and dip of minor fault (whose trace is not shown on the map)

Line Symbols

- accurately located contact
- approximately located contact
- concealed contact
- accurately located fault
- approximately located fault
- concealed fault
- marker bed
- map boundary

Cross Section



Tps = Peach Spring Tuff (units not on the map)

QT = Quaternary to late Tertiary undivided

X = Early Proterozoic undivided

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