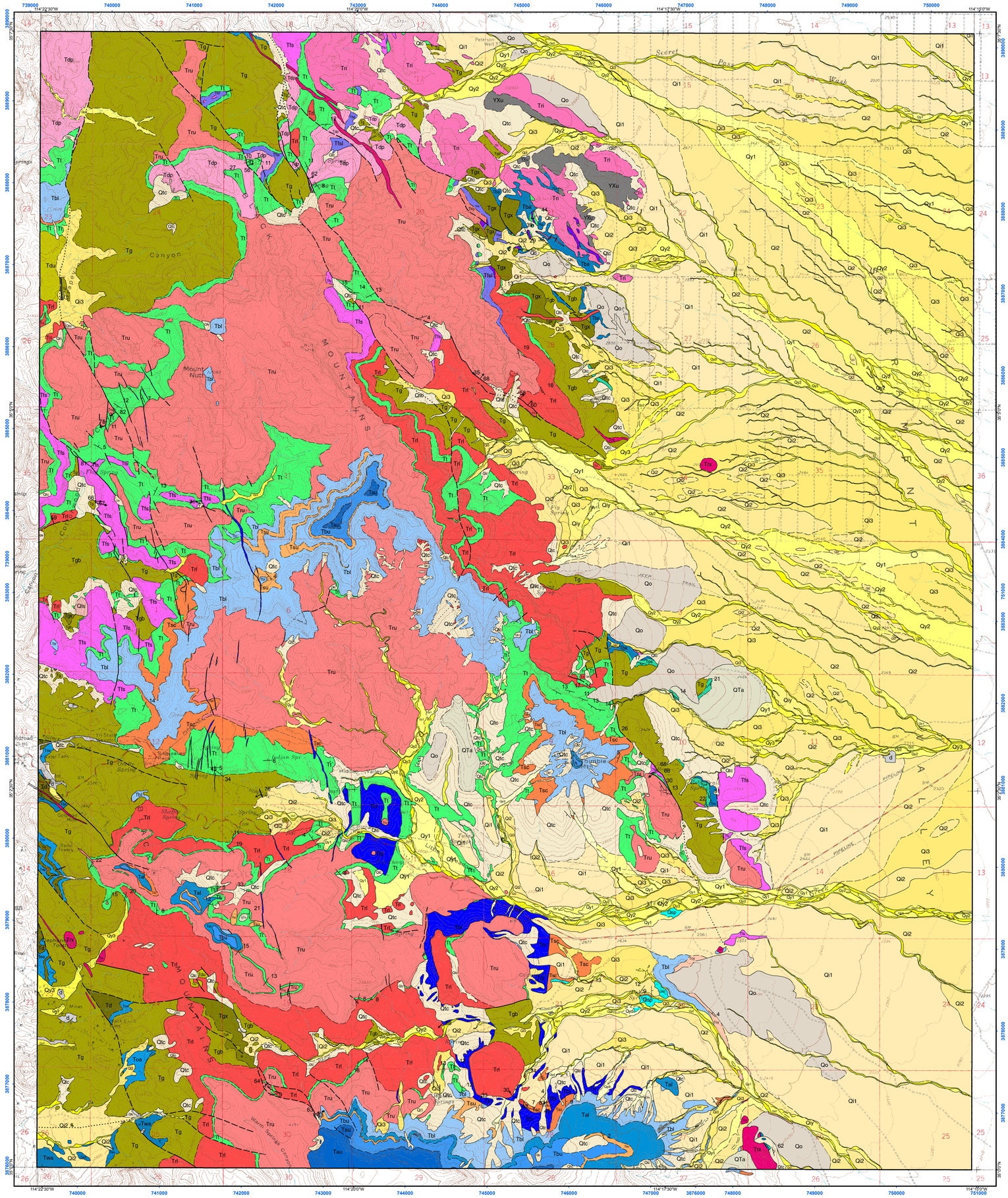

Geologic map of the Mount Nutt 7 ½' Quadrangle, Mohave County, Arizona

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Arizona Geological Survey

Digital Geologic Map 118 (DGM-118), version 1.0

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Introduction

The Mount Nutt 7 ½' Quadrangle is located in the Black Mountains just west of Oatman, AZ in Mohave County, western Arizona. The Quadrangle encompasses portions of the Mount Nutt and Warm Springs Wilderness areas and includes the east flank of the northern Black Mountains and the piedmont that extends eastward from the foot of the range into Golden Valley. Geologic 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 assistance award #G14AC00424. Mapping was compiled digitally using ESRI ArcGIS software.

Surficial Geology

The surficial geologic units in the Mount Nutt 7 ½' Quadrangle consist of very high-standing relict alluvial fan deposits, boulder-dominated debris flow scars, levees, and snouts, and deeply incised canyons and inset alluvial terraces near the mountain front. In the middle and distal piedmont deposits include widespread successions of high-standing and well-armored Pleistocene alluvium, unconsolidated distal Holocene terrace and channel deposits, and isolated spring deposits.

Surficial geologic units were mapped using field observations, digital aerial imagery, and digital elevation models (DEMs). Relative ages of alluvial deposits were estimated using characteristics of clast weathering, soil development, carbonate accumulation, and position in the landscape (Gile et al., 1981; Machette, 1985; Bull, 1991; Birkland, 1999). Soil development and carbonate accumulation begin once a deposit is isolated from active alluvial processes. As a result, the degree of soil development and carbonate accumulation are one of the criteria used to identify the approximate ages of surficial units.

Younger alluvial deposits have little to no soil development, retain the original grey or brown color of the alluvial sediment, and no carbonate accumulation. Clasts in these deposits have no weathering rinds or surface patinas and thus appear brighter and fresher than older clasts. Young alluvial surfaces often retain original depositional characteristics such as bars and swales. Conversely, older alluvial deposits have better developed soils that appear orange or red in color, with soil horizons reflecting clay and carbonate accumulations. Clasts on older alluvial deposits often exhibit darkened weathering rinds or rock varnish, and thus appear darker on the ground and in aerial photographs. Preserved alluvial surfaces may be smooth and flat (Qi3), becoming more rounded and coarser with age (Qi2). The oldest alluvial surfaces (Qi1, Qo, and QTa) are often eroded, well-rounded ridges with no soils preserved and the carbonate horizon exposed. These surfaces appear white on aerial photos due to widespread exposure of the carbonate horizon.

Debris flow deposits are present on steep slopes of the mountain front and along proximal channels and terraces. Other proximal alluvial deposits exhibit strong carbonate accumulation and are very resistant to erosion resulting in deeply incised, narrow channels near the mountain front. Exposures of well-cemented older alluvium are present along active channels and within younger, unconsolidated alluvium throughout the mapping area, indicating burial of older alluvium is relatively shallow. Holocene alluvium along modern washes and arroyos is often inset below older deposits by several meters and confined to relatively narrow expanses within older alluvium. Within the modern incised channel bottom, young terraces are prone to flooding.

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Map Unit Descriptions

other units

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

Qyd — **Holocene debris flow deposits** - Snouts, levees, scoured debris flow channels, and debris flow-dominated fans. Qyd deposits are located on or at the base of steep bedrock slopes along the Black Mountains and along some channels within and near the mountain front. Unit Qyd also includes areas of erosion (debris flow scars) on hillslopes associated with debris flow deposits. Coarse cobble and boulder lag forms linear levees bordering steep hillslope channels or elongate lobate 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 between larger clasts.

Qtc — **Quaternary hillslope talus and colluvium** - Unconsolidated to weakly consolidated very poorly sorted angular rock debris deposited on and at the base of bedrock or high-standing alluvial slopes and mantling highly eroded bedrock hills.

Qsp — **Spring deposits** - Fine grained, mounded, chalky white spring deposits found near channel bottoms in the proximal piedmont east of the Black Mountains. Some Qsp deposists are located near active seeps characterized by wet, muddy soil and locally dense vegetation. Baker Spring is one such location and is labelled on the topographic basemap.

Qls — **Landslide** - **Landslide** composed of the trachyitic lava of Flag Spring in a tributary of Cottonwood Canyon.

Piedmont Alluvium

Qyc — **Active channel and arroyo deposits** - Qyc deposits are composed of unconsolidated, very poorly sorted sandy to cobbly ephemeral piedmont channel sediments. Large boulders and cobbles are common in poorly sorted Qyc alluvium near the mountain front while distal Qyc alluvium is composed primarily of well-sorted sand with isolated pebble and cobble-dominated bars. Channels exhibit bar and swale microtopography with bars composed of coarser sediments. Qyc deposits range from unvegetated in active channels to well-vegetated with small shrubs, catclaw acacia, creosote, and desert broom on bars. No soil development is present in Qyc alluvium although varnished and CaCO3-coated clasts reworked from adjacent older deposits may be present. 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 1.5m below adjacent Holocene alluvium and may be incised into adjacent Pleistocene alluvium by 5m or more.

Qy_3 — **Secondary channel alluvium, low terraces, and in-channel bars** - Recently active piedmont alluvium located primarily along or within 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 alluvium with a discontinuous pebbly cover. Qy3 drainages are often wider, lower energy, and more heavily vegetated than the Qyc channels they drain into. Vegetation consists of large creosote, brittlebush, goldeneye, and other small desert shrubs. These deposits may exhibit low-relief bar and swale microtopography and are susceptible to inundation during moderate to extreme flow conditions when channel flow exceeds capacity. Qy3 deposits are generally unincised but may exhibit small rill networks adjacent to Qyc deposits. Soil development is generally absent or incipient on Qy3 deposits which exhibit pale buff to light brown (7.5 - 10 YR 5/4) surface coloration although local color variations exist depending on parent material. Qy3 terraces are located 0.5-1m below Qy2 deposits and 3-5m below Pleistocene alluvium close to the mountain front.

Qy_2 — **Broad, low relief alluvial fan and terrace deposits** - Qy2 deposits consist of piedmont terrace deposits located primarily along the flanks of incised drainages, isolated intrachannel remnants, and low-relief terraces inset into older alluvium. These deposits consist of predominantly fine grained unconsolidated to weakly consolidated poorly to moderately well-sorted sediments with sub-rounded to sub-angular cobble and boulder-dominated bars. 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 (7.5 YR 5/6) surface coloration with locally redder deposits where derived from granitic parent material. In some locations thin Qy2 deposits overlie older Pleistocene deposits. In these locations well-varnished boulders protrude through unvarnished, younger, sandy Qy2 alluvium and vegetation may be more similar to populations observed on Pleistocene deposits. Vegetation on Qy2 surfaces consists of numerous medium creosote, yucca, small shrubs, weeds, grasses, and cactus. 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 0.5 - 1.5m above younger alluvium and active channels with less relief relative to other surfaces with increasing distance from the mountain front.

Qy_1 — **Inactive alluvial fan remnants, terraces, and bars** - Qy1 deposits consist of planar terraces along larger fan drainages inset into older alluvium. They stand up to 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, especially near the mountain front. Qy1 deposits are composed of sandy to pebbly swales with coarser unvarnished to moderately varnished cobble to small boulder bars. Bar and swale microtopography is somewhat muted by incipient pavement formation. Pebbles and cobbles exposed in cross section exhibit stage I-II calcium carbonate accumulation with some clasts exhibiting thicker CaCO3 rinds on the undersides. Many areas of Qy1 deposits appear lighter on aerial photos due to the abundance of overturned CaCO3-coated clasts and carbonate flakes on the surface. Larger clasts are surrounded by a medium brown matrix of fine sand to silt. Surface color ranges from 5-7.5 YR 5/4-5/6 depending on location in the piedmont and dominant parent material. Vegetation on Qy1 deposits is similar to that found on Qy2 deposits; medium creosote, yucca, catclaw, small shrubs, weeds, and grasses. Elevation difference between Qy1 and Qy2 deposits decreases with distance from the mountain front.

Qiy — **Partially buried Pleistocene alluvial fan deposits** - Qiy deposits represent areas in the piedmont where patterns of alluvial fan erosion and deposition have resulted in minor to discontinuous burial of older alluvium by younger deposits. Qiy deposits are characterized by intermittent exposure of older, CaCO3-rich piedmont alluvium beneath unconsolidated Holocene deposits. The distribution of Qiy exposures is predominantly along eroded edges and broad swales within the underlying older alluvial unit. Qiy deposits occupy similar elevations in the piedmont as the older deposits they cover.

Qi_3 — **Intermediate alluvial fan and terrace deposits** - Qi3 deposits near the mountain front are located at higher elevations in the landscape than Holocene alluvium but are partially buried by younger deposits farther from the mountain front where relief between Pleistocene and Holocene deposits is reduced or absent. Wide terraces are planar where preserved and exhibit remnant bar and swale microtopography which has been overprinted and smoothed by pavement formation, inflation, and churning by vegetation. Very coarse, medium to well-varnished boulder dominated bars are partially buried by moderate pavement development in surrounding swales. Clast cover is composed of vesicular basalt and mixed volcanics. Basalt clasts are the most varnished lithology and Qi3 surface color varies depending on lithology dominance. Vegetation on Qi3 surfaces consists of small shrubs, creosote, catclaw acacia, yucca, cholla, and ocotillo. Many Qi3 surfaces appear whitish on aerial photos due to abundant overturned CaCO3-coated clasts and carbonate flakes on the surface. Surface soil color is medium brown 5-7.5 YR 5/4.

Qi_2 — **Older intermediate alluvial fan and terrace deposits** - Qi2 deposits stand 1 - 2m higher in the landscape than Qi3 deposits. Some Qi2 terraces are inset below older alluvium by 3 - 4m near the mountain front. Clast lithology includes basalt and mixed volcanics. These deposits exhibit darker, more well-developed varnish than nearby Qi3 deposits especially where basalt clasts are abundant. Some large, long-standing stationary basalt boulders within Qi2 deposits exhibit thick shiny rock varnish. Qi2 deposits also exhibit a more mature, interlocking pavement and more advanced (stage II-III) calcium carbonate accumulation than Qi3 deposits. Near-surface laminar layers of calcium carbonate and interlocking, carbonate-coated boulders are exposed along eroded edges of Qi2 deposits along active channels. Qi2 remnants are broadly planar but may exhibit subtle rounding near the edges of broad surfaces. The flanks of preserved Pleistocene surfaces are covered by abundant overturned clasts exhibiting carbonate rinds and varying degrees of varnish. CaCO3 flakes litter eroded crests and flanks of Qi2 surfaces. Pavement in these areas has been destroyed by veg churning and disturbance of underlying soil carbonate horizons. Vegetation on Qi2 surfaces consists of small shrubs, creosote, yucca, and ocotillo.

Qi_1 — **Older, higher standing intermediate alluvial fan deposits** - Qi1 deposits are relict alluvial fan remnants located close to the mountain front that stand higher in the landscape than Qi2 and younger deposits. Qi1 deposits may be deposited atop eroded bedrock pediment or older, well-cemented alluvium including Qo deposits and basin-filling alluvium. Exposed, partially buried clasts are well-varnished except where exfoliation weathering has degraded the surface of long-exposed clasts. Despite the presence of well varnished clasts present at the surface in basalt-dominated deposits, Qi1 surfaces appear white on aerial photos due to an abundance of CaCO3 rinds, flakes, and overturned clasts littering the surface. The presence of abundant soil carbonate at the surface indicates Qi1 deposits are sufficiently long standing to have developed significant soil carbonate and subsequently become churned by vegetation and bioturbation. Undisturbed desert pavement is discontinuous or absent over much of the surface except in pebble dominated swales. Qi1 deposits are broadly rounded and exhibit deeply incised mature tributary drainage networks. Where exposed in channel walls, these deposits exhibit well developed (stage III-IV) calcium carbonate accumulation. Channel walls may be undercut and exhibit a coarsely sculpted appearance due to the level of cementation exposed by incision. Vegetation on Qi1 deposits is similar to that found on Qi2 deposits although yucca and ocotillo are more abundant.

Qo — **High standing, deeply dissected and eroded alluvial fan remnants** - Qo deposits appear very white on aerial photos due to abundant and continuous exposure of calcium carbonate flakes, rinds, and aggregate chunks of underlying carbonate layers. Qo deposits stand up to 6m higher in the landscape than adjacent Qi1 deposits in the proximal piedmont and even higher relative elevations near Hidden Valley west of Thimble Mountain. Some Qo deposits are deposited atop a bedrock pediment 1.5 km from the mountain front. Former bar and swale deposition has been erased by bioturbation and the majority of varnished clasts have been overturned, exposing carbonate coatings on the undersides of clasts. Ocotillo, cholla, yucca, and creosote are the dominant vegetation on Qo deposits.

QTa — **Very old alluvial fan deposits** - QTa deposits are deeply dissected, very well-rounded, high-standing, relict alluvial fans located close to the mountain front. QTa deposits are very poorly sorted, with particles ranging in size from very large boulders to sand, but consist mostly of cobbles and boulders. QTa deposits form rounded ridgecrests and are relatively thin over bedrock close to the mountain front. In these settings, QTa sediment originally mantled bedrock pediment and have subsequently been dissected. These deposits represent ancient erosion and deposition of the landscape and grade to former levels of valley fill. Subsequent erosion and incision of the landscape has left QTa remnants standing up to 100m above adjacent modern channel bottoms.

Bedrock units

Tcy — **Conglomerate** - Poorly indurated, gently east-dipping conglomerate and sandstone

Tbs — **Basaltic dikes** - **Basaltic dikes** containing 2-10% phenocrysts of <3mm iddingsite and pyroxene in a plagioclase-rich crystalline matrix

Tau — **Upper basaltic andesitic lava** - Mafic lava containing sparse (1-3%) <2mm phenocrysts of plagioclase > iddingsite and/or pyroxene. Matrix is typically glassy to very fine-grained crystalline.

Tbu — **Upper basaltic lava** - Mafic lava containing 2-10% <3mm phenocrysts of iddingsite and pyroxene >> plagioclase. Matrix is typically strongly crystalline.

Tal — **Lower basaltic andesitic lava** - Mafic lava containing 2-4% <4mm plagioclase phenocrysts >> <2mm iddingsite and/or pyroxene. Matrix is typically glassy to very fine-grained crystalline.

Tbl — **Lower basaltic lava** - Mafic lava containing 2-10% <3mm phenocrysts of iddingsite and pyroxene >> plagioclase. Matrix is typically strongly crystalline. This unit occurs in very thick (>50m) flow units in the south-central part of the map area (particularly along old route 66) where it grades into similarly thick sill and dike masses that intrude rhyolite lavas (Trl and Tru).

Tsu — **Volcaniclastic rocks** - Sandstone, conglomerate, and lesser, nonwelded, mostly felsic pyroclastic rocks

Tsc — **Conglomerate of Sitgreaves Pass** - Volcaniclastic conglomerate and sandstone dominated by sub-angular to sub-rounded clasts of felsic volcanic rocks; phenocryst-poor trachytic lava, phenocryst-rich dacitic lava, rhyolitic lava, and rhyolitic ignimbrite. Sparse granitic and porphyritic clasts of probable Proterozoic and Laramide (Late Cretaceous – early Paleogene) are locally present.

Tdp — **Trachytic lava of Dodger Peak** - Light colored phenocryst-poor trachytic lava containing <5% <3mm plagioclase > <3mm biotite and/or hornblende phenocrysts. The lava is named for Dodger Peak, a prominent peak just to the north of the northwest corner of the map area. The peak is a probable source volcano for the map unit. This map unit correlates with the Flag Spring Trachyte lava as mapped by Thorson (1971) in the northern part of the map area, but is given a different name since it is clearly a younger unit.

Tri — **Rhyolite porphyry** - Aphyric to very phenocryst-poor rhyolite. Contact relationships indicate that this unit is mostly intrusive with respect to adjacent rocks.

Tdu — **Upper dacitic lava** - Dark colored moderately phenocryst-rich dacitic to trachydacitic lava containing 12-30% phenocrysts of 2-15mm plagioclase > <3mm biotite, pyroxene, and/or hornblende.

Trx — **Phenocryst-rich rhyolite porphyry** - Rhyolite dikes containing 10-25% <10mm phenocrysts of K-feldspar and plagioclase, <6mm quartz, and sparse <3mm biotite.

Tru — **Upper rhyolitic lava** - Light colored moderately phenocryst-rich rhyolitic lava containing 5-15% phenocrysts of <20mm K-feldspar and plagioclase > <7mm quartz > <3mm biotite, and <7mm hornblende. The mafic phenocrysts range from <1% to 3% by volume and the biotite:hornblende ratio varies between 5:1 to 1:5. Older flows in sequences generally have more abundant and large hornblende phenocrysts. This map unit correlates generally with the Cottonwood rhyolites of Thorson (1971).

Tfs — **Trachytic lava of Flag Spring** - Light colored phenocryst-poor trachytic lava containing 1-5% <3mm phenocrysts of plagioclase > <3mm biotite and/or hornblende. This map unit correlates with the Flag Spring Trachyte lava of Thorson (1971) at its type area.

Tfsl — **Lower trachytic lava of Flag Spring** - Dark colored, aphyric to very phenocryst-poor trachytic to andesitic lava containing <1% <1mm phenocrysts of biotite and/or hornblende > <1mm plagioclase. Lavas of this type locally underlie the Trachytic lava of Flag Spring in the northern part of the map area.

Tt — **Felsic pyroclastic rocks undifferentiated** - Light colored nonwelded ignimbrite, ash-fall tuff, and surge deposits occurring in sequences up to several tens of meters thick interbedded with rhyolitic and dacitic lavas throughout the map area. The unit also includes interbeds of volcaniclastic sandstone and pebbly sandstone, especially where associated with the volcanic breccia (Tbr) unit in the northern part of the map area.

Tbr — **Volcanic breccia** - Clast-supported unimodal to bimodal (in terms of clast types) volcanic breccia dominated by clasts of phenocryst-poor trachytic lava and/or moderately phenocryst-rich dacitic lava. The unit occurs interbedded with several lava units in the lower part of the volcanic pile in the northern part of the map area.

Trl — **Lower rhyolitic lava** - Rhyolitic to rhyodacitic lava containing 3-7% phenocrysts of <20mm K-feldspar and plagioclase > <10mm quartz and <2% <3mm biotite and/or hornblende. The lavas are generally darker in color than the overlying Tru rhyolitic lavas and the K-feldspar phenocrysts, which are generally more abundant and large than the plagioclase, are commonly rimmed with plagioclase (rapakivi texture). The unit correlates generally with the Antelope quartz latite of Thorson (1971).

Tg — **Dacitic to trachydacitic lava** - Dark colored, phenocryst-rich lavas containing 10-25% phenocrysts of <8mm plagioclase with 1-3% <4mm biotite and/or green pyroxene (augite). In some areas, flows can be differentiated on the basis of dominance of biotite versus pyroxene phenocrysts, and in general, pyroxene>biotite varieties are older. This unit correlates generally with the Gold Road Latite of Thorson (1971).

Tgb — **Biotite-dominant dacitic lava** - Dark colored, phenocryst-rich lavas containing 10-25% phenocrysts of <8mm plagioclase with 1-3% <4mm biotite > green pyroxene (augite).

Tgx — **Pyroxene-dominant dacitic lava** - Dark colored, phenocryst-rich lavas containing 10-25% phenocrysts of <8mm plagioclase with 1-3% <4mm green pyroxene (augite) > biotite.

Tps — **Peach Spring Tuf** - Welded rhyolitic ignimbrite containing 5-35% phenocrysts of <5mm sanidine > <3mm plagioclase and <1% <3mm biotite. The ignimbrite is zoned with phenocryst content increasing gradually upwards from 5-15% in the main mass of the ignimbrite. The uppermost part is a vitrophyre that records a dramatic upward increase in phenocrysts from 15-35% that is accompanied by a transition from rhyolitic to trachytic composition (Pamucku et al., 2013). The **Peach Spring Tuff** has yielded a sanidine Ar/Ar date of 18.78 +/- 0.02 Ma (Ferguson et al., 2013).

Twa — **Basaltic trachyandesite of Wrigley Mine** - Mafic lava containing 3-7% phenocrysts of <4mm green clinopyroxene and black orthopyroxene > <5mm plagioclase. The unit occurs in the southwest corner of the map area where it underlies dacitic lavas of the Tg unit. In the vicinity of the Black Eagle Mine, the lava overlies less mafic (slightly biotite-phyric) lavas of the Oatman Andesite. To the southwest, the unit extends at least 15km into the Boundary Cone map area where it overlies the Esperanza Trachyte of Ransome (1923) and has been analyzed for geochemistry (Spencer et al., 2007).

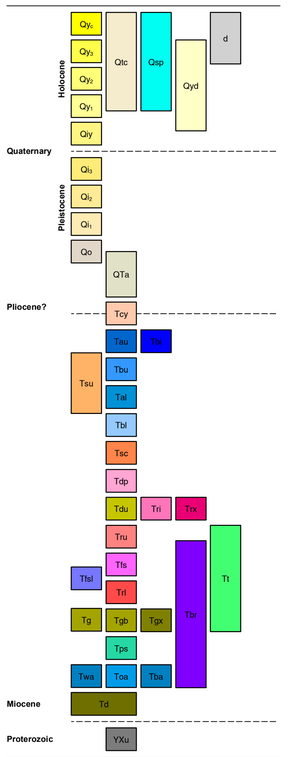
Toa — **Oatman Andesite** - Andesitic to trachydacitic lavas containing 5-10% <10mm plagioclase phenocrysts > <4mm green pyroxene (augite) > <5mm biotite. The classic **Oatman Andesite** of Ransome (1923) is named for extensive exposures in and around the town of Oatman just to the west of the southwest corner of the map area. Actually a quartz latite based on analyses by Thorson (1971) the unit has long been equated with more mafic (two pyroxene, no biotite) flows of the basaltic trachyandesite of Wrigley Mine. The Esperanza Trachyte, which pinches out just to the southwest of the map area, is overlain by the Wrigley Mine lava and overlies the **Oatman Andesite**. Lavas of this unit are interbedded with uppermost dacitic lavas of the Td unit.

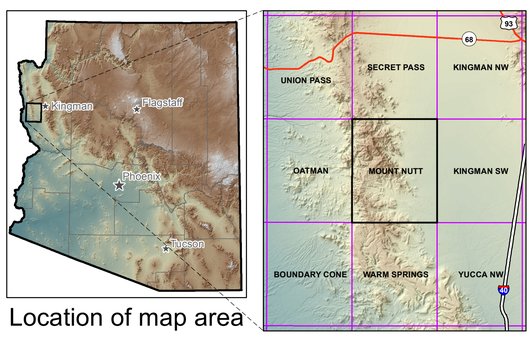
Tba — **Basaltic andesitic lavas** - Mafic lavas containing 3-10% phenocrysts of 1-4mm green pyroxene (augite) > <4mm plagioclase. Thin (<15m) flows of this unit occur in the east-central to northeastern parts of the map area in a stratigraphic interval similar to the Wrigley Mine (Twa) and Oatman (Toa) mafic lavas.

Td — **Lower dacitic lava** - Dark colored moderately phenocryst-rich dacitic lava containing 15-30% <10mm plagioclase > <4mm biotite and sparse hornblende and/or pyroxene. Flows are generally lighter colored than the overlying Oatman Andesite (Toa). An intervening unit, the Esperanza Trachyte, pinches out just to the southwest of the southwest corner of the map area. This unit is correlative generally with the Alcyone Trachyte of Ransome (1923).

YXu — **Proterozoic igneous and metamorphic rocks** - Granitic gneiss, granitoid, schist, and diorite. Diorite is probably Mesoproterozoic in age.

Correlation of map units





Location of map area

SCALE 1:24,000

1 0.5 0 1 Miles

1 0.5 0 1 Kilometers

0 1000 2000 3000 4000 5000 Feet

CONTOUR INTERVAL 20 FEET

TRUE NORTH
MAGNETIC NORTH
12°
Approximate mean declination, 2013

Topographic base map derived from Mount Nutt 7.5' USGS topographic quadrangle map originally with NAD27 datum. Reprojected to UTM NAD83 datum (zone 11) using iGage All Topo Maps V9. UTM NAD 83 grid and lat-long markers produced using ESRI ArcMap v. 10.4.

Contacts and faults

- Contact, accurate
- Contact, approximate
- Contact, obscured by anthropogenic modification
- Fault, accurate
- Fault, approximate
- Fault, concealed

Structure symbols

- Bedding
- Eutaxitic foliation
- Slickenline lineation
- Dip of fault or contact

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