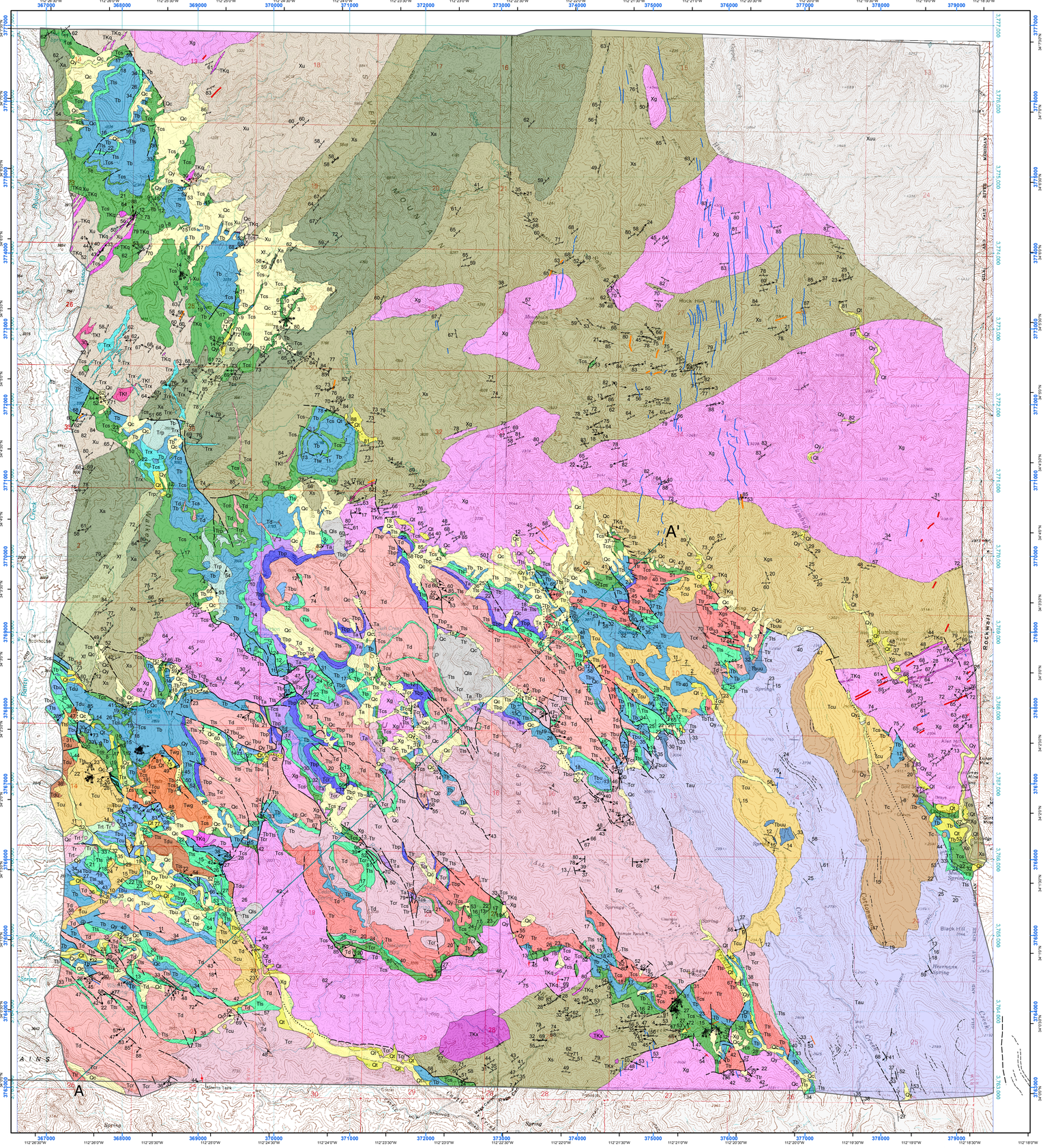


Projection: UTM Zone 12, Datum: NAD83
AllTopo V7 Pro Topographic Basemap with NAD83 grid.
Topographic base map derived from Copperopolis 7.5' USGS topographic quadrangle map originally with NAD27 datum.

1:24,000 scale

0 0.5 1 2 3 4 5 Kilometers

0 0.5 1 2 3 4 5 Miles

11° TRUE NORTH MAGNETIC NORTH

APPROXIMATE MEAN DECLINATION, 2013

OrientationDataPoints

- Horizontal bedding
- Strike and dip of inclined bedding
- Strike and dip of overturned bedding
- Strike and dip of inclined bedding, right-way-up indicated by primary sedimentary structures
- Strike and dip of eutaxitic foliation (compaction foliation) in ash-flow tuff and pyroclastic dikes
- Strike and dip of inclined primary flow foliation
- Trend and plunge of flow-lineation in volcanic and hypabyssal rocks
- Trend and plunge of mineral-aggregate lineation
- Trend and plunge of slickenlines
- Trend and plunge of lineation formed by intersection of main-phase (S1) and second-phase (S2) tectonic foliations
- Trend and plunge of axis of F2 synform
- Trend and plunge of axis of F2 fold with S-shaped asymmetry
- Trend and plunge of axis of F2 fold with Z-shaped asymmetry
- Trend and plunge of lineation formed by crenulation of main-phase tectonic foliation
- Trend of horizontal lineation formed by crenulation of main-phase tectonic foliation
- Strike and dip of inclined main-phase tectonic foliation and compositional layering
- Strike of vertical main-phase tectonic foliation and compositional layering
- Strike and dip of second-phase tectonic foliation (S2)
- Strike and dip of third-phase tectonic foliation (S3)
- Dip of contact
- Trend and plunge of slickenlines, down-plunge relative movement of hanging wall indicated
- Trend of paleocurrent lineation from imbricated clasts, arrow in direction of paleoflow

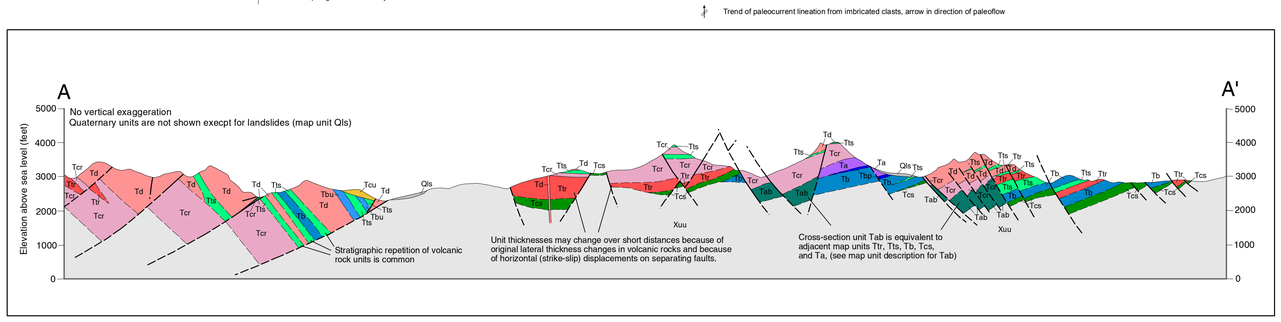
ContactsAndFaults

- contact, accurate
- contact, approximate
- fault, accurate
- fault, approximate
- fault, concealed

Other Lines

- quartz vein
- calcite vein
- marker bed within a map unit
- quartz porphyry dike (TKg)
- pyroclastic dacitic dike
- trachyte dike
- mafic dike

Location of map area



Description of map units

Surficial deposits

- d — **Areas of human disturbance (Holocene)** - Earthen dams and disturbed areas.
- Qy — **Active alluvium (Quaternary)** - Active alluvium (incised less than 2m)
- Qt — **Terraced alluvium (Quaternary)** - Terraced alluvium incised greater than 2m and up to 50m above local base level.
- Qc — **Alluvial fans, colluvium, and talus (Quaternary)** - Alluvial fans, colluvium, and talus. This unit is dominated by alluvial fans which merge upslope in steep areas with colluvium and talus aprons which are not differentiated.
- Qls — **Landslides (Quaternary)** - Landslide masses are defined by large areas of partially intact bedrock, and/or megablocks and boulders. The upper surfaces of these deposits are irregular with multiple pluvial depressions.

Upper Tertiary sequence

- Tcu — **Conglomerate of Eagle Rock (Miocene)** - Boulder-cobble-pebble volcaniclastic conglomerate, pebble-cobbly conglomeratic sandstone, and pebbly sandstone. Typically light colored and gently dipping, this unit occurs in low-lying areas along Cow Creek, French Creek, and Castle Creek.
- Tbuu — **Uppermost basaltic lava (Miocene)** - Basaltic lava containing 0-10% <3mm olivine (mostly altered to iddingsite) and pyroxene phenocrysts with lesser plagioclase typically <1mm. Texture ranges from vesicular with vitric matrix to massive with crystalline matrix.
- Tc — **Conglomerate and andesite (Miocene)** - Conglomerate, pebbly sandstone, and sandstone with locally abundant lenses of pyroxene andesite lava (similar to the pyroxene andesite) and lava breccia. Sedimentary rocks are chiefly volcaniclastic, but locally contain up to 30% Proterozoic granitoid, schist, and amphibolite clasts. Most of the volcanic clasts are pyroxene andesite with lesser amounts of phenocryst-poor trachytic lava, basaltic lava, and dacitic lava. The sandy matrix is typically pumiceous. Minor amounts of pyroclastic rocks may also be present.
- Tcx — **Sedimentary megabreccia and conglomerate (Miocene)** - A unit dominated by areas of either disrupted volcanic bedrock or very large (>10 meters) blocks of trachyte lava, basaltic lava, dacitic lava, and felsic nonwelded tuff. The boundaries between the blocks are rarely exposed.
- Tau — **Pyroxene andesite of Cow Creek (Miocene)** - Andesitic lava, lava breccia, monomict andesitic sedimentary breccia, conglomerate, and basaltic lavas. The andesite contains up to 7% <2.5mm pyroxene phenocrysts along with 2-15% generally <2mm plagioclase phenocrysts in a vitric to finely crystalline matrix.

Lower Tertiary sequence

- Tr — **Rhyolitic lava (Miocene)** - Rhyolitic lava containing ~5% 1-2mm quartz and feldspar (sanidine and plagioclase) phenocrysts with sparse <1mm biotite.
- Trt — **Rhyolitic tuff (Miocene)** - Nonwelded, mostly thick-bedded rhyolitic tuff associated with the rhyolite lava (Tr) in the southwest corner of the map area.
- Tdu — **Upper Dacite (Miocene)** - Dark weathering moderately phenocryst-rich dacite lava and intrusive rock containing 10-20% <4mm plagioclase and <2mm biotite. This dacite occurs in the immediate hangingwall of the Castle Creek fault in the southwest corner of the map area. Much of this unit is intrusive in this area. The dacite is differentiated from the main dacite (Td) because it occurs higher in the section and appears to be slightly less phenocryst-rich.
- Tbu — **Upper basalt (Miocene)** - Basaltic lava containing 0-10% <3mm olivine (mostly altered to iddingsite) and pyroxene phenocrysts with lesser plagioclase typically <1mm. Texture ranges from vesicular with vitric matrix to massive with crystalline matrix. This map unit includes basaltic lavas interbedded with moderately to steeply tilted volcanics of the lower volcanic sequence that overlie the dacitic lava unit (Td).
- Td — **Dacitic lava (Miocene)** - Dacitic lava containing 10-30% <6mm plagioclase and up to 5% <3mm biotite and/or <5mm hornblende. Map unit also includes some amount of volcaniclastic and pyroclastic dacitic rocks near the base of lava flows. In most areas the associated pyroclastic rocks are nonwelded, but at the base of the lower flow that holds up Sheep Mountain, a basal, strongly welded, medium- to thick-bedded, up to 20m-thick ignimbrite is present that contains up to 30% obsidian flamme. Intrusive dacite in the throat of vents or in dikes is not differentiated. Pyroclastic dacitic dikes (Tdi) are probably related to this unit.
- Tts — **Tuff and volcaniclastic rocks (Miocene)** - This unit is dominated in most areas by thin-, medium-, and thick-bedded, mostly tabular, felsic, nonwelded tuffs. Most of the tuffs are ignimbrites, but ash-fall tuffs are also locally abundant. Tuffs associated with dacitic lavas contain abundant biotite, whereas tuffs associated with rhyolites are generally phenocryst-poor with little or no biotite. Tuffs are undifferentiated from volcaniclastic sedimentary rocks, which are typically intimately interbedded with the pyroclastic rocks and in many areas overwhelm them in abundance. The sedimentary rocks range from thin- to thick-bedded, and from silty ashstones to boulder conglomerate and breccia. Some of the breccias are very thick-bedded and may grade locally into dacitic and rhyolitic autobreccia. Clasts are chiefly volcanic; dacite, andesite, basalt, and rhyolite, but Proterozoic granitoid, schist, amphibolite and vein quartz clasts are also locally present.
- Ttr — **Trachytic lava (Miocene)** - Phenocryst-poor, very fine-grained typically dark gray matrix lava of probable trachytic composition. Phenocrysts (0-7%) consist of ubiquitous <2mm feldspar (plagioclase) with either/or biotite (<2mm) and/or hornblende (<4mm). Some of the lavas are nearly aphyric, and others are dominantly biotite or hornblende-bearing.
- Tpx — **Pyroxene basalt (Miocene)** - Mafic lava containing 2-10% 3-6mm green pyroxene (probably clinopyroxene) with lesser amounts of <2mm iddingsite (<5%), and <2mm plagioclase (<<5%) phenocrysts.
- Ta — **Andesite (Miocene)** - Mafic lava containing 10-25% <2.5mm plagioclase and lesser mafic phenocrysts <2mm (0-7%).
- Tb — **Basalt (Miocene)** - Basaltic lava containing 0-10% <3mm olivine (mostly altered to iddingsite) and pyroxene phenocrysts with lesser plagioclase typically <1mm. Texture ranges from vesicular with vitric matrix to massive with crystalline matrix. This map unit is interbedded with moderately to steeply tilted volcanics of the lower volcanic sequence that underlie the dacitic lava unit (Td). This unit also probably contains flows of pyroxene-rich basalt similar to the pyroxene basalt (Tbp).
- Ttw — **Tuff of Elston Mountain (Miocene)** - A single flow of welded phenocryst-poor felsic ignimbrite interbedded with basaltic lava near the headwaters of French Creek. The ignimbrite contains about 5% sanidine phenocrysts.
- Tcr — **Pyroxene andesite of Champie Ranch (Miocene)** - Andesitic lava, lava breccia, monomict andesitic sedimentary breccia. The andesite contains up to 7% <2.5mm pyroxene phenocrysts along with 2-15% generally <2mm plagioclase phenocrysts in a vitric to finely crystalline matrix. The andesite of this unit is virtually identical to the pyroxene andesite of Cow Creek, and can only be distinguished from that younger unit by continuity with strata of the older volcanic sequence. The pyroxene andesite of Champie Ranch is abundant in the south and southwestern parts of the map area where it is interbedded with basaltic lavas (Tbn-bedded), tuffs and volcaniclastic sedimentary rocks (Tts), and trachytic lava (Ttr). To the north, the andesite pinches out rapidly into a sequence of basalt (Tb), andesite (Ta), and pyroxene basalt (Tbp). In some areas flows of andesitic and basaltic lavas are interbedded with the pyroxene andesites typical of this unit.
- Twg — **Hornblende andesite of Walker Gulch (Miocene)** - A distinctive hornblende-phyric andesitic lava present at or near the base of the volcanic section along the lower reaches of Walker Creek. Hornblende phenocrysts up to 7mm constitute up to 10% of this lava along with 5-10% <3mm plagioclase.
- Tcs — **Arkosic sandstone and conglomerate (Miocene)** - Red, arkosic sandstone, pebbly sandstone, and pebble-cobble-boulder conglomerate. Clasts in the conglomerate are rounded to sub-rounded and consist chiefly of Proterozoic granitoid with lesser amounts of schist, amphibolite, and vein quartz, plus up to 10% quartz and feldspar porphyry, and locally, up to 5% basalt. The unit is typically medium- to thick-bedded in plane-bedded to trough cross-stratified sets. Minor amounts of felsic nonwelded tuff and volcaniclastic sandstone occur within this unit in some areas.
- Tab — **Andesite and basalt (Miocene)** - Undifferentiated lavas, tuffs, and volcaniclastic rocks at the base of the volcanic section (shown only on the cross section).

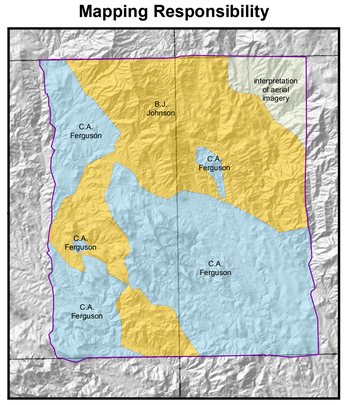
Intrusive Rocks

- Trx — **Phenocryst-rich rhyolite porphyry (Miocene)** - Dikes and intrusions of light gray, fine-grained matrix, typically flow-foliated rhyolite porphyry. The porphyry typically contains 10-25% <3mm quartz, feldspar (sanidine and plagioclase), and biotite phenocrysts. The porphyry intrudes the arkosic sandstone and conglomerate (Tcs) and appears to intrude the phenocryst-poor rhyolite porphyry (Trp). The southernmost exposures of this unit are more phenocryst-rich, containing 30-40% <5mm feldspar, <4mm quartz, and <3mm biotite. The more phenocryst-rich porphyry appears to intrude the arkosic sandstone and conglomerate unit (Tcs) along the lower reaches of the west fork of Walker Gulch, but, considering the close proximity to the Castle Creek fault zone, it is possible that all of the contacts are faults, and the porphyry might be akin to the TKq quartz porphyry which is older than Tcs.
- Trp — **Phenocryst-poor rhyolite porphyry (Miocene)** - Dikes and intrusions of phenocryst-poor, white to light gray fine-grained matrix, typically flow-foliated rhyolite porphyry. The rock ranges from aphyric to very phenocryst-poor where it typically contains <1% <1mm feldspar. The stock that holds up the 3660' peak along Walker Gulch in the center of section 36 contains up to 2% sanidine with sparse quartz phenocrysts.
- Tdi — **Pyroclastic dikes (Miocene)** - Dikes up to 10m thick of welded, variably vitric, dacite with 10-30% phenocrysts of <3mm feldspar (plagioclase mostly), <2mm biotite, and hornblende. The dikes contain up to 15% obsidian flamme, and they are probably akin to a vitric, strongly welded dacitic ignimbrite at the base of the lowermost dacite lava that holds up Sheep Mountain.
- TKc — **Calcite veins (Cretaceous or Tertiary)** - Coarse-grained crystalline, typically dark gray and/or brown calcite veins.
- TKqv — **Quartz veins (Cretaceous or Tertiary)** - White, mostly finely crystalline quartz veins.
- TKq — **Quartz porphyry (Cretaceous or early Tertiary)** - Dikes and intrusions of quartz and feldspar porphyry containing 5-15% <4mm quartz phenocrysts, 10-35% <6mm feldspar and up to 5% biotite <4mm. The feldspar phenocrysts are commonly chalky altered.
- TKf — **Feldspar porphyry (Cretaceous or early Tertiary)** - Dikes and intrusions of porphyry containing 20-55% <4mm feldspar and up to 5% <4mm biotite. The feldspar phenocrysts are commonly chalky altered.
- TKm — **Mafic dikes (Cretaceous or early Tertiary)** - Mafic dikes containing up to 10% <3mm mafic phenocrysts (chiefly pyroxene, with lesser amounts of iddingsite).
- TKx — **Diatreme breccia (Tertiary – Cretaceous)** - Fragmental rock containing subangular to rounded pebbles, cobbles, and boulders of foliated biotite granitoid rocks, pegmatite, leucogranite, fine-grained diorite, and green to gray feldspar and quartz-feldspar porphyries; supported in fine-grained, tan to green, altered matrix that contains sparse sand-sized grains of quartz, feldspar, lithics, and mica. Zones of strong quartz-sericite-iron oxide alteration are common.

Proterozoic Metamorphic and Plutonic Rocks

- Xg — **Granodiorite (Paleoproterozoic)** - Medium- to fine-grained equigranular granodiorite containing 5-12% biotite. Typically this rock is weakly to moderately foliated except near screens of older schist where it is strongly foliated. DeWitt (1989) informally named this unit the granodiorite of Lane Mountain. Younger dikes of tourmaline-muscovite pegmatite and fine- to medium-grained leucogranite are locally abundant, especially near contacts with adjacent metamorphic units. The pegmatite and leucogranite dikes, which are genetically related to the Crazy Basin Quartz Monzonite (Blacet, 1968; Anderson and Blacet, 1972), are typically massive and discordant with respect to the foliation in the granodiorite, but are foliated and concordant in the zones of strongly foliated granodiorite. Related pegmatite and leucogranite dikes have intruded all of the Paleoproterozoic units in this map area.
- Xgs — **Heterogeneous metamorphic and plutonic rocks (Paleoproterozoic)** - Schist and amphibolite of units Xs and Xa intruded by, and interfoliated with, granodiorite of unit Xg. All of these rocks have been intruded by leucogranite and pegmatite. The distribution and proportions of the different rock types varies substantially across and along strike within this unit.
- Xs — **Metasedimentary schist (Paleoproterozoic)** - Unit dominated by metasedimentary rocks, especially fine-grained, semipelitic, biotite-quartz-feldspar schist interlayered with fine- to medium-grained, pelitic, muscovite-biotite-quartz-feldspar schist. Many layers contain 1-3-mm garnet, and the pelitic layers commonly contain andalusite(?) porphyroblasts up to 1 cm long (entirely or partly replaced by muscovite and quartz). Rare garnet-staurolite-muscovite-quartz-feldspar schist contains staurolite porphyroblasts up to 2 cm long. Quartzofeldspathic psammite is common in some intervals. Amphibolite and foliated granitoid rocks are present locally. Pegmatite and leucogranite dikes are common and are locally predominant.
- Xa — **Amphibolite (Paleoproterozoic)** - Medium- to fine-grained amphibolite composed mainly of hornblende and plagioclase. In addition, some layers contain epidote and some contain abundant light-brown carbonate. The unit contains minor quartzofeldspathic layers.
- Xf — **Quartzofeldspathic schist (Paleoproterozoic)** - Fine-grained schists, including biotite-quartz-feldspar schist and siliceous schist of either sedimentary or volcanic protolith.
- Xu — **Undivided metamorphic rocks (Paleoproterozoic)** - Undivided Paleoproterozoic rocks including schist, amphibolite, minor quartzite, and local granitoid rocks, intruded by pegmatite and leucogranite dikes. In the Silver Mountain area these rocks have all been intruded by swarms of quartz monzonite and porphyry dikes (units TKf and TKq).
- Xuu — **Undivided metamorphic and plutonic rocks (Paleoproterozoic)** - Paleoproterozoic rocks east of Humbug Creek have not been subdivided.

Mapping Responsibility



Geologic map of the western half of the Columbia 7 ½' Quadrangle and the eastern half of the Copperopolis 7 ½' Quadrangle, Yavapai County, Arizona

Arizona Geological Survey
Digital Geologic Map 109 (DGM-109), version 1.0

By
Charles A. Ferguson and Bradford J. Johnson

Citation for this map:
Ferguson, C.A., and Johnson, B.J., 2013, Geologic map of the western half of the Columbia 7 ½' Quadrangle and the eastern half of the Copperopolis 7 ½' Quadrangle, Yavapai County, Arizona: Arizona Geological Survey Digital Geologic Map DGM-109, scale 1:24,000.

Research supported by the U. S. Geological Survey, National Cooperative Geologic Mapping Program, under USGS award number G12AC20464. The views and conclusions contained in this document are those of the authors and should not be interpreted as necessarily representing the official policies, either expressed or implied, of the U. S. Government.

Introduction

The Columbia and Copperopolis 7 ½' Quadrangles are located approximately 80 km northwest of downtown Phoenix in central Arizona. The Quadrangles encompass part of the southern Bradshaw Mountains and include the Sheep Mountain porphyry prospect. 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 #G12AC20464. Mapping was compiled digitally using ESRI ArcGIS software.

Bedrock Geology

The map area consists of faulted and tilted blocks of lower Proterozoic metamorphic and plutonic rocks and overlying Oligo-Miocene volcanic rocks. Normal faults generally strike to the northwest and dip to the southwest. The map area approximately straddles the boundary between tilted and extended fault blocks of the Basin and Range Province to the southwest and largely intact Proterozoic bedrock of the Transition Zone to the northeast. Mapping to the southwest identified highly tilted and extended rocks, including areas where multiple generations of normal faulting and tilting had locally overturned beds and tilted normal faults beyond horizontal to make them appear as reverse faults (Capps et al., 1986; Stimac et al., 1987; Wahl et al., 1988). Surficial deposits are of very limited extent in the map area.

A large, low-grade mineral deposit in the southern part of the map area, known as the "Sheep Mountain copper-molybdenum deposit" and the "Castle Copper property," is interpreted as a Laramide porphyry copper deposit similar to numerous others in Arizona. Exploration, including drilling, in the area of porphyry sulfide mineralization has led to estimates of "inferred resources" of 40 million metric tons of ore with an average grade of 1.4% copper and an average grade of molybdenum of 0.035% where copper grade is >0.8%. Supergene copper mineralization pre-dated Oligo-Miocene volcanism, and has been identified from drilling into the paleoweathering zone beneath the volcanic rocks (Tanaka, 2009).

Bedrock map units are divided into four groups, from oldest to youngest: 1) Proterozoic plutonic and metamorphic rocks, 2) Laramide and younger intrusive rocks, including quartz and feldspar porphyries and mineral veins, 3) a lower sequence of Tertiary volcanic and sedimentary rocks which are unconformably overlain with strong angular discordance by 4) an upper sequence of Tertiary volcanic and sedimentary rocks.

The Proterozoic rocks consist of a variety of supracrustal metamorphic rocks including pelitic and semipelitic metasedimentary schist, quartzofeldspathic schist of probable volcanic and/or hypabyssal origin, and amphibolite. Minor calc-schist, marble, and quartzite are also present. The supracrustal units have been intruded by biotite granodiorite plutons, and all of these rocks have been intruded by extensive swarms of tourmaline-muscovite pegmatite and leucogranite dikes. The supracrustal rocks and granodiorite have been deformed by penetrative foliation that generally dips steeply to the northwest. Pegmatite and leucogranite are foliated only locally, suggesting that they may have been emplaced during final stages of Proterozoic tectonism.

Proterozoic crystalline rocks are intruded by a swarm of northeast-striking, Laramide quartz porphyry and feldspar porphyry dikes with a few small stocks. A suite of mostly north-striking mafic dikes are also present, but their age relationship with the Tertiary volcanic pile is unkown.

Tertiary strata are dominated by volcanic rocks ranging from basalt to rhyolite with a massive, cliff-forming sequence of dacitic lava in the middle of the pile. The base of the pile is marked by an arkosic sandstone and conglomerate containing pebbles, cobbles, and locally boulders derived chiefly from the Proterozoic basement; locally abundant clasts of quartz and feldspar porphyry are also present. The basal arkosic unit also contains sparse basaltic clasts. In the volcanic rocks, two profound northeast-trending transitions occur across the middle of the map area. The oldest is marked by a change from a thick pyroxene andesite unit near the base of the pile that abruptly pinches out to the northwest into a sequences of interbedded mafic lavas, felsic pyroclastic rocks and a suite of phenocryst-poor trachytic lavas. A younger transition with the same trend is located a bit farther to the south, and is defined by a profound angular unconformity between rocks of the lower sequence and a younger moderately to steeply east-tilted pile of pyroxene andesite lava virtually identical to the pyroxene andesite that occurs near the base of the lower sequence.

Structurally, the Tertiary volcanic pile in the hangingwall of the Castle Creek fault is steeply tilted to the northeast much like rocks in southwesterly adjacent areas (Stimac et al., 1987). The rocks in the lower part of this pile bear strong similarity to those in the lower volcanic sequence to the northeast. Rocks in the footwall of the Castle Creek fault are broadly folded into an asymmetric northwest- to north-striking syncline. The southwest limb is gently tilted to the northeast. The northeastern limb is defined by the Proterozoic – Tertiary contact along the southwest flank of Silver Mountain which is a fairly steeply southwest-dipping unconformity. The unconformity turns to the east across the middle of the map area where it is eventually truncated by a major west-side-down fault that is overlapped by the strata of the younger sequence. The younger sequence is more tightly folded than the older rocks. Strata of the basal unit of this sequence, the andesite of Cow Creek (Tau), define a syncline whose western limb appears to conformably overlie rocks of the lower sequence along lower French Creek, but to the north progressively cuts into more gently dipping lower sequence strata until a profound angular unconformity between the two sequences occurs north of Champie Ranch.

Note on volcanic rock names

Volcanic rock names used on this map are field terms based on phenocryst assemblages present in the rocks and follow the recommendations of McPhie et al., 1993. In this scheme, rhyolitic rocks contain K-feldspar +/- plagioclase and quartz whereas dacitic rocks contain plagioclase +/- K-feldspar and rarely quartz. Mafic phenocrysts in rhyolitic and dacitic rocks are generally dominated by hydrous phases such as biotite and hornblende with lesser amounts of pyroxene. Andesitic rocks contain plagioclase > mafic minerals that are generally dominated by anhydrous phases (pyroxene and olivine), and basaltic rocks contain olivine and/or pyroxene that typically are more abundant than plagioclase. The term trachyte is used for phenocryst-poor silicic rocks without quartz phenocrysts. They typically contain a few percent phenocrysts of plagioclase with mafics dominated by biotite and/or hornblende.

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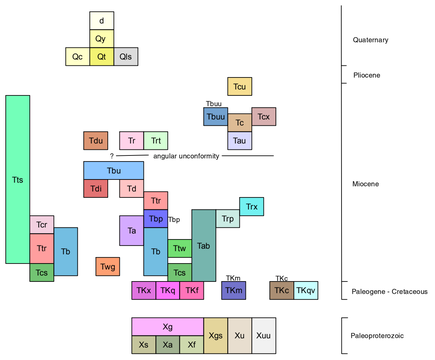
Correlation of Map Units



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