Geologic Map of the Maverick Mountain 7.5' Quadrangle, Maricopa County, Arizona

by

Steven J. Skotnicki and Robert S. Leighty

Arizona Geological Survey
Open-File Report 98-14

July, 1998

Arizona Geological Survey
416 W. Congress, Suite #100, Tucson, Arizona 85701

Includes 18 page text, and 1:24,000 scale geologic map.

*Partially funded by the Arizona Geological Survey
and the U.S. Geological Survey STATEMAP Program
Contract #1434-HQ-97-AG-01824.*

INTRODUCTION

This map depicts both the bedrock geology and the general ages and distribution of Late Tertiary and Quaternary surficial deposits in the Maverick Mountain Quadrangle (see Figure 1). Mapping of the surficial deposits was based both on field observations and interpretation of color 1:30,000-scale aerial photographs (taken in 1996) obtained from the Tonto National Forest in Phoenix. Field work was performed during January to April, 1998, and was continuous with mapping in the Lion Mountain quadrangle and the Boulder Mountain quadrangle.

Access to the area is limited. The marina on the west side of Bartlett Lake rents boats that will provide access to the northwest section of the quadrangle. State Route 87 cuts through the very southeast corner of the map area, and just north of it is the Dos S Ranch. With permission, you can follow a very rough jeep trail westward from the ranch all the way to Herder Mountain (in the Adams Mesa quadrangle) and beyond at least as far a Ryan Tank. However, because the trail is in such bad condition, it is probably easier to begin at the road up Ironwood Wash (also in the Adams Mesa quadrangle) and drive north to Ryan Tank. The trail from Ryan Tank to Cottonwood Tank is nearly impassable even with a 4-wheel drive. In the north, the road paralleling the powerlines is passable southward until Alder Creek. It is passable from the south until Log Corral Wash, assuming you can ford the Verde River.

Elevations in the quadrangle range from about 1748 feet (the spillway elevation at Bartlett Dam) to about 5000 feet at Diamond Mountain. During this study Bartlett Reservoir was completely full.

PREVIOUS STUDIES

Wilson, Moore, and Pierce (1957) published reconnaissance geology of the area in a geologic map of Maricopa County, and later in the geologic map of Arizona (Wilson and others, 1969). Anderson and others (1986), and more recently Pearthree and others (1995), made investigations along the Sugarloaf Fault south of the study area in the Adams Mesa quadrangle. Skotnicki (1992) completed a study of the Tertiary rocks in the region and mapped the area to the west in the Bartlett Dam quadrangle (Skotnicki, 1996). Skotnicki and Leighty (1997) mapped the Adams Mesa quadrangle to the south. Leighty (in press AZGS Open-File Report) mapped part of the Lion Mountain quadrangle to the north. Pope (1974) investigated the Verde River terraces from Coon Bluff to Bartlett Dam, and also described the general bedrock and basin-fill geology of the Lower Verde River Valley. Camp (1986) produced a series of soil maps, in which the study area is included. This study was done during the same field season as mapping to the east in the Boulder Mountain quadrangle (Skotnicki and Leighty, 1998).

GEOLOGIC SETTING

Proterozoic metamorphic rocks

Northern exposures. The oldest rocks in the study area are Early Proterozoic metasedimentary and metavolcanic rocks exposed in the northeastern part of the quadrangle between Diamond Mountain and Alder Creek. They include fine-grained phyllite and psammite (map unit Xs), metamorphosed tuffaceous rocks and possible reworked tuffs, quartzites (map unit Xq), and metamorphosed intermediate volcanic rocks (andesite and dacite--map unit Xvi). The sequence can be broadly subdivided into two groups: (1) pelitic, psammitic, and intermediate volcanic rocks to the southeast, and (2) a sequence of interbedded and undivided pelitic and psammitic metasedimentary and metavolcaniclastic rocks to the northwest near Alder Creek.

In the first group, the meta-andesite rocks are typically massive, dark greenish grey, and very fine-grained with feldspar phenocrysts less than 1 mm wide. The meta-dacite rocks are

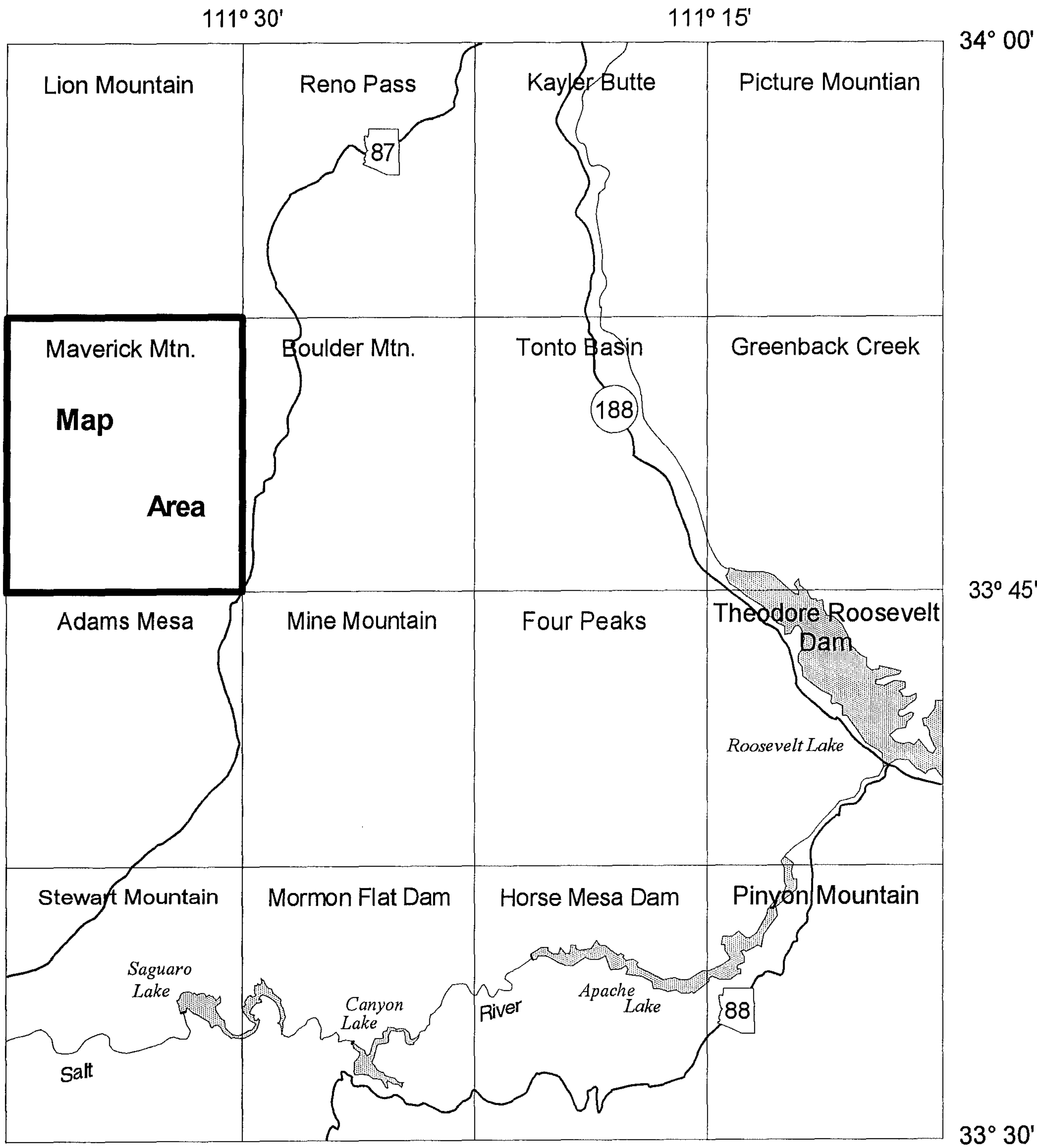

Figure 1. Location of U.S.G.S. topographic maps and study area.

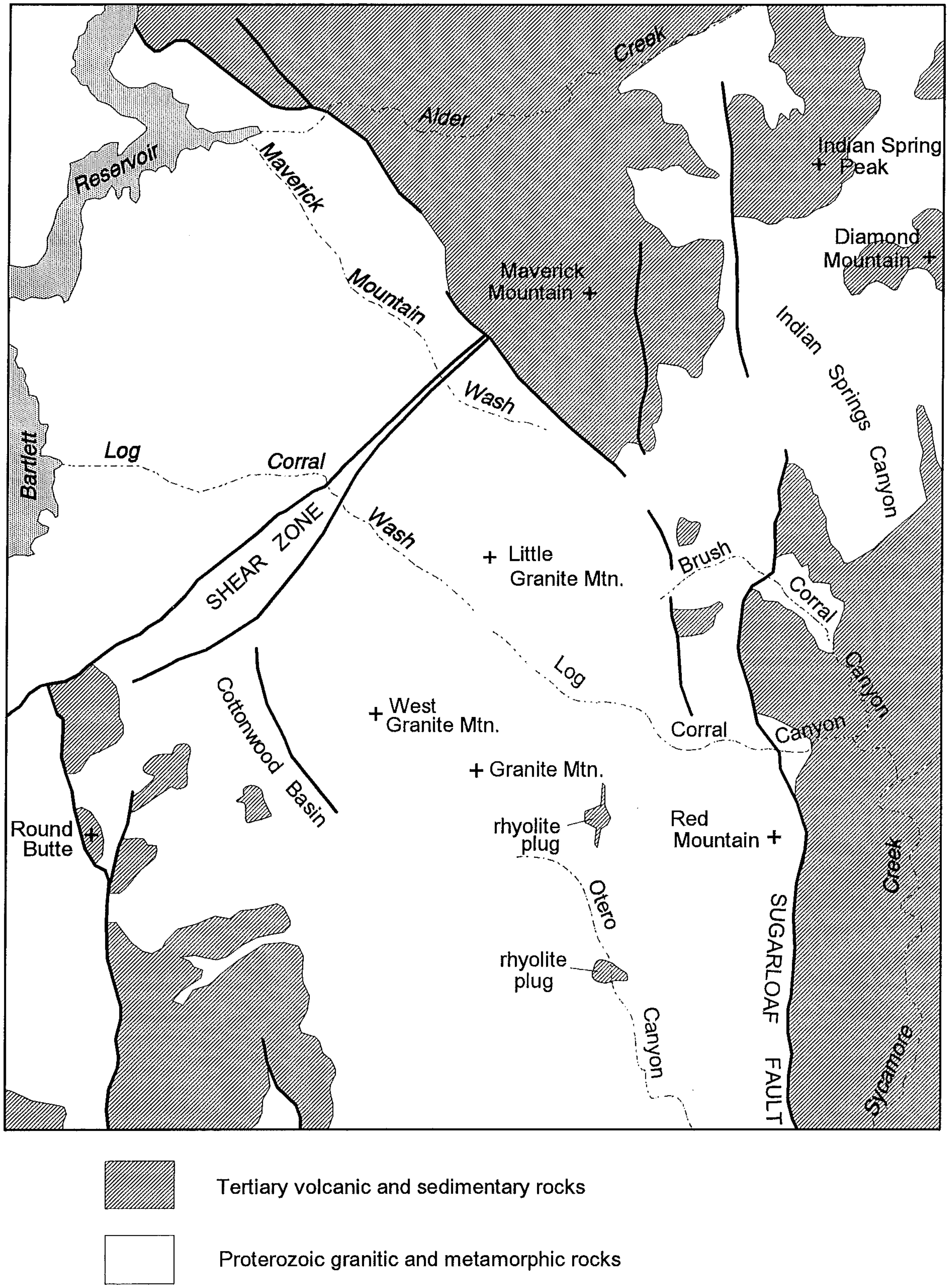

Figure 2. Index map showing general geology and geographic place names in the Maverick Mountain quadrangle.

medium greenish grey and more crystal-rich with light grey feldspar phenocrysts. Relative to the meta-andesite the meta-dacite generally contains more pervasive epidote alteration. These metavolcanic rocks may represent an assemblage of extrusive flows and hypabyssal intrusions. The pelitic and metasedimentary rocks are interbedded with quartzites. The pelitic rocks are very fine-grained, geenish-grey to dark bluish grey phyllite and argillite. The psammitic rocks are fine-grained metasandstones, with minor metaconglomerate. These units were probably derived from fine- to medium-grained clastic sedimentary protoliths. The second group contains fine- to very fine-grained phyllites and more mature quartzite beds interbedded with thin, highly foliated beds of felsic tuff.

The sequence underwent tilting and regional folding during the Early Proterozoic before being intruded by the Sunflower Granite at around 1640 ± 15 Ma (Silver, 1965). Cross-bedding was only observed in two places--both observations point in opposite directions, suggesting the sequence may be folded. The sequence has been metamorphosed to greenschist facies. The abundance of fine-grained clastic and volcaniclastic rocks, as well as thick quartzites and intermediate volcanic rocks, is similar to lithologies found in the Horse Camp and Ord members of the Alder Group (Ludwig, 1974). Ludwig reported a U/Pb age of 1710 ± 20 Ma from zircon in a rhyolitic breccia and tuff in the Alder Group about 1 km stratigraphically below the Red Rock Rhyolite in the Mazatzal Mountains. The rocks in the Maverick Mountain quadrangle project along strike to those rocks mapped by Ludwig (1974). The intermediate metavolcanic rocks (map unit Xvi) project north of Diamond Mountain into the Boulder Mountain quadrangle and northward into the Reno Pass quadrangle where they are buried by Tertiary rocks down-dropped along the Sunflower Fault. Conway (1995) mapped similar metavolcanic rocks, which he called mafic volcanic rocks (his map unit Xmv), northeastward along strike towards Mount Ord, but it is not clear if these rocks correlate with the intermediate volcanic rocks near Diamond Mountain or if they are younger intrusive rocks.

Southern exposures. Foliated early Proterozoic quartzite and metarhyolite are exposed in the southeast part of the study area. Bedding, cross-bedding, and rare ripple marks show that the quartzite overlies the metarhyolite with the top toward the northwest. Locally, the metarhyolite contains light grey radiating crystals of pyrophyllite and black tourmaline. These rocks have been intruded by a nonfoliated, middle Proterozoic, coarse-grained K-feldspar porphyritic granite. Exposures of the metamorphic rocks are separated into small, lens-like enclaves.

Although the metarhyolite is clearly overlain by quartzite to the south near the southern border of the quadrangle, its relationship is not clear farther north. However, farther east in the Boulder Mountain quadrangle, a felsic hypabyssal rock, mineralogically similar to the metarhyolite, intrudes quartzite. So although the rocks in both quadrangles look very similar the rock near Boulder Mountain is intrusive, and the rock in the southern part of the Maverick Mountain quadrangle is extrusive. If the two rocks have a common source then the rhyolite in the Maverick Mountain quadrangle may have been extruded into progressively shallower levels of the upper crust to the south and the rock here is the extrusive equivalent of the rock at Boulder Mountain.

Granitic rocks

Granitic rocks comprise most of the basement in the map area (see figures 2 and 3). These rocks are divided into three major plutons; (1) a weakly to strongly foliated, equigranular to porphyritic coarse-grained rapakivi granite to the northeast (map unit Xgr), (2) a nonfoliated coarse-grained K-feldspar porphyritc granite which comprises most of the study area (map unit Yg), and (3) a nonfoliated medium- to fine-grained granite (map unit Ygm).

The rapakivi granite (map unit Xgr) is weakly foliated to nonfoliated where it is exposed in the northeast part of the quadrangle. Farther to the east however, east of State Route 87 in the Boulder Mountain quadrangle, the pluton is strongly foliated. In some areas to the east the rock is deformed into narrow mylonite bands, but in the Maverick Mountain quadrangle foliation is lacking. Rapakivi texture is a characteristic feature of this pluton, but it is not prominent everywhere. However, we use the term because it is convenient for distinguishing the granite from other plutons.

The nonfoliated K-feldspar-porphyritic granite (map unit Yg) intrudes the rapakivi granite and truncates the band of Early Proterozoic metamorphic rocks. This rock contains abundant large pink K-feldspar megacrysts and fresh books of biotite. This pluton underlies most of the study area and, indeed, most of the Lower Verde River Valley to the west. This coarse-grained granite was intruded by a medium- to fine-grained granite (map unit Ygm). While studying the rocks in the Bartlett Dam quadrangle it was thought that the coarse-grained granite intruded the medium-grained granite. However, exposures were ambiguous, and unequivocal evidence in the Maverick Mountain quadrangle shows that Ygm intrudes Yg. In the study area Ygm forms discontinuous, sheet-like intrusions that commonly have very shallow dips. A good example of this is at West Granite Mountain where exposures of coarse- and medium-grained granite are 'interlayered' in near horizontal sheets. In the Cottonwood Basin, at Cottonwood Tank, the contact between Yg and Ygm was difficult to follow. Either Yg becomes finer-grained or Ygm becomes coarse-grained--in either case the two rocks closely resemble each-other.

There are at least two phases of the medium-grained granite. A lighter colored, leucocratic phase forms thick, resistant dikes several meters thick that cross-cut the slightly darker more biotite-rich phase. The two phases are very difficult to distinguish in the field except where the leucocratic dikes cut the older, slightly more mafic phase. The two phases were not mapped separately but can be distinguished on the map about 1 mile S/SE of Granite Mountain. The leucocratic dikes locally have pegmatitic cores with crystals of K-feldspar and quartz up to 10 cm across. Some pegmatite zones contain muscovite and large rectangular iron oxide pseudomorphs.

Tertiary rocks

The base of the Tertiary section is defined by a pre-volcanic conglomerate (map unit Tc). Throughout most of the study area the unit contains mostly granitic clasts comprising thinly to medium-bedded grusy sandstones and conglomerates. The thickness of the conglomerate varies greatly. In most of the study area the unit occurs as a thin deposit 0-10 meters thick at the base of the volcanic rocks, but locally it reaches several hundred feet thick.

Near the northern edge of the map area, between Indian Spring Peak and Alder Creek, the conglomerate was deposited on a steeply northwest-dipping erosional surface cut into Proterozoic granitic and metamorphic rocks. Deposits southeast of Alder Creek are several hundred feet thick, whereas deposits along the northwest side of Alder creek are much thinner. Even though the sedimentary deposits rest on metasedimentary and metavolcanic rocks, they contain mostly granitic clasts. This suggests material derived from the south was transported northward. The Proterozoic metamorphic rocks north of Diamond Mountain appear to have been a paleo-topographic high during deposition of Tc. It is not clear, however, whether the topographic relief on the basement was created by differential erosion, faulting, or a combination of the two processes.

Along the east-central edge of the map are, in Indian Springs Canyon, a steep, linear, northeast-striking contact separates conglomerate on the east from granite on the west. West of the contact, the basal conglomerate below the overlying basalt is a mere 10 to 20 meters thick. Immediately east of the contact the conglomerate is at least 200 feet thick. The contact resembles a fault, but it is not clear if it cuts any of the Tertiary rocks. We tentatively interpreted this contact as a buttress unconformity, where conglomerates and the lower part of the basalt sequence filled a local fault-bounded basin. Closer study may show this contact to be a growth fault.

Miocene basaltic lavas (map unit Tb), scoria (map unit Tbc), and interbedded fluvial sediments (map unit Ts) are exposed mostly in the northeastern part of the quadrangle. The basaltic lavas are typically porphyritic, containing phenocrysts of olivine and pyroxene (variable amounts) in a dark grey, very fine-grained, almost trachytic matrix. Olivine is variably altered to a dark reddish brown (possibly iddingsite) and is commonly 1-4 mm wide. Pyroxene is commonly dark green and between 2-5 mm wide, and locally almost as wide as 10 mm. The lavas are typically fresh, massive, and only locally vesicular. Significant deposits of scoria are locally interbedded with the basalt lavas and probably represent accumulations around cinder cones. Indian Springs Peak is a resistant spire of a small plagioclase porphyry intrusion (map unit Tvh), which intrudes basalt. Another, smaller intrusion on the east side of Granite Mountain, labeled Tah, is probably correlative with Tvh. Wrucke and Conway (1987) dated similar rocks to the north in the Lion Mountain quadrangle and farther north with ages between 16.1 ± 0.15 Ma and 9.9 ± 0.5 Ma, and correlated them with the widespread Hickey Formation. Tilted mafic flows probably correlative to these basalts have been dated near Bartlett Dam at 14.78 ± 0.40 Ma (K/Ar/w.r., Shafiqullah, 1980), and north of Stewart Mountain at 15.43 ± 0.34 Ma (K/Ar/w.r., Shafiqullah, 1980).

Northwest of Alder Creek a sequence of basalt flows (map unit Tbu) overlie and are interbedded with two prominent felsic tuff layers (map unit Tt). These white to light grey lithic tuffs, lapilli tuffs and tuff breccias thin to the south. It is not clear, but it is possible the tuff grades southward into sandstone layers interbedded with basalts high on Maverick Mountain and Diamond Mountain. Wrucke and Conway (1987) interpreted the source of these tuffs to be an intrusive rhyolite plug to the north at Lion Mountain. Their age from the plug of 5.3 ± 0.2 Ma (K-Ar/bio) indicates that the associated basalt flows are Late Miocene in age. These rocks may correlate to the map unit Tby of Wrucke and Conway (1987).

In both the upper and lower sequences of basalts interbedded fluvial sandstones are common. They are typically only a few meters or less thick, though locally they are much thicker (and were mapped). Lower in the section these beds are dominantly arkosic, and are thinly bedded tan-colored sandstone and gravely conglomerate. Higher in the section the deposits contain dominantly basaltic debris.

Small plugs of rhyolite intrude granite near Granite Mountain. They contain crystal-poor lavas containing sparse phenocrysts of plagioclase, biotite, and minor quartz. The intrusion directly east of Granite Mountain has several discontinuous, north-south-striking rhyolite dikes associated with it. The center of this plug contains subcircular zones of lithic-rich dark glassy lava containing angular clasts of granite and basalt. Flow-banding in the dikes is near-vertical. The intrusions to the north of Granite Mountain and to the south in Otero Canyon both contain steeply dipping flow-banded lava. These rhyolite intrusions have not been dated, but they are presumed to older than the conglomerate (map unit Tc) interbedded with basalt near the base of Sheep Mesa to the southwest in the Adams Mesa quad (Skotnicki, 1992; Skotnicki and Leighty, 1997a). The conglomerate at Sheep Mesa contains pumice and low-density rhyolite clasts which look very similar to the plugs. However, as stated above, the tuffs interbedded with map unit Tbu are presumed to have originated from a felsic vent in the Lion Mountain quadrangle dated at 5.3 ± 0.2 Ma. Therefore, is not clear if the rhyolite intrusions in the study area are older or younger than the conglomerate and basalt (map units Tc and Tb).

STRUCTURE

Older fault trend

The older set of faults is dominated by a northeast-southwest striking ductile shear zone, exposed northwest of Granite Mountain. The shear zone is bounded by two near-vertical brittle faults that overprint the foliation. Almost all of the faults to the northeast of the shear zone show ductile fabrics which have subsequently been overprinted by brittle faulting. The strike of the faulting followed, more or less, the same orientation as the foliation. The shear zone contains a north- and northeast-striking foliation within the otherwise unfoliated K-feldspar porphyritic coarse-grained granite (map unit Yg). Curiously, where the shear zone is thickest south of Log Corral Wash, the foliation strikes north and slightly northwest--oblique to the trend of the shear zone (a similar orientation was observed in shear zones in the Usery Mountains to the south; Skotnicki and Ferguson, 1996). The intensity of the foliation decreases to the south, roughly corresponding to the increase in the width from north to south. A small body of the medium-grained granite (map unit Ygm) within the shear zone on the north side of Cottonwood Basin is foliated, but within more extensive exposures of Ygm to the southwest foliation is not visible. Foliation is strongest along the east side of the shear zone, where the rocks have been deformed into mylonite containing highly elongated quartz. The shear zone appears to be the eastern margin of deformation, for no northeast-striking faults nor foliated zones were found east of here. A possible exception is an erosional scarp directly south of Indian Springs Tank, near the east-central side of the map. Slicks and fault surfaces clearly show that the scarp was formed by faulting, but the Tertiary conglomerate (map unit Tc) butts up against this scarp and it is not clear from field observations if it is a fault contact or a buttress unconformity.

The timing of deformation is not clear. Based on the small exposure of foliated Ygm ductile deformation probably occurred after intrusion of the medium-grained granite. It is not clear if brittle faulting occurred immediately after ductile deformation, as the rocks raised above the ductile/brittle boundary for instance, or if brittle faulting occurred much later. It is possible that both ductile and brittle deformation occurred during the Proterozoic, or they may have occurred much later during the Laramide, or the two styles occurred at widely spaced times. At least one of the faults bounding the shear zone cuts Tertiary basalt south of Bartlett Lake in the western part of the map area. All faulting may have occurred during the Tertiary or pre-existing faults may have been reactivated during the Tertiary. The shear zone is parallel to and nearly along strike with a Tertiary fault cutting basalt northwest of Maverick Mountain. Reconnaissance field work to the north in the Lion Mountain and Reno Pass quadrangles (Leighty; in press AZGS Open-File Report) suggests that there is a large, northeast-striking Tertiary normal fault along this strike. Interestingly, this trend is also roughly parallel and along strike with the Proterozoic-age Slate Creek shear zone (Karlstrom et al., 1990). This suggests that the shear zone in the Maverick Mountain quadrangle may be an extension of the Slate Creek shear zone and that sections of this zone may have been reactivated several times, at different crustal levels, possibly up until the middle or late Tertiary. A soon-to-be-published U-Pb zircon age of about 1422 Ma on the coarse-grained granite (map unit Yg) shows that the foliation in the granite is younger than the circa 1700 Ma orogeny thought to be responsible for deforming the Early Proterozoic rocks. This suggests that some of the deformation in the Slate Creek shear zone may be younger than about 1400 Ma.

Younger fault trend

The second structural trend is a younger set of north- to northwest-striking, northeast-dipping normal faults. These faults cut the Tertiary rocks and have down-dropped them into a series of west- to southwest-dipping fault blocks. A major fault connects the north end of Bartlett

Lake (possibly an extension of the Horseshoe Dam Fault) with the Sugarloaf Fault in the southeast. This fault is parallel to the Sunflower fault to the northwest (Skotnicki and Leighty, 1998) and together these major structures down-drop the Tertiary section against Proterozoic basement. The northwest-striking fault on the south side of Maverick Mountain cuts across the shear zone and apparently also truncates the north-northwest striking Tertiary fault on the west side of Maverick Mountain. Following the northwest-striking fault to the southeast, it disappears in the granite, but it may bend southward and link with either the Sugarloaf Fault or the closely spaced faults south of Brush Coral Canyon. It seems unlikely that such a major feature would die out in less than a mile.

Pearthree and Scarborough (1984) and later Skotnicki (1992) identified (on aerial photographs) a possible Quaternary fault scarp associated with a northwest-striking fault in the Cottonwood Basin. This study has subsequently shown that although there is a fault at this location, the scarp is defined by differential erosion of coarse- and medium-grained granites on opposite sides of the fault and probably not by recent movement.

Anderson and others (1986), and more recently Pearthree and others (1995), made investigations along the Sugarloaf Fault south of the study area in the Adams Mesa quadrangle. Faulting along the Sugarloaf Fault created a structural basin into which conglomerates and basalts were deposited. Thick accumulations of these rocks were deposited on the east side of the fault (within the basin) compared to thin deposits on the west side (Skotnicki and Leighty, 1997). The younger conglomerate (map unit Tcb) is thickest along the fault to the south at Mesquite Wash and indicate that faulting continued at least on the southern part of the fault through deposition of this unit.

Younger Holocene alluvial deposits bury the Sugarloaf Fault along Mesquite Wash in the Adams Mesa quadrangle to the south. A trench dug across the fault directly west of where the highway crosses the fault revealed a thin, unfaulted Holocene alluvial cover about 1 meter thick overlying faulted Late Pleistocene alluvial sediments (Pearthree et al., 1995). With data from this and other trenches and gullies along the fault, Pearthree and others (1995) concluded that the last rupture on the Sugarloaf Fault occurred not less than about 10,000 ka, with a probable surface rupture of about 1 meter. This fault strikes north past Maverick Mountain and Indian Spring Peak where it apparently dies out in Proterozoic metamorphic rocks.

The rather linear, northwest-striking course of both Log Corral Wash and Log Corral Canyon suggests they were formed by a structure. Near the head of Log Corral Wash a vegetation lineation, springs, and red-stained granite reveal a segment of northwest-striking fault. Even though there were no other visible indications of faulting anywhere else along both drainages, their linear nature suggests otherwise.

MINERALIZATION

Within the major northeast-striking shear zone, pervasive fractures in the coarse-grained granite (map unit Yg) are stained with hematite, giving most of the region between the two bounding faults a dark red color. Some fractures contain crystals of specular hematite up to 1 cm or more long. Locally in the shear zone, and in the narrow faults to the northwest, white quartz veins a few centimeters wide intrude both concordant to and discordant to fracturing. Most quartz veins are highly fractured as well, while some are only partly fractured. These areas are highly silicified and commonly form dark linear ridges.

To the east near Red Mountain, highly fractured Yg and Ygm are also extensively stained red with hematite. North of Red Mountain Yg locally contains small disseminated crystals of muscovite, probably secondary. Throughout the central part of the map area, particularly near Granite Mountain and at Red Mountain, small veins 5-10 mm thick of dark grey manganese-rich psilomelane intrude Yg. The veins are very localized and most could not be followed for more than a meter. Some psilomelane eroded from the rock exhibits a botryoidal texture.

Within Indian Springs Canyon sub-circular outcrops of white quartz intrude the coarse-grained granite. These intrusions vary in diameter from a few meters across to about 20 meters across. The larger features are bordered by a zone of graphic granite a few meters wide. The center of some of the larger ones contain very coarse-grained, intergrown pink K-feldspar crystals. A few of the intrusions have been mined. The are brilliant white and visible from miles away. A similar quartz intrusion exists near Mud Springs to the east in the Four Peaks quadrangle.

Red Mountain, in the southeastern part of the quadrangle, is mostly composed of a thick, irregularly shaped band of metarhyolite (map unit Xr) which has been intruded by irregular bodies of Ygm and Yg. Xr and Yg are highly fractured and locally brecciated. The mafic minerals in all three rocks have been extensively altered to hematite, which is distributed throughout the rock, especially on fracture surfaces, giving the mountain its red color. Xr and Yg are locally strongly silicified, and plagioclase is locally altered to K-feldspar(?). Some fractures are filled with thin, black, botryoidal pselomelane veins up to about 5 mm thick. The complex contacts, fracturing, and alteration make distinguishing the units difficult.

Locally along the north-striking Sugarloaf Fault in the southeast corner of the study area, the fault forms a resistant red ridge of highly brecciated granite. The fractures between clasts are permeated by dark red hematite and white quartz veins, which are themselves fractured. No slicks are visible but preferred fracture planes dip about 55°W. Between Red Mountain and Brush Corral Canyon fractures Yg and Ygm, associated with several closely spaced faults, are filled with dark red hematite. Manganese coats many of the clasts.

REFERENCES

Anderson, L.W., and Hansen, R.A., 1986, Seismotectonic investigation for Stewart Mountain Dam, Salt River Project, Arizona: Bureau of Reclamation Seismotectonic Report 86-2, scale 1:12,250, and 1:24,000.

Camp, P.D., 1986, Soil Survey of the Aguila-Carefree area, parts of Maricopa and Pinal Counties, Arizona: U.S. Department of Agriculture and Soil Conservation Service soil survey.

Karlstrom, K.E., Doe, M.F., Wessel, R.L., Bowring, S.A., Dann, J.C., and Williams, M.L., 1990, Juxtaposition of Proterozoic crustal blocks; 1.65-1.60 Ga Mazatzal orogeny, *in* Gehels, G.E., and Spencer, J.E., eds., Geologic excursions through the Sonoran Desert region, Arizona and Sonora: Arizona Geological Survey Special Paper 7, p. 114-123.

Leighty, R.S., In press AZGS Open-File Report.

Pearthree, P.A., Vincent, K.R., Brazier, Rick, Fellows, L.D., and Davis, O.K., 1995, Seismic hazard posed by the Sugarloaf Fault, central Arizona: Arizona Geological Survey Open-File Report 95-7, scale 1:12,350.

Pewe, T.L., 1978, Terraces of the Lower Salt River in relation to the Late Cenozoic history of the Phoenix basin, Arizona, *in* Burt, D.M., and Pewe, T.L., (eds.), Guidebook to the geology of central Arizona: Arizona Bureau of Geology and Mineral Technology Special Paper No. 2, p. 1-45, scale 1:32,000.

Pope, C.W., 1974, Geology of the Lower Verde River Valley, Maricopa County, Arizona: Tempe, Arizona State University unpub. M.S. thesis, 104 p., 5 pl., scale 1:24,000.

Skotnicki, S.J., 1992, Geologic map of the Sycamore Creek region, Maricopa County, Arizona: Tempe, Arizona State University unpub. M.S. thesis, scale 1:24,000.

Skotnicki, S.J., 1996, Geologic map of the Bartlett Dam quadrangle and the southern part of the Horseshoe Dam quadrangle, Maricopa County, Arizona: Arizona Geological Survey Open-File Report 96-22, scale 1:24,000.

Skotnicki, S.J., and Leighty, R.S., 1997, Geologic map of the Adams Mesa quadrangle: Arizona Geological Survey Open-File Report 97-10, scale 1:24,000.

Skotnicki, S.J., and Leighty, R.S., 1998, Geologic map of the Boulder Mountain quadrangle, Maricopa County, Arizona: Arizona Geological Survey Open-File report 98-15, scale 1:24,000.

Wilson, E.D., Moore, R.T., and Pierce, H.W., 1957, Geologic map of Maricopa County, Arizona: Tucson, Arizona Bureau of Mines, scale 1:375,000.

Wilson, E.D., Moore, R.T., and Cooper, J.R., compilers, 1969, Geologic map of Arizona: Tucson, Arizona Bureau of Mines and U.S. Geological Survey, scale 1:500,000.

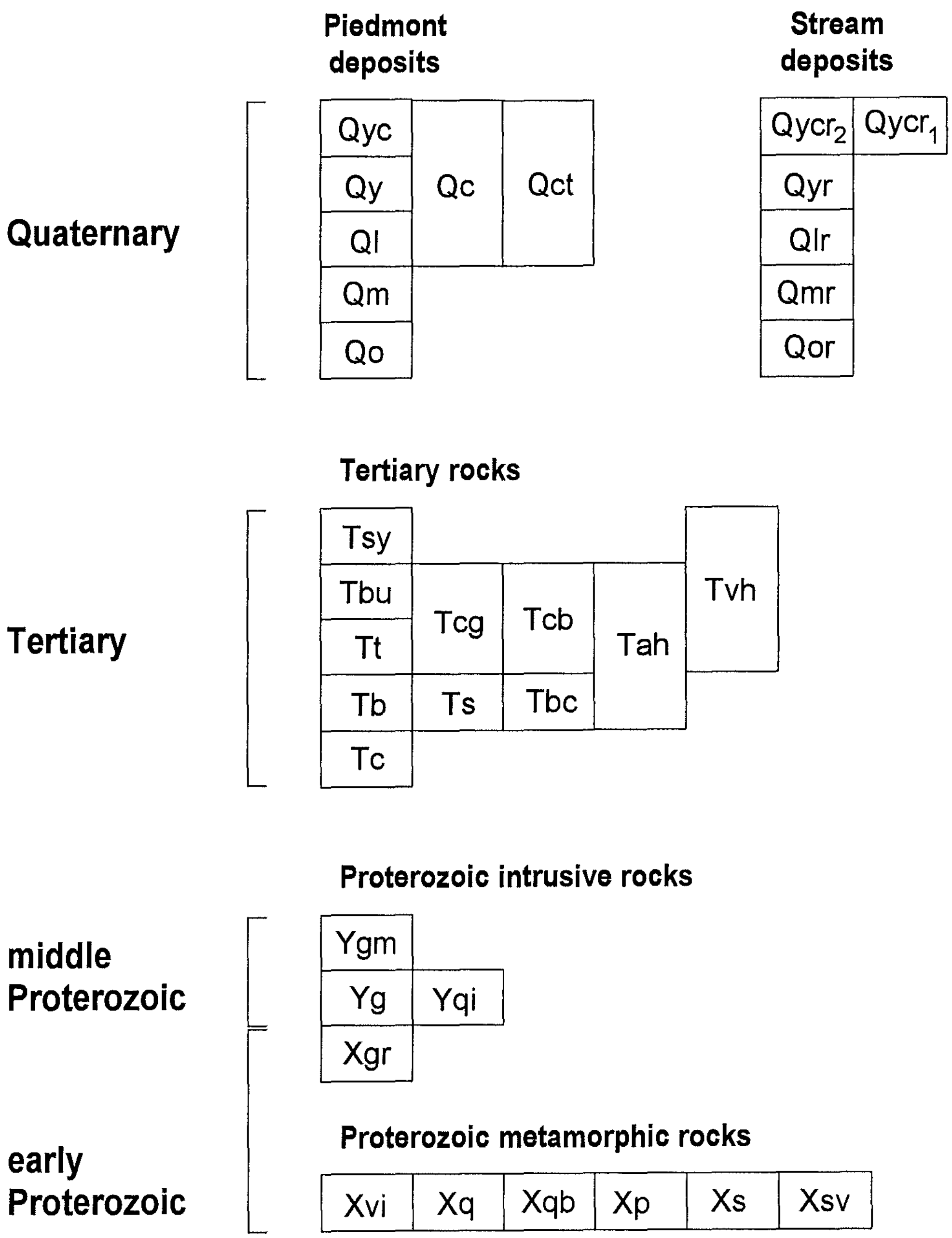

Figure 3. Correlation diagram for the Maverick Mountain quadrangle.

UNIT DESCRIPTIONS
FOR THE MAVERICK MOUNTAIN QUADRANGLE
AZGS OFR-98-14

Quaternary

Piedmont Deposits

Qc **Colluvium, undivided (Holocene to middle Pleistocene).** Unconsolidated to moderately consolidated deposits on hillslopes. These deposits typically contain fairly coarse, subangular to angular clasts, and are weakly bedded and very poorly sorted.

Qct **Colluvium and talus, undivided (Holocene to middle Pleistocene).** Poorly sorted deposits present on the steeper hillslopes near Black Mesa and Diamond Mountain.

Qyc **Active channel deposits (<100 yrs).** Deposits in the active channel of Alder Creek and its tributaries. Subrounded to well-rounded clasts of various compositions range in size from gravel to boulders. The deposits in Alder Creek are coarser than in the tributaries.

Qy **Holocene alluvium (<10 ka).** Unconsolidated sand to small boulders reaching several tens of centimeters in diameter upstream but smaller and fewer downstream. Qy soils are characterized by stratified, poorly to moderately sorted sands, gravels and cobbles frequently mantled by sandy loam sediment. On the surface the main channel commonly diverges into braided channels. Locally exhibits bar and swale topography, the bars being typically more vegetated. Soil development is relatively weak with only slight texturally or structurally modified B horizons and slight calcification (Stage I). Some of the older Qy soils may contain weakly developed argillic horizons. Because surface soils have little clay or calcium carbonate, Qy deposits have relatively high permeability and porosity. Throughout the study area these deposits are dissected as much as 3 meters where a narrow inner gully has dissected the broader fan-like deposits. In Otero Canyon the nick point of this inner gully has not yet reached as far north as the southernmost rhyolite intrusion.

Ql **Late Pleistocene alluvium (10 to 250 ka).** Moderately sorted, clast-supported sandstones and conglomerates containing subangular to subrounded locally derived clasts in a grusy and sandy tan to brown matrix. Ql surfaces are moderately incised by stream channels but still contain constructional, relatively flat, interfluvial surfaces. Ql soils typically have moderately clay-rich, tan to red-brown argillic horizons. They contain some pedogenic clay and some calcium carbonate, resulting in moderate infiltration rates. Thus, these surfaces favor plants that draw moisture from near the surface. Ql soils typically have stage II calcium carbonate development.

Qm **Middle Pleistocene alluvium (250 to 750 ka).** Moderately to poorly sorted, clast-supported sandstones and conglomerates containing subangular subangular to subrounded pebbles to boulders of locally derived rocks. Argillic horizons are weak to strong. The deposits are locally strongly indurated by calcium carbonate. Clasts are slightly to moderately varnished. The unit is deeply dissected and ravines reveal relatively thin deposits, from 2 to 5 meters thick. Argillic horizons are strongly developed where original depositional surfaces are well-preserved, but are much weaker or nonexistent on ridge slopes.

Stream Deposits along Sycamore Creek

$Qycr_2$ **Active channel deposits.** Unconsolidated, moderately to poorly sorted, clast-supported sand, cobbles, and small boulders. Deposits along Sycamore Creek alternate between rounded cobbles and grusy sand. Because the channel is relatively active there is little or no vegetation.

$Qycr_1$ **Modern flood plain deposits (0 to 100 yrs).** This surface is inundated during floods. It consists of moderately sorted, unconsolidated to poorly consolidated sand, cobbles, and small boulders in recently active channels separated from the main active channel. The unit also contains sandy and silty overbank deposits.

Qyr **Holocene stream terrace deposits (0 to 10 ka).** Equivalent to the Lehi Terrace of Pewe (1978). Consists mostly of unconsolidated, well-rounded pebble- to cobble-size river gravels surrounded by a sand and minor silt matrix. Also includes overbank sediments (finely laminated clays, silts, and fine sands). Soil development is weak, primarily consisting of slight organic accumulation at the surface and some bioturbation. This unit is used for terraces along Sycamore Creek that are about 10 to 20 feet above the modern channel and do not show evidence of recent flooding. Most have upper surfaces covered by thick groves of mesquite. Surfaces with obvious alluvial fan morphology are grouped in unit Qy.

Qlr **Late Pleistocene stream terrace deposits (10 to 250 ka).** Equivalent to the Blue Point terrace of Pewe (1978). Well-rounded, pebble- to cobble-size river gravels surrounded by a sand and minor silt matrix. Soil development includes moderate clay and calcium carbonate accumulation.

Qmr **Middle Pleistocene stream terrace deposits (250 to 750 ka).** Equivalent to the Mesa terrace of Pewe (1978). Well-rounded pebble- to cobble-size river gravels strongly indurated by calcium carbonate (poorly exposed). Well-developed argillic horizons where terrace surface is well-preserved.

Qor **Early Pleistocene stream terrace deposits (750 ka to 2 Ma).** Equivalent to the Sawik terrace of Pewe (1978). Well-rounded pebble- to cobble-size river gravels. Exposed as one small terrace remnant above Sycamore Creek in the southeast corner of the map.

Tertiary Units

Tsy **Younger sedimentary basin-fill deposits (late Tertiary).** Tan-colored, moderately to poorly sorted sandstones and conglomerates. Finer-grained matrix is composed mostly of subangular granite grus. Coarser cobbles and small boulders are mostly subangular to subrounded clasts of metamorphic rocks, Tertiary basalt, and, locally, granite. The unit is exposed in the southwest corner of the map where it overlies basalt.

Tcg **Granite-clast conglomerate (middle to late Tertiary).** Tan to light grey, thinly bedded, weakly to moderately consolidated sandstone and conglomerate exposed in the southeast corner of the map. This unit has a lower part containing almost entirely granite clasts (mostly grus) and an upper part rich in foreign clasts. The foreign clasts are subrounded pebbles to cobbles of fine-grained granite (Ygm), foliated rhyolite or intrusive rhyolite, light grey to purple quartzite, tan argillite, and Tertiary basalt (Tb), all in a grusy matrix. The clast-assemblage is very similar to the clasts found in the basal conglomerate at Sunflower to the northeast. This unit unconformably overlies Tcb in the southeast corner of the map area.

Tcb **Basalt-clast conglomerate (middle to late Tertiary).** The lower part contains subangular to subrounded sand- to cobble-size basalt clasts in a tan sandy matrix. Upper part is mostly granite grus. Both parts are medium bedded. This unit overlies basalt in the southwestern corner of the map and is probably equivalent to map unit Tcg which overlies basalt in the southeastern corner of the map.

Tbu **Upper basalt (middle to late Tertiary).** Basaltic lavas exposed above the prominent felsic tuff (map unit Tt) north of Alder Creek.

Tt **Felsic tuff (middle to late Tertiary).** Contains white to light grey lithic tuff, lapilli tuff, and tuff breccia. May be locally reworked. Lithic tuff contains clasts of various Proterozoic rocks and grey-white rhyolite to dacite fragments, all typically less than 5 cm wide (Tertiary?). The unit includes thin basaltic sandstone and conglomerate beds. It is divisible into upper (map unit Tt_2) and lower (map unit Tt_1) units. The rock thins to the south where it grades into a more fluvial clastic facies. Wrucke and Conway (1987) interpreted the source of these tuffs to be an intrusive rhyolite plug to the north at Lion Mountain (5.3 ± 0.2 Ma, K-Ar/bio).

Tt_2 **Upper member of felsic tuff.**

Tt_1 **Lower member of felsic tuff.**

Tvh **Plagioclase porphyry (middle to late Tertiary).** This crystal-rich intrusion at Indian Spring Peak intrudes basalt (map unit Tb). The rock contains glassy to creamy white, subhedral, subequant plagioclase phenocrysts (up to about 40%) as much as 5 mm across. Slightly smaller (1-3 mm) subhedral red-brown phenocrysts represent a completely altered mineral (olivine?). The unit also contains minor amounts (<2%) of glassy quartz less than 3 mm wide, and minor black biotite, all in a very fine-grained pale grey-red matrix.

Tah **Hypabyssal andesite (middle to late Tertiary).** This rock contains phenocrysts of subhedral, black hornblende up to 5 mm long, prismatic hematite pseudomorphs, and fragments of granite, all in a dark grey aphanitic matrix. Forms one small plug 1 mile east of Granite Mountain.

Ts **Sandstone and conglomerate (middle Tertiary).** These thin fluvial sandstones and conglomerates are interbedded with basalt (map unit Tb) are typically 1-3 meters thick, but locally much thicker. Lower in the section, these beds are composed dominantly of arkosic sandstone and conglomeratic sandstones, whereas higher in the section they contain mostly basaltic sandstone. Some beds are rich in scoria, probably derived from nearby basaltic vents. It is possible that the felsic tuffs to the north grade southward into one or more of these sedimentary strata.

Tbc **Basaltic cinder, scoria, and agglomerate (middle Tertiary).** Significant accumulations of scoria probably associated with buried cinder cones. Locally interbedded with basalt flows. Good exposures are located north of Alder Creek and between Maverick Mountain and Alder Creek. In the southeast corner of the map the matrix is very fine-grained (ash?) and strongly cemented with calcite. The deposits locally contains basalt bombs up to about 30 cm long. The deposits which contain thin basalt flows, dip radially away from a central, dark purple, scoria-rich topographic high.

Tb **Basalt (middle Tertiary).** These basaltic lavas have various textures and phenocryst assemblages. Flows are typically porphyritic and contain olivine and pyroxene phenocrysts. This unit includes minor interbedded scoria and basaltic sandstones. Thicker, cliff-forming flows suggest that basaltic andesite and andesite flows may be present locally. In the Indian Spring Peak area the rock is a finely porphyritic olivine/pyroxene basalt. Phenocrysts in this unit (commonly about 5%) are less than 2 mm wide in a dark grey, very fine-grained groundmass. Olivine is dark red-brown, up to 4 mm wide, and commonly altered to iddingsite. Dark green pyroxene is generally smaller, but locally up to 1 cm wide. These lavas are typically fresh, massive and non-vesicular. These lavas locally contain mafic xenoliths, some containing pyroxene and plagioclase phenocrysts less than 1 mm wide. The rocks between Maverick Mountain and Alder Creek are porphyritic with red-brown olivine and dark green pyroxene phenocrysts both 2-5 mm wide, in a dense, dark grey massive groundmass. Wrucke and Conway (1987) dated similar rocks to the north in the Lion Mountain quadrangle and farther north with ages between 16.1 ± 0.15 Ma and 8.3 ± 2.9 Ma, and correlated them with the widespread Hickey Formation.

Tc **Conglomerate (middle Tertiary).** Tan to slightly red-colored, interbedded sandstone and conglomerate. The unit is clast-supported, inversely to normally graded (where grading exists), and consists almost entirely of granitic clasts and grus. The larger clasts range in size from a few centimeters to half a meter or more, and are commonly poorly sorted and subangular to rounded. Stratification is best seen from a distance. Exposures are poorly to moderately consolidated. The top 2 meters below basalt contact is commonly a dark rusty red color. Erodes easily into slopes.

Trh **Hypabyssal rhyolite (middle Tertiary).** Crystal-poor. Contains less than 1% phenocrysts of anhedral biotite and subhedral clear feldspar (sanidine?) up to 4 mm across, but commonly <1 mm, in a light pink, aphanitic, flow-banded matrix. The unit forms two small intrusive masses (vents) east and southeast of Granite Mountain. The northern intrusion contains vitric rhyolite breccia containing angular clasts of granite and basalt (see Skotnicki, 1992, p. 34). This unit also forms north-south striking dikes east and north of Granite Mountain. Pumice and low density rhyolite clasts within conglomerate at Sheep Mesa to the south in the Adams Mesa quadrangle suggests that the rhyolite may be older then the basalts.

Proterozoic Intrusive Rocks

Yqi **Quartz intrusions (middle Proterozoic).** These features are circular in plan and range from a few meters to about 15 meters across. They are very resistant compared to the surrounding granite and form steep-sided conical hills in Indian Springs Canyon. Their brilliant white color makes them very obvious even from several miles away. The smaller features are composed only of coarse-grained quartz. A few of the larger features are composed of massive quartz surrounded by a gradational zone of graphic granite. The center of the largest features commonly exhibit a roughly circular core of massive, coarse-grained, pink K-feldspar. The quartz is mostly white but is locally a deep rose color and rarely clear. Their graphic texture suggests they are the same age as the granite (map unit Yg) they intrude, and may represent highly evolved fluids related to the later stages of intrusion of the granite.

Ygm **Medium- to fine-grained granite (middle Proterozoic).** Contains anhedral to subhedral phenocrysts of clear quartz, fresh biotite, light grey K-feldspar, and plagioclase. This granite is mostly equigranular, but contains large, outsized phenocrysts of K-feldspar and quartz commonly al large as 2 cm long. The larger quartz and K-feldspar crystals are mostly subhedral but locally rounded and the K-feldspar is locally zoned. The quartz in this unit is almost everywhere stained light rusty orange (except at the top of Granite Mountain). This gives the rock a rusty orange shade which is generally slightly darker than that of the coarse-grained granite (map unit Yg) and is useful for distinguishing the two units. This unit generally weathers into small angular blocks, rather than spheroidal boulders. Some surfaces exhibit weak varnish. This rock is locally cut by rare pegmatite veins 10 cm to 1 meter wide containing coarse-grained pink K-feldspar and grey quartz. Some veins form the cores of wider dikes composed of Ygm, and appear to be associated with intrusion of this unit. This granite is mineralogically identical to exposures of granite to the east at The Boulders and Pine Mountain, in the Boulder Mountain quadrangle, and to the west in, in the Bartlett Dam quadrangle.

Yg **Coarse-grained granite (middle Proterozoic).** Nonfoliated, coarse-grained granite containing large, abundant, pink, subhedral to euhedral K-feldspar phenocrysts up to 5 cm long, in a matrix of subhedral plagioclase, quartz, and biotite. Plagioclase is light grey and commonly sericitized. Biotite (about 2-10%) of rock) occurs as anhedral to subhedral books 4-5 mm wide, locally altered to hematite. Quartz is clear-grey. This rock is less resistant than the older granite to the northeast (map unit Xgr) and weathers into smooth rounded hills with spheroidal boulders and grus. Locally, the rock weathers into mushroom-shaped hoodoos with narrow necks and tops that blossom 2 to 3 meters above the ground. This is probably the same granite that is exposed in the northern McDowell Mountains and at Carefree.

Xgr **Granite (early Proterozoic).** This coarse-grained granite is slightly porphyritic with ovoid to subhedral phenocrysts of light grey K-feldspar (microcline), in a matrix of light grey subhedral plagioclase, biotite, and quartz. The rock is not as coarse-grained as map unit Yg. Biotite occurs a dark clumps mostly altered to chlorite. Quartz is a distinctive milky blue and translucent. The 1-2 cm K-feldspar phenocrysts are typically surrounded by a rim of light grey plagioclase (rapakivi texture). Locally, K-feldspar crystals are completely altered to plagioclase, while other K-feldspar crystals within the same sample exhibit only a very thin rim or are completely unaltered and grey. The rapakivi texture is most obvious on a weathered surface. Locally, along the highway, fine pyrite (chalcopyrite?) crystals occur as disseminated grains within the rock and within small quartz veins. The unit is weakly foliated to non-foliated northwest of the highway, but southeast of the highway it is locally strongly foliated.

Proterozoic Metamorphic Rocks

Exposures in the south

Xq **Quartzite (early Proterozoic).** Blue-grey to tan, fine- to coarse-grained quartzite. Typically fine-grained (grains less than 1 mm) and laminated with thin ilmenite/magnetite layers. Locally recrystallized. Grains are well-sorted and subrounded to rounded. Contains minor metamorphic muscovite. Locally the unit contains light grey, radiating mica crystals (pyrophyllite?), black tourmaline, rectangular hematite crystals up to about 3 mm wide, and rare red garnet. Locally the unit is a stretched-pebble conglomerate. The pebbles are between 1 and 4 cm long, are felsic (probably vein quartz or quartzite), and are elongated in northeast-southwest direction. The conglomerate locally contains small distinctive jasper grains. Bedding, where visible, is approximately parallel to foliation, though foliation is not expressed well in the more competent units. Abundant cross-bedding to the south in the Adams Mesa quadrangle show that the top of the sequence is to the northwest. Contacts with Yg are sharp.

Xr **Rhyolite (early Proterozoic).** This rock contains about 5-10% anhedral to subherdal phenocrysts of light grey quartz and feldspar, and less abundant biotite, in a pink to tan aphanitic to sericitic matrix. Quartz phenocrysts are not everywhere visible. The unit commonly shows laminar to contorted laminations that were originally thought to be flow-banding. It may be flow-banding or it may be tectonic foliation. Biotite crystals are very small but appear aligned within laminations. This unit is very similar both mineralogically and texturally to the felsic rock mapped to the east at Boulder Mountain.

Exposures in the north

Xqb **Massive quartzose bed (Early Proterozoic).** Very fine-grained, granular, dark blue-grey quartz-rich bed exposed within the metavolcanic sequence just east of Indian Spring Peak. This unit also contains very fine-grained biotite. The protolith of this rock may have been an impure quartz sandstone.

Xvi **Intermediate-composition metavolcanic rocks (Early Proterozoic).** Dark green-grey meta-andesite flows are typically massive and very fine-grained, with feldspar phenocrysts less than 1 mm across. Medium green-grey meta-dacite flows are more crystal-rich, and contain creamy white feldspar phenocrysts. Relative to the meta-andesite, the meta-dacite generally contains more abundant K-feldspar, is coarser-grained, and epidote alteration is more pervasive. These rocks likely represent an assemblage of hypabyssal intrusions to extrusive flows.

Xq **Quartzite (Early Proterozoic).** Massive, highly resistant quartzite. The unit is well sorted and thinly bedded, with cross-bedding defined by magnetite/ilmenite laminations. Derived from a mature quartz sandstone protolith.

Xs **Pelitic to psammitic metasedimentary rocks (Early Proterozoic).** A sequence of fine-grained metasedimentary rocks that are interbedded with more mature quartzite (map unit Xq) and argillites. The pelitic rocks are very fine-grained, greenish grey to dark bluish grey phyllites and argillites. The psammitic rocks are largely mostly fine-grained metasandstone, and minor conglomerate. Unlike within the quartzite, discrete primary sedimentary structures were not identified in these rocks. The pelitic and psammitic rocks were probably derived from fine- to medium-grained clastic protoliths.

Xsv **Metasedimentary and metavolcanic rocks (Early Proterozoic).** Interbedded pelitic to psammitic metasedimentary rocks and felsic metavolcanic rocks. These rocks are typically fine-grained to very fine-grained. Mature quartzite beds are common. Locally, the unit contains thin, highly foliated beds containing fragments of felsic rocks--possibly tuffaceous beds. These tuff beds are light purple-grey and contain altered red phenocrysts up to a few millimeters wide.