BEDROCK GEOLOGIC MAP OF THE APACHE JUNCTION AND BUCKHORN QUADRANGLES, MARICOPA AND PINAL COUNTIES, ARIZONA

by

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Arizona Geological Survey
Open-File Report 96-8

June 1996
(revised August, 1997)

Arizona Geological Survey
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Includes 16 page text and 1:24,000 scale geologic map.

Partially funded by the Arizona Geological Survey
and the US. Geological Survey STATEMAP Program
Contract #1434-95-A-1353

INTRODUCTION

This study encompasses the southern part of both the Usery Mountains and the Goldfield Mountains and includes all areas where bedrock is exposed in the Apache Junction and Buckhorn USGS 7.5' topographic quadrangle maps (see figures 1 and 2). The eastern edge of the study area includes part of the Superstition Mining District and contains many pits and prospects.

The region is near the northern margin of the Basin and Range Province and the southern margin of the Transition Zone. Elevations range from about 1280 feet in the northwest corner of the map to 3269 feet near the northeast corner of the map. Field work was carried out between February and April, 1996.

Access to the area is good. The Bush Highway, Power Road, and McKelleps Road. are all good avenues of entry to the Usery Mountains. Several dirt roads provide good access to the Goldfield Mountains. The road down Bulldog Canyon requires a permit (locked gate) and even with 4-wheel drive the road is very rough. The road through Bulldog Canyon is impassable if driven from north to south.

PREVIOUS STUDIES

Sheridan (1968) published a 1:117,000 scale geologic map for the Goldfield-Superstition area, and later (Sheridan, 1978) produced a series of 1:32,000 scale maps for areas along the Apache Trail (which was updated in Sheridan, 1987). Fodor (1969) performed the first relatively detailed geologic and petrologic study of the Goldfield Mountains, which includes the eastern half of the study area. Damon and others (1969) reported a K-Ar biotite date of 21.85 ± 0.80 Ma for a 'quartz latite' near Pass Mountain (the sample is mislocated). The volcanic stratigraphy in the Goldfield and Superstition Mountains was described along with K-Ar and fission-track ages by Stuckless and Sheridan (1971), which complemented an earlier paper about the same area (Sheridan, Stuckless, and Fodor, 1970).

Fission-track ages for samples of the granitic basement were reported by Stuckless and Naeser (1972). Suneson (1976) mapped the north-central part of the Goldfield-Superstition area and described the rhyodacite of Apache Gap, a sample of which was dated by Shafiqullah and others (1980).

Hillier (1978) performed a geochemical study of the latite of Government Well. In his Q-A-P ternary diagram he shows most of his samples having a latite composition. On his geologic map of his study area, much of the area was labeled 'dacite breccia'. In this report the latite of Government Well, with all its various subunits, has been collectively called 'dacite'. This may or may not be justified, but appears to be a useful field term.

Sheridan and Prowell (1986) provide a good overview of the structure in the Goldfield-Superstition volcanic complex. Kilbey (1986) produced a detailed 1:10,000 scale geologic map of the region from Siphon Draw on the east, westward almost to the rhyolite dome in Bulldog Canyon. Later, Melchiorre and Clemens (1993) published a 1:10,000 scale map of most of the western half of the same area.

The environmental geology and general bedrock geology of the Apache Junction quadrangle were studied by Turek (1975). Pewe (1978, 1987)) produced a report about the terraces along the Salt River and includes the northwestern corner of the study area. A more detailed report, which includes bedrock mapping, was produced by Drosendahl (1989).

To the east, the Goldfield Quadrangle was mapped by Skotnicki and Ferguson (1995). Bedrock and surficial geology in the Mount McDowell area to the northwest was mapped by Skotnicki (1995). The history of stratigraphic names usage in the Goldfield and Superstition Mountains was compiled and reviewed by Trapp (1996).

STRATIGRAPHY/GEOLOGIC SETTING

Granitic Rocks

The oldest rocks in the area are Precambrian granites. There are four separate, mappable bodies. From west to east, in general, they are: (1) coarse-grained granite/quartz monzonite (map unit Xgc), (2) mostly fine-grained but locally medium-grained granite to quartz monzonite (map unit Xgf), (3) medium-grained granodiorite to syenite (map unit Xgm), and (4) coarse-grained granite to syenite (map unit YXg). Map units Xgf and Xgc have very similar mineralogies, though their grain sizes differ, and could be co-genetic. Map units Xgc and YXg are also very similar. They are both coarse-grained, K-feldspar-porphyritic granites, but YXg was mapped separately on the tentative distinctions that (1) biotite in this rock generally occurs in separate crystals or books and is not as intergrown and fine-grained (felty) as in Xgc, and (2) because the K-feldspar phenocrysts in YXg are light gray to pink and not blue-gray as in Xgc. All of the granitic units are foliated and locally lineated; though map unit YXg is foliated only in its western-most exposures.

Conglomerates

Resting unconformably on the granitic rocks are predominantly pre-volcanic conglomerates and arkosic sandstones. In the eastern part of the study area the conglomerates contain a large percentage of clasts derived from Apache Group sedimentary rocks, and less abundant Precambrian metamorphic and granitic rocks and Paleozoic limestone (map unit Tc). At the base of the section the conglomerates contain a much greater proportion of locally derived granitic material, and have been mapped separately as Ts. The overlying conglomerates probably reflect drainage into the area from outside the region. Together, the conglomerates and underlying granitic-rich unit filled a basin (as was first suggested by Kilbey, 1984, who named it the "Goldfield Basin"). The eastern boundaries of the basin are not exposed, but the sedimentary rocks rapidly pinch out along strike to the northwest where they disappear to the west of and just north of Blue Ridge (about 0.5 miles south-southeast of Rock House). Immediately south of Rock House, the conglomerate appears again and thickens rapidly to the west, but is intercallated with abundant tuffaceous material. Tuff is progressively more abundant westward and northeast of Pass Mountain the conglomerate unit (map unit Tst) is dominated by thinly bedded tuffs with minor sedimentary deposits. However, exposures below Pass Mountain are composed of mostly non-volcanic material.

Rhyolite Plugs

The bedded tuffs at the base of the section (interbedded with conglomerates in unit Tst) originated from the rhyolite dome in Bulldog Canyon (and probably the dome to the south of the dome in Bulldog Canyon as well--map units Trb and Tr). These domes were originally thought to be 'late stage domes' (Fodor, 1969) associated with much younger rocks. Mapping during this study, however, has revealed that these domes and their associated pyroclastic deposits lie below a sequence of basalts and dacite and directly overlie granite. These rhyolite intrusions represent the earliest exposed volcanic rocks in the area.

Basalt and Dacite

The conglomerates, sandstones, and tuffaceous conglomerates are overlain by a sequence of olivine basalts and interbedded felsic lithic tuffs. There are a maximum of three separate tuff layers which appear to thicken to the south and thin and/or coalesce with each other towards the east and west. The tuff/basalt package is overlain by a crystal-rich sequence of dacite flows, tuffs and breccias (not mapped separately--map unit Tdc). Suneson (1976) named this unit the latite of Government Well. To the east the unit crops out all the way to Hieroglyphic Canyon in the Goldfield quadrangle. Stuckless and Sheridan (1971) reported a fission-track age of 29.90 $\pm$ 0.50 Ma for a sample of the rock from Hieroglyphic Canyon. To the west, the dacite, basalt, and underlying sedimentary and tuffaceous rocks all thin northwestward where they pinch out just north of the quadrangle boundary below the west side of Dome Mountain. About 2 miles east of Pass Mountain, basalt and dacite underlying a thick cap of rhyodacite also pinch out to the northwest.

Strange Rock

Overlying the dacite is an unusual volcanic rock containing phenocrysts (in variable amounts) of olivine, pyroxene, plagioclase, hornblende, biotite and quartz (map unit Tab). The unit forms a dark, prominent cliff between the underlying dacite and an overlying sequence of tuffs and rhyolites. The upper contact is an angular unconformity. The lower contact appears conformable. The unit was easily mappable north of the rhyolite dome in Bulldog Canyon where it forms an obvious cliff. Farther to the east, however, the rock looks similar to the dacite and was not mapped separately, but probably exists. This rock marks a transition, both temporally and lithologically, from mafic- and intermediate-composition lavas below to felsic lavas above (with the exception of the initial intrusion of felsic lava of the rhyolite of Bulldog Canyon).

Rhyodacite

In the northeast corner of the study area, crystal-rich rhyodacite (map unit Trd) overlies dacite and clearly underlies a thick sequence of relatively crystal-poor lithic tuffs (map unit Trt) and rhyolite flows. A thin lithic tuff and basalt flow occur at the base of the rhyodacite. To the west towards Pass Mountain, however, crystal-rich rhyodacite overlies crystal-poor lithic tuffs. Unfortunately, nowhere is the rhyodacite in the west in contact with rhyolite. If the crystal-poor lithic tuffs in the west are indeed associated with the rhyolite flows farther to the northeast (map unit $Tr_{1,2,3}$), then the rhyodacite at and near Pass Mountain would be younger than the rhyolite and much younger than the rhyodacite in the northeast corner of the map. If the crystal-poor lithic tuffs below the rhyodacite are not associated to the lithic tuffs related to the rhyolite flows then the rhyodacite near Pass Mountain and the rhyodacite below lithic tuffs in the northeast corner of the map may be correlative. The rhyodacite in the northeast corner is probably correlative with the Ryodacite of Apache Gap, as defined by Suneson (1976), and was dated at 20.60 ± 0.62 Ma (K/Ar-bio) by Damon and others (1969). The rhyodacite near Pass Mountain (the sample appears to have been mislocated) has a similar age of 21.85 ± 0.80 Ma (K/Ar-bio, Damon and others, 1969).

Rhyolites

The youngest rocks exposed in the study area are a sequence of at least three crystal-poor rhyolite flows interbedded with relatively crystal-poor lithic tuffs. The crystal-content of the flows varies slightly both within and between flows--plagioclase, biotite, and quartz phenocrysts vary between 2 and 10%. The interbedded tuff layers vary greatly in thickness from zero to several hundred feet. The variation probably reflects quite a bit of topographic relief in the immediately underlying strata.

TERRACES

River terraces are well-exposed along the Salt River in the northwestern corner of the map area. In section 26, T. 2 N., R. 6 E., there appear to be at least five distinct terrace levels above the Blue Point Terrace. Along the Salt and Verde Rivers north of the map area, the four terrace levels defined by Pewe (1978) have been subdivided into two sublevels each (Skotnicki, 1995). There the elevation difference between terraces of different ages (i.e., the Mesa terrace vs. the Sawik terrace) is everywhere greater than the elevation difference between the sublevels within individual terraces of a given age. However, in section 26, although the upper level of the Sawik terrace is much higher than the lower level of the Mesa terrace (about 70 feet higher) the intermediate terraces show no obvious preference for being associated with one or the other. Instead they form a continuous series of step-like levels separated by between 10 and 30 feet and, hence, the labeling is somewhat arbitrary. The proximity in elevation of the different terrace levels may in part be due to the fact that all of the terraces along both the Salt and Verde Rivers converge downstream (Pewe, 1978).

STRUCTURE

[Note: The term "S-C foliation", as used on the map, is used to denote mylonitic fabrics within granitic rocks where the S and C surfaces are well-displayed. This is in contrast to the term "mylonite" and the symbol for mylonite used on the map, where the term is used to denote intensely foliated and lineated zones with little or no original fabric remaining, and displaying only one very prominent foliation. This convention is useful because mylonites (as defined here) mainly occur in this area in narrow zones, whereas S-C fabrics are widespread. The authors understand that this definition deviates from the thorough decription of S-C mylonites as defined by Lister and Snoke (1984).]

Shear Zones

Foliations in the granitic basement strike approximately northeast-southwest. Cutting across this trend, striking north to south, are two narrow shear zones in the Usery Mountains. The zones are between about 2 meters to several tens of meters wide. They both have very sharp margins and are characterized by strong gneissic foliation to local incipient mylonitization, and locally contain zones of light-colored crushed rock and gouge, and weakly to strongly foliated chlorite-hematite altered zones. Small quartz veins and mafic dikes (now chloritized) have intruded the shear zones and are themselves foliated. The chlorite-hematite altered zones are very much like similar altered zones found to the north, on the south side of the Salt River east of Blue Point Bridge (Scarborough, 1981, and preliminary mapping by authors). Locally, bands of fine-grained biotite schist (map unit Xs) form dark gray bands within the shear zones and may represent metamorphosed mafic intrusions.

Interestingly, although the shear zones are strongly foliated and lineated, the strike of the foliations within the zones are not subparallel to the strike of the shear zone, as one might expect, but strike obliquely to the northeast, parallel to the regional foliation. Also, at least one and possibly more smaller, narrow northeast-striking foliated zones are truncated by the larger north-south trending shear zones.

To the east of around Usery Pass the foliation is rather diffuse and spread throughout a large area of the granite. But west of Usery Pass, and at least as far west as Arizona Dam Butte, foliations are confined to relatively narrow zones, including the north-south trending shear zones. Areas where few or no foliations are shown were walked across to a large extent, and do indeed represent areas that are weakly to non-foliated. It is not clear whether the larger shear zones were formed during the Proterozoic or whether they formed much later, but the northeast-striking foliation direction is consistent with Proterozoic foliation directions.

Faults

In the southern Goldfield Mountains many northwest-striking, down-to-the-southwest, closely spaced normal faults bound fault blocks of granite, sedimentary rock, basalt, and dacite now tilted about 20 to 50 degrees to the northeast. Thickness changes in dacite (map unit Tdc) across a fault southwest of the dome in Bulldog Canyon suggest that faulting began, at least locally, during eruption of the dacite (dated at 29.90 $\pm$ 0.50 Ma [FT/zircon] by Stuckless and Sheridan, 1971, recalculated by Reynolds and others, 1986). Continued faulting tilted the dacite and all older rocks gently to the northeast. At about 21 Ma (an average of the dates by Suneson, 1976, and Damon and others, 1969) the ryhodacite (map unit Trd) was erupted onto an erosional surface formed on the older rocks. Then, between about 20 and 16 Ma (based on K-Ar and fission-track dates from Stuckless and Sheridan, 1971), the sequence of rhyolites and lithic tuffs was deposited onto an erosional unconformity on the rhyodacite in the northeast corner of the map. It is not clear from exposed outcrops if the rhyodacite was tilted prior to deposition of the rhyolite. Extreme differential thickness on opposite sides of faults on the steep mountain north of the dome in Bulldog Canyon shows that faulting was synchronous with deposition. Although the thicknesses of lithic tuffs and, to a lesser extent the rhyolites, are very different on opposite sides of some of the faults, the thicknesses of the underlying dacite layers are more or less constant. This shows that the main phase of faulting occurred after deposition of the dacite and during deposition of the rhyolite and tuff.

All of the older faults have been cut by younger, north- to northeast-striking, west-dipping, moderate- to low-angle normal faults. These faults are best exposed on the east side of the study area, where they displace granite, conglomerate, basalt, tuff, and dacite, into a complex pattern of small tilted, fault slivers. Many of the faults split into branches. The major fault along the east side of Blue Ridge splits about 1 mile north of Saddle Rock, and one branch strikes northwest, where it may have followed and possibly reactivated an older fault.

MINERALIZATION

The eastern end of the study area is by far the most heavily prospected area in the study area. During this study close to a hundred separate prospect pits and trenches were seen. Most of them have been dug into conglomerate and basalt. Many show traces of chrysocolla and hematite along fractures. A few prospects have been dug in dacite less than 1 mile north and south of the Apache Trail, and a few, notably the Bulldog Mine, have been dug in granite.

The Bulldog Mine is located just south of the Maricopa/Pinal county line in Pinal County just east of Saddle Rock. It was dug into a large, vertical manganiferous calcite vein 400 feet in length trending north in granite. The south end of the calcite vein contained a large shoot of epithermal quartz 45 feet long and three feet wide rich in electrum and assaying in gold up to 250 ounces per ton. The quartz is locally surrounded by calcite and brecciated rock, indicating late-stage quartz. Near the surface the ore contained pyrolusite but no sulfides. At 105 feet pyrite was abundant. The vein is fractured and slickensides are present on fracture surfaces, indicating faulting after emplacement. The mine is thought to have produced about 6,700 ounces of gold (description of the Bulldog Mine modified after Wilburn, 1993, and Wilburn, unpub.).

About 300 feet west of the Bulldog Mine another large manganiferous calcite vein 1-2 meters thick fills a north-trending fault zone and a small exposed branch fault. The vein dips between 45 and 55 degrees to the west and several small pits have been dug into the east side of the calcite vein. No obvious mineralization was visible.

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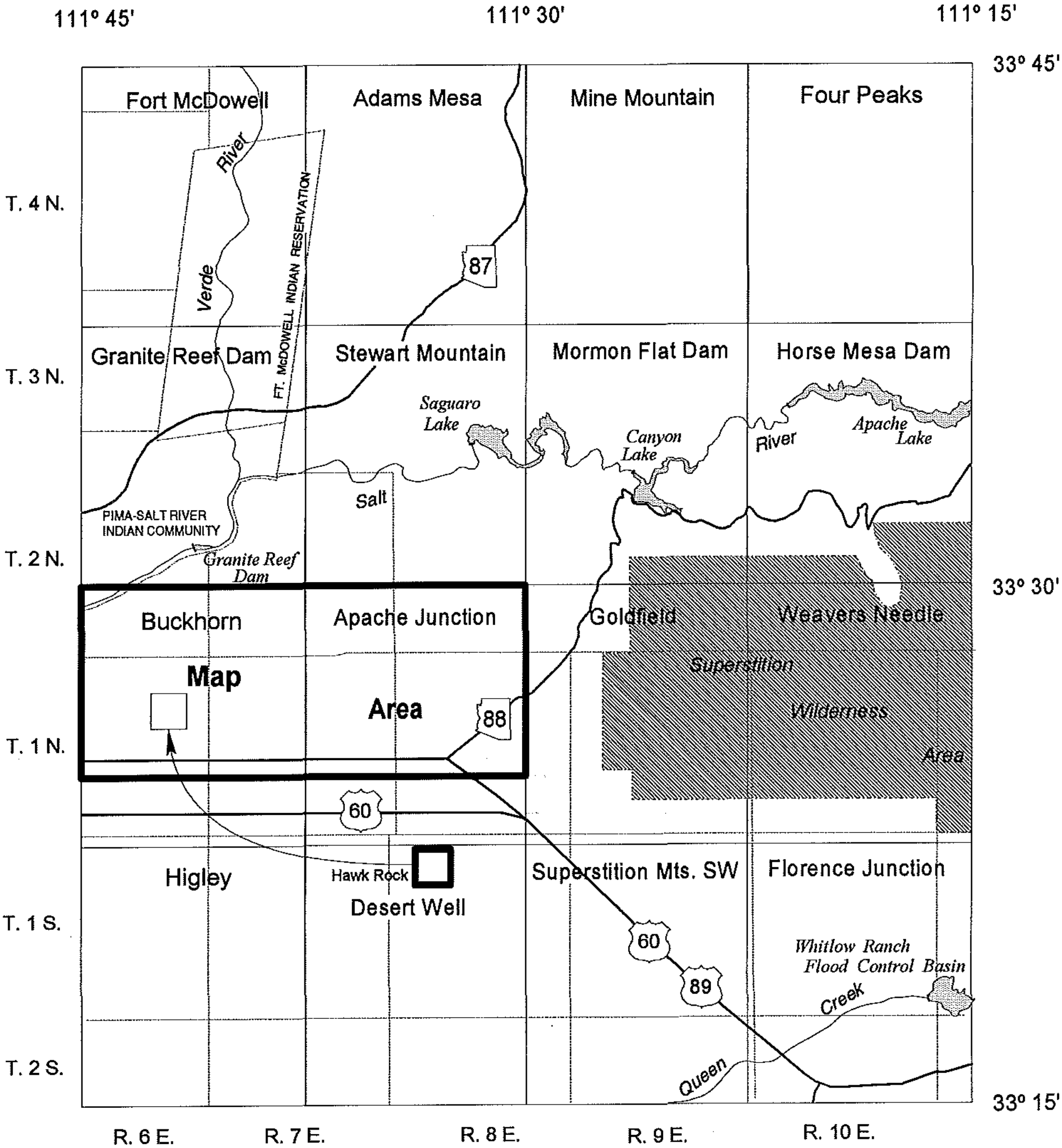

Figure 1. Location of U.S.G.S topographic maps and study area.

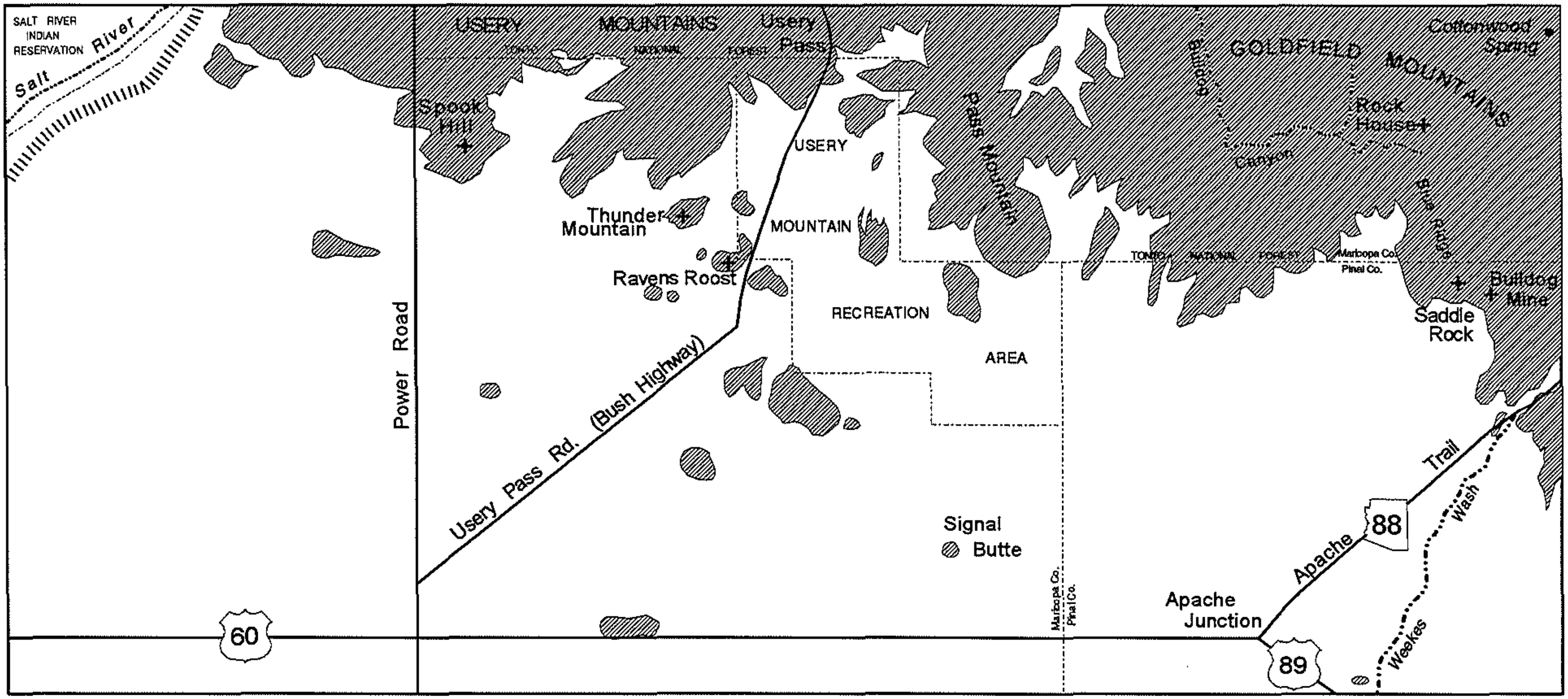

Figure 2. Index map showing place names and political boundaries.

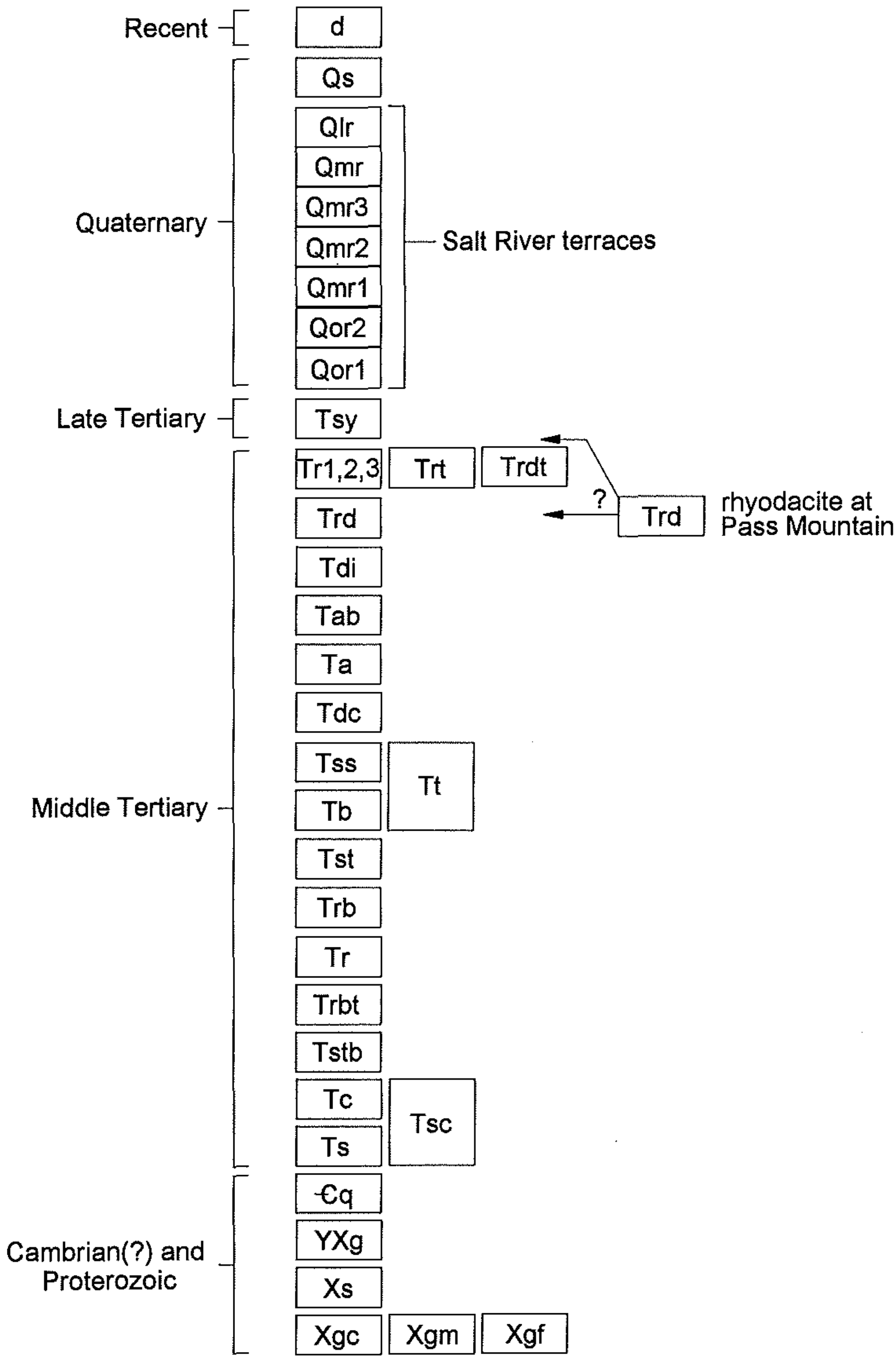

Figure 3. Correlation diagram for rocks in the Apache Junction and Buckhorn quadrangles.

UNIT DESCRIPTIONS FOR THE APACHE JUNCTION AND BUCKHORN QUADRANGLES

Quaternary Units

d(YXg) Disturbed ground(Recent)--These areas have been disturbed by human activity and the geology has been covered or otherwise obscured. Most of these areas are open-pit quarries in granitic rock. The letters in parentheses denote the rock exposed in the pit.

Qs **Quaternary surfacial deposits (Quaternary)**--Unconsolidated to moderately well-consolidated sand, gravel and conglomerate deposits of various ages, undifferentiated. Older and middle Pleistocene boulder-strewn fans are well exposed in the valley northeast of Pass Mountain.

Qlr **Late Pleistocene river terrace deposits (10 to 250 ka)**--Equivalent to the Blue Point terrace of Pewe (1978). Poorly consolidated, well-rounded pebble- to cobble-size river gravels in a matrix of a sand and minor silt. Mostly covered by younger piedmont fans and exposed only in patches along the south side of the Salt River.

Qmr **Middle to late Pleistocene river terrace deposits (about 200 to 400 ka)**--Equivalent to the Mesa terrace of Pewe (1978). Well-rounded, pebble- to cobble-size river gravels, strongly indurated by caliche. Strongly developed petrocalcic horizons capped with carbonate laminae locally form small resistant cliffs 1-4 meters thick below gravels. In the northwest corner of the study area there appear to be three distinct levels of the Mesa terrace.

Qmr_3 **Younger member of the Mesa terrace.**

Qmr_2 **Middle member of the Mesa terrace.**

Qmr_1 **Older member of the Mesa terrace.**

Qor_2 **Early Pleistocene river terrace deposits (750 ka to 2 Ma)**--Equivalent to the Sawik terrace of Pewe (1978). Well-rounded pebble- to cobble-size river gravels, very strongly indurated by caliche. Clasts exhibit strong desert varnish, and larger clasts are split and pitted.

Qor_1 **Older member of the Sawik terrace.**

Tertiary Units

Tsy **Younger sedimentary deposits (late Tertiary)**--The basin-fill deposits on the northeast side of Pass Mountain consist of poorly sorted, angular to rounded pebbles to small boulders of tuff and rhyodacite, in a tan sandy to silty carbonate-rich matrix. Almost no granitic material is present except for a few large boulders exposed on the surface. The deposits are moderately to strongly consolidated and form steep, rounded, dissected hills. Where these deposits are exposed along the salt river they are composed of fine-grained, pebble-size subangular clasts of granite and K-feldspar crystals, all in a tan sandy matrix.

$Tr_{1,2,3}$ **Rhyolite (middle Tertiary)**--This unit consists of multiple flows of crystal-poor rhyolite lavas containing 2-10% anhedral to subhedral phenocrysts of sanadine, quartz, and minor biotite and plagioclase, all up to about 3 mm, in a dark gray to brown glassy (often perlitic) aphanitic matrix. Much of the unit is vitric. Three stacked flows form resistant ridges at the northeast edge of the Apache Junction Quadrangle. Division of map units reflects age relationships between flows established by field relationships.

Trdt **Massive lithic tuff (middle Tertiary)**-- Crystal-rich, massive lithic tuffs and tuff breccia associated with the rhyodacite at the southeast end of Pass Mountain. These tuffs can be distinguished from the tuffs farther west below Pass Mountain (map unit Trt) because this unit is moderately crystal-rich and contains more mafic minerals than map unit Trt. Locally intrudes and overlies map unit Trt.

Trt **Lithic tuff (middle Tertiary)**--Light-colored, crystal-poor, massively bedded lithic tuffs containing fresh, subhedral to euhedral sanadine, biotite, and quartz phenocrysts up to 5 mm wide. The unit also contains abundant angular to subrounded lithics of dacite, basalt rhyolite, and pumice. The tuff is interbedded with all three rhyolite lavas (map units $Tr_{1,2,3}$). They vary in thickness from 0 to about 350 feet thick.

Trd **Rhyodacite (middle Tertiary)**--Light gray crystal-rich (20-30% phenocrysts) lava containing subhedral 1-6 mm phenocrysts of fresh biotite, plagioclase, sanadine?, quartz, and minor amphibole in a light chalky gray aphanitic matrix. Locally biotite is slightly altered to hematite. The unit is resistant and forms steep rugged outcrops and cliffs. The rock outcrops in the northeast corner of the map area where it is underlain by thin tuff and basalt, and unconformably overlies dacite (map unit Tdc). The unit also crops out at the western end of the Goldfield Mountains where it intrudes massive lithic tuffs (map unit Trdt) and overlies light yellow crystal-poor lithic tuff (map unit Trt)--see text for discussion of the possibility of two different rhyodacite units. The rock forms steep, ridge-capping flows. Here, it is commonly vitric near the base and flow banded. Vertical flow-banding and complex relationships with older volcanic rocks suggest that there is an intrusive complex about two miles directly east of the south end of Pass Mountain. In this area, rhyodacite appears to intrude a fault.

Tdi **Intrusive dacite (middle Tertiary)**--Crystal-rich dacite containing 1-10 mm subhedral to euhedral phenocrysts of light gray plagioclase, black biotite and hornblende (both locally altered to hematite), and less abundant embayed quartz, all in a pale green to tan aphanitic matrix. Plagioclase crystals commonly have white rims or are completely white, with altered cores. The rock forms resistant dikes which locally intrude faults near the eastern edge of the Apache Junction Quadrangle. This unit is best exposed south, east, and northeast of the Bulldog Mine, where it intrudes several faults the appear to merge south of the mine.

Tab **Andesite/basalt(?) (middle Tertiary)**--This strange, mineralogically diverse mafic lava contains subhedral 1-5 mm phenocrysts of iddingsite after olivine, hornblende and/or pyroxene, biotite, and quartz (all in variable amounts), in a purple to gray aphanitic matrix. Quartz(?) also occurs as large (>5 mm) greenish-clear xenocrysts/phenocrysts. The unit overlies dacite unconformably(?) (map unit Tdc) and forms a prominent dark cliff below the base of the thick lithic tuffs associated with the overlying rhyolite. It is separated from the overlying tuff by an angular unconformity. In thin section, scarce quartz phenocrysts are rounded and rimmed by pyroxene (hypersthene?). Olivine and all mafic minerals have been altered to opaques. Locally, there are fine-grained intergrowths of quartz and pyroxene.

Ta **Andesite (middle Tertiary)**--Dark purple-gray, fine- to medium-grained lava containing phenocrysts of abundant subhedral, clear to light gray plagioclase from 2-10 mm, very small pyroxene or hornblende less than 2 mm, and minor embayed quartz, in a dark purple-gray aphanitic matrix. The unit forms small isolated exposures overlying and possibly intruding basalt north of Saddle Rock on the north side of Blue Ridge, and is also locally interbedded with dacite (map unit Tdc).

Tdc **Dacite (middle Tertiary)**--Complex assemblage of massive dacite flows, autobrecciated flows, tuffaceous breccias and tuffs (not mapped separately, but studied by Kilbey, 1986). The unit contains abundant euhedral to subhedral 1-15 mm phenocrysts of clear to light gray plagioclase and subhedral to euhedral 1-8 mm phenocrysts of biotite and hornblende, in a tan to dark maroon or blue-purple matrix. The unit is crystal-rich, containing about 25-30% phenocrysts. The mafic minerals are locally fresh or altered to hematite. Locally, the abundance of hornblende appears to increase upwards. In most places the base of the unit is thin-bedded tuff and/or tuffaceous breccia, from about 1 meter to 20 meters thick. This basal tuff contains abundant subangular clasts of dacite 1-15 cm wide. Thin dacite breccias and tuffs are locally interbedded with basalt and, locally, andesite.

Tt **Lithic tuff (middle Tertiary)**--Light yellow lithic-rich tuffs containing subhedral phenocrysts of clear feldspar and biotite and poorly sorted subangular to subrounded lithics of granite, dacite, and less abundant basalt. The thinner tuff layers are heterogeneous and locally contain zones of massive, nonbedded tuff, thinly bedded yellow tuff, and interbedded granite conglomerates. This unit forms at least three distinct layers interbedded with basalt in the eastern part of the map area. A small outcrop of tuff associated with the dacite (map unit Tdc) was mapped above basalt at the northwest end of Blue Ridge.

Tss **Sandstone (middle Tertiary)**--This unit consists of light tan thin- to medium-bedded, moderately sorted to well-sorted arkosic sandstone containing subrounded to well-rounded sand-size grains of quartz and feldspar. The grains are moderately consolidated and the rock is relatively easy to break. It forms a discontinuous layer below lithic tuffs and above basalt on the southwest side of Blue Ridge.

Tb **Basalt (middle Tertiary)**--Fine-grained, medium to dark blue-gray flows and, locally, autobrecciated flows containing 1-3 mm phenocrysts of clear plagioclase, and olivine altered to red iron oxides. It is locally vesicular. The unit is interbedded with dacite (map unit Tdc) and tuff (map unit Tt). It erodes easily into crumbly to blocky dark rounded slopes and hills. Locally, the rock forms thin dikes.

Tst **Tuffaceous conglomerate (middle Tertiary)**--This unit is composed of both non-volcanic arkosic conglomerate and sandstone, bedded, unwelded, lithic-rich ash-flow tuffs, and tuffaceous sandstones and conglomerates. The relative amounts of these three types of rocks changes from place to place. In the east near Rock House tuffaceous conglomerate and sandstone appear to grade laterally into thin-bedded tuff layers. Farther west, on the hill intruded by the southernmost rhyolite dome (map unit Trb), the base of the unit consists of very coarse-grained breccia or conglomeratic sandstone with little or no volcaniclastic material, and changes gradually upwards into an interbedded volcaniclastic/sedimentary sequence in the middle to a pyroclastic-dominated sequence at the top. Farther west, below Pass Mountain, the unit is fine-grained, non-volcanic, and includes rare thin tuffs near the top. In the vicinity of the rhyolite dome in Bulldog Canyon, the unit is dominated throughout by pyroclastic rocks which appear to be related to the dome, and may include vent breccias similar to those mapped around the rhyolite dome to the south (map unit Trbt). Exposures of conglomerate and sandstone are generally covered with a coarse lag gravel but are locally well-exposed. Where exposed the sandstones and tuffs are thin- to medium-bedded. The conglomerate layers are generally massive, or medium- to thick-bedded. This unit contains almost no Apache Group clasts. Instead most clasts are locally derived, angular to subrounded, poorly sorted, foliated and non-foliated fine- and coarse-grained granite. The tuffaceous conglomerate pinches out along strike towards the east, about 1/4 mile south-southeast of Rock House. East of this point, the sedimentary rocks do not contain tuff but contain abundant Apache Group clasts as well as granite.

Trb **Rhyolite of Bulldog Canyon (middle Tertiary)**--This crystal-poor intrusive rhyolite lava contains about 5-7% phenocrysts of sanadine, and traces of biotite and quartz. The type area for this unit is a lava dome dissected by Bulldog Canyon where the canyon turns sharply to the north. A major fault cuts through the dome exposing the deeper, more crystalline core of the dome on the east against a flow-banded, vitric upper zone on the west that grades upward into carapace autobreccia. The dome is surrounded by correlative bedded tuffs and massive tuff breccias that directly overlie basement and are continuous with map unit Tst. This unit also includes another intrusive rhyolite plug about 1 mile to the south.

Tr **Rhyolite, undifferentiated (middle Tertiary)**--Undifferentiated rhyolite lava and intrusive rhyolite, containing about 5% sanadine and traces of mafic minerals. The unit is similar petrographically to the rhyolite of Bulldog Canyon and is possibly correlative.

Trbt **Massive tuff (middle Tertiary)**--Massive, unwelded, lithic tuff and vent breccia associated with the rhyolite lava dome 1 mile south of the Bulldog Canyon rhyolite dome. Similar massive tuffs exist near the dome in Bulldog Canyon but were not mapped separately there.

Tstb **Granite breccia (middle Tertiary)**--Very coarse-grained, poorly sorted, monolithic breccia containing subangular clasts of locally derived granite, ranging in size from sand to large boulders. Poorly exposed, rubbly exposures. The unit is exposed at the base of map unit Tst immediately to the north of the rhyolite dome in Bulldog Canyon. The unit is interpreted as either avalanche breccia or talus breccia, and is believed to be related to the emplacement of the rhyolite dome.

Tc **Conglomerate (middle Tertiary)**--Poorly sorted, poorly to moderately indurated, clast-supported cobble conglomerate in a red, sandy, arkosic matrix, locally interbedded with thin red sandstone layers (which are rarely exposed). The unit contains clasts derived mostly from the Middle Proterozoic Apache Group, including quartz-jasper metaconglomerate, tan to purple argillite and siltstone, and tan-brown-purple quartzite. Other clasts include red-gray limestone (possibly Paleozoic), light gray foliated metarhyolite, chlorite schist, foliated granite/granodiorite, nonfoliated diorite, nonfoliated granite, and rare basalt. The unit forms resistant, red-tan-colored rounded hills mantled by their own debris.

Ts **Sandstone (middle Tertiary)**--Thin- and medium-bedded, clast supported pebbly sandstone and conglomerate, containing subangular, moderately sorted to poorly sorted clasts derived almost entirely from granitic rocks. The unit commonly forms light tan to pale red smooth outcrops that are generally better exposed than the overlying conglomerate (map unit Tc).

Tsc **Conglomerate and sandstone, undivided (middle Tertiary)**--Interbedded red sandstone and conglomerate. The unit contains a mixture of clast types contained in both map units Tc and Ts. Also mapped where slope wash and vegetation made it difficult to distinguish between map units Tc and Ts.

Cambrian(?) and Proterozoic Units

(Rocks were assigned an early Proterozoic age if they were overprinted by a generally NE-striking foliation over most of their outcrop area)

Cq **Quartzite (Cambrian?)**--Strongly indurated light gray quartz arenite. The only outcrop is Hawk Rock in the Desert Well Quadrangle, south of Apache Junction just west of Ironwood Road. The exposure is fractured and slightly varnished. Bedding is steeply inclined. Medium-scale cross-beds are visible, showing that the top is to the northwest. May be correlative to the Cambrian Bolsa Quartzite. The unit was not correlated with the Proterozoic Dripping Spring Quartzite because the nearest outcrops of Dripping Spring Quartzite exposed between Peralta Canyon and Florence Junction are finer-grained and contain mostly quartz arenites and argillites. However, this does not exclude the possibility that the quartzite at Hawk Rock is Dripping Spring Quartzite.

YXg **K-feldspar porphyritic granite (early to middle Proterozoic)**--Coarse-grained granite to syenite and quartz monzonite. This rock contains large 1-2 cm light gray to pink, subhedral K-feldspar phenocrysts in a medium- to coarse-grained matrix of milky gray quartz, light gray plagioclase, and fresh subhedral biotite (about 10-20%). Where resistant the rock forms steep hills covered by spheroidal boulders. Locally, the rock erodes easily into a coarse grus. This unit is mineralogically very similar to map unit Xgc, but was mapped separately on the tentative distinctions that biotite in this rock generally occurs in separate crystals or books, and not as felty masses as in Xgc, and also because the K-feldspar phenocrysts in this unit are light gray to pink and not blue-gray as in Xgc. This unit is foliated and lineated in areas west of the heads of Bulldog Canyon and Bulldog Wash, but from just south of Rock Cabin eastward to Siphon Draw (in the Goldfield Quadrangle) the rock is not foliated. This unit generally is unfoliated and resembles 1.4 Ga granites exposed elsewhere in Arizona. Because it is overprinted locally by a northeast-striking foliation, however, it could be a member of the 1.6-1.7 Ga granitoid suite.

Xs **Biotite schist (early Proterozoic)**--This rock is a dark gray-green, medium- to fine-grained biotite schist containing biotite, and less abundant light gray feldspar and hornblende. It occurs as a strongly foliated band within a north-south trending shear zone in the western Usery Mountains. The mafic minerals are strongly chloritized and the rock forms crumbly, dark gray-green outcrops.

Xgm **Medium-grained granite (early Proterozoic)**--Granite to quartz monzonite to granodiorite. This rock is mostly medium-grained and contains subhedral light gray phenocrysts of K-feldspar, plagioclase, quartz, and 5-10% fresh to hematite-altered biotite. Locally the rock is slightly coarse-grained and slightly K-feldspar porphyritic. Foliation, lineation, and locally S-C fabrics are well-developed. The contact between this unit and map unit Xgf is sharp.

Xgf **Fine- to medium-grained sparsely K-feldspar porphyritic granite (early Proterozoic)**--Granite to quartz monzonite. This rock is composed of a fine-grained matrix of anhedral to subhedral biotite (5-30%), K-feldspar, plagioclase, and quartz all up to about 3 mm wide, containing relatively few (about 1-10%), dispersed anhedral to subhedral large K-feldspar and locally quartz phenocrysts 0.5-2 cm wide. Quartz is commonly rounded and milky blue-gray, and is seldom larger than 1 cm wide. K-feldspar phenocrysts are light gray and locally have indistinct edges that seem to blend with the surrounding matrix. This rock is commonly steel gray, locally exhibiting a slight green-yellow tint. It is resistant and forms steep, angular, blocky outcrops between Pass Mountain and Bulldog Canyon. The rock is foliated and lineated locally, though the lineation is not as well pronounced as it is in the coarser-grained granite (map unit Xgc).

Xgc **Coarse-grained granitoid (early Proterozoic)**--This porphyritic coarse-grained granite/quartz monzonite contains 1-3 cm long blue-gray K-feldspar phenocrysts in a matrix of anhedral to subhedral 2-15 mm wide phenocrysts of light gray plagioclase, clear-gray to milky blue-gray quartz, and felty masses of biotite. Plagioclase locally appears chalky white compared to the blue-gray K-feldspar. Biotite is commonly chloritized, and imparts a slight green tint to the rock. In other areas, biotite is partially altered to hematite and gives the rock an orange hue. K-feldspar crystals are light gray to pink from about Bulldog Canyon eastward, and may signify a different pluton in that area. Sphene is visible locally. In many areas the rock contains rounded, oblong xenoliths of fine-grained biotite-feldspar-quartz and possibly hornblende. In the Usery Mountains the unit contains well-defined lenticular foliated zones with sharp boundaries, whereas in the east foliation is more widespread. This rock correlates with the granite at Arizona Dam Butte, north west of the study area, and, in general, grain-size increases slightly from west to east.