GEOLOGIC MAP OF THE MINE MOUNTAIN QUADRANGLE, MARICOPA AND GILA COUNTIES, ARIZONA

by

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INTRODUCTION

The Mine Mountain quadrangle covers part of the southwestern flank of the Mazatzal Mountains. The northern side of the study area is drained by Picadilla Creek, Mesquite Wash, and Rock Creek. The region to the south is drained by Cottonwood Creek.

The best access to the area is provided by the Four Peaks Road. The turn-off from State Route 87 is directly across from the road to Sugarloaf Mountain. The Four Peaks Road is mostly well-graded and passable by a 2-wheel-drive all the way over the ridge line of the Mazatzal Mountains and into the Tonto Basin. The road from the Four Peaks Road down Mesquite Wash is blocked and impassable. The southern parts of the study area are best reached by taking the dirt road south over The Rolls until it intersects Cottonwood Creek in the Mormon Flat Dam quadrangle. At this point it crosses the creek and becomes rough, but passable by a 4-wheel-drive at least as far as Cane Spring.

Elevations range from about 2200 feet along Mesquite Wash to 6236 feet at Pine Mountain. Field work was carried out during March and April, 1997. In the lower elevations saguaro, palo verde, acacia, and cholla cactus dominate. Above about 3500 feet chaparral vegetation forms thick, almost impenetrable thickets. Fortunately (or unfortunately) the Lone Fire of 1995 cleared most of the vegetation from Brushy Basin and a large part of the Mazatzal Mountains, making it easier to hike and to see the rocks.

Mapping of the surficial deposits was based on both field observations and interpretation of color 1:30,000 scale aerial photographs (dated 6-12-88) obtained from the Tonto National Forest Service in Phoenix. All of the region is administered by the Tonto National Forest.

PREVIOUS STUDIES

Wilson, Moore, and Pierce (1957) published reconnaissance geology of the area in a geologic map of Maricopa County, an later in the geologic map of Arizona (Wilson, Moore, and Cooper, 1969). Anderson and others (1986), and more recently Pearthree and others (1995), made investigations along the Sugarloaf Fault in the northwest corner of the study area. Skotnicki (1992) completed a detailed study of the region and mapped the area to the west in the Lower Verde River Valley (Skotnicki, 1995, 1996a, 1996b). Pope (1974) made a detailed investigation of 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 west in the Adams Mesa quadrangle (Skotnicki and Leighty, 1997a) and to the south in the Mormon Flat Dam quadrangle (Ferguson and Gilbert, 1997).

GEOLOGIC SETTING

Metamorphic rocks

In the southeast corner of the map small exposures of quartzite and metarhyolite are intruded by quartz monzonite and overlain by Tertiary bedded tuff and basin-fill conglomerates and sandstones. The metamorphic rocks form lenticular roof pendants and strike to the northeast. Foliation in these rocks is strong and parallel to bedding. These rocks appear continuous with large exposures of rhyolite, and possibly quartzite, associated with Four Peaks to the east.

Granitic Rocks

From a distance, the western slope of the Mazatzal Mountains looks like a vast, remote, brush-covered expanse of granite. Hidden behind this seeming monotony is an interesting intrusive series, revealed in the Mine Mountain quadrangle. The oldest rocks exposed are remnants of a fine- to medium-grained granite to quartz monzonite pluton (map unit Xgm) which is expressed as relatively small, irregularly shaped bodies at Mine Mountain and to the southwest. Contacts with the younger quartz monzonite pluton are sharp and it is difficult to determine which pluton has intruded the other. However, south of Mesquite

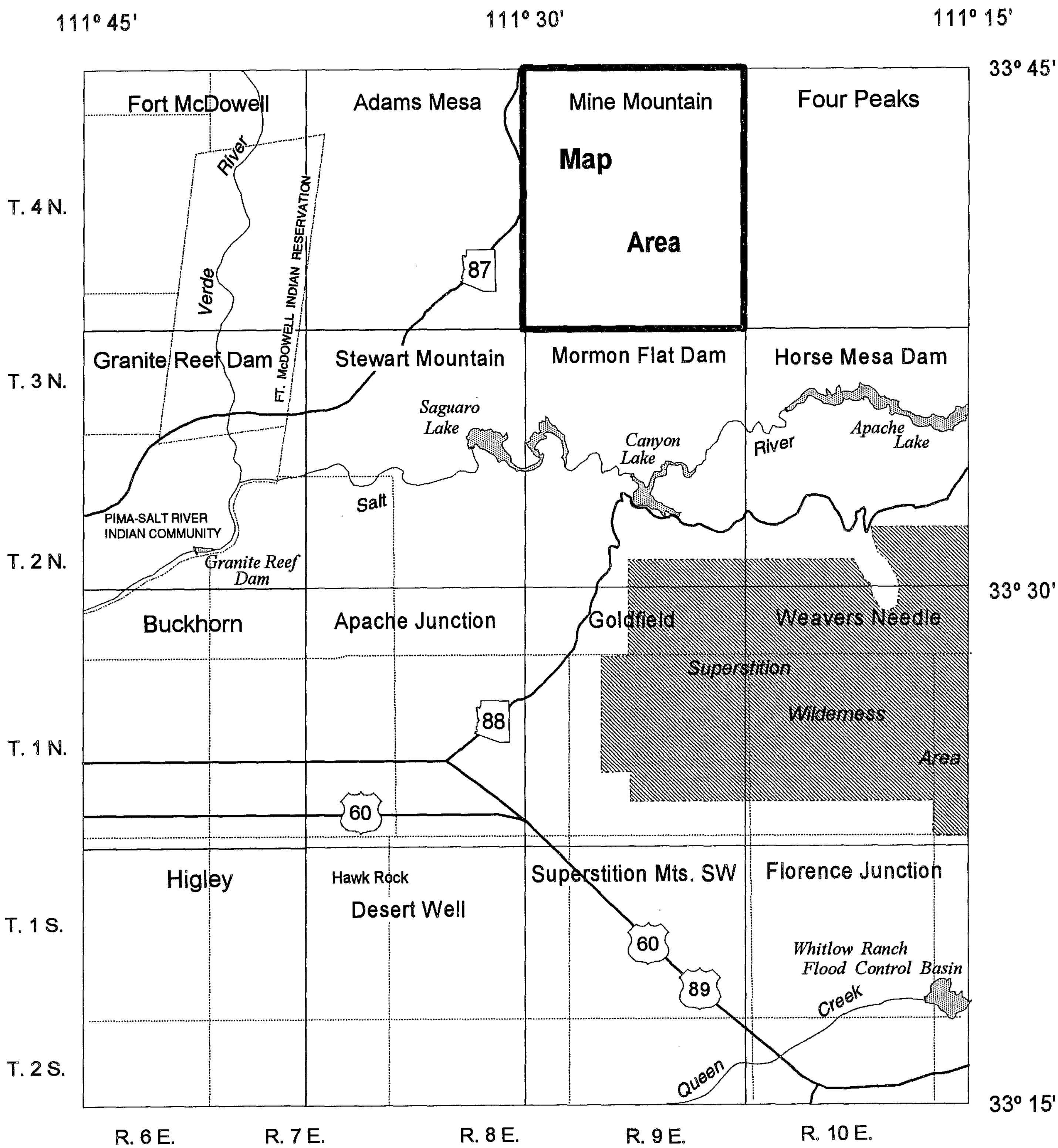

Figure 1. Location of U.S.G.S topographic maps and study area.

Wash foliation in Xgm is strong right up to a sharp contact with Xg but disappears completely in Xg. It is on that basis that Xgm is considered to be older.

A voluminous quartz monzonite pluton (map unit Xg) intruded Xgm, and forms most of the resistant mass of the southwestern Mazatzal Mountains. This pluton is very homogeneous, but contains a very local phase where the matrix is fine-grained (mapped as Xgp north of Mine Mountain). What makes it distinctive from the other plutons is that it contains very little quartz and abundant light grey, square K-feldspar phenocrysts nowhere larger than 1.5 to 2 cm.

Map units Xgm, Xg, and Xgp are all foliated. They were intruded by two younger, possibly related, non-foliated plutons in the northeast corner of the map. The older of the two, a K-feldspar megacrystic biotite granite (map unit Yg), intruded Xg in the Brushy Basin area. This pluton is very similar to the granite in the northwestern part of the Adams Mesa quadrangle and in the Carefree area--the latter of which is about 1.4 Ga in age. The coarse-grained granite was intruded by a fine- to medium-grained granite (map unit Ygm). Pine Mountain is held up by the larger of two small plutons of Ygm. The other, smaller body intrudes Xgm, Xg, and Yg on the north side of Mine Mountain.

On air photos and on the ground from a distance all of the plutons look virtually the same (except for Xgm which can be distinguished fairly easily south of Mesquite Wash). Generally, rocks of map unit Yg can be distinguished from those of Xg because, in Brushy Basin, Yg locally weathers into large exfoliating sheets, and not the boulder fields typically displayed by Xg. This distinction disappears east of the ridge line of the Mazatzal Mountains. Yg also erodes slightly more easily, forming the relatively flat and subdued Brushy Basin, whereas Xg forms the steep, resistant hills adjacent to the basin. Xgm and Ygm are also resistant and form boulder-covered Mine Mountain and Pine Mountain, respectively, but from 5 meters away it is very difficult to distinguish the rocks from Xg or Yg.

Tertiary rocks

Exposures of middle Tertiary rocks are very limited in the Mine Mountain quadrangle. In the northwest corner of the map movement on the Sugarloaf Fault created a basin into which a thick sequence of sandstones and conglomerates (map unit Tc) and overlying olivine basalts accumulated. Continued faulting has tilted these rocks to the west-southwest.

Three small rhyolite intrusions intrude quartz monzonite at the southern edge of the study area. The southern-most two are relatively crystal-rich, whereas the northern plug is almost aphyric. Rhyolite flows and breccias crop out along Cottonwood Creek where they are tilted between 15 and 30 degrees to the south. Small exposures of basalt crop out just east of the rhyolite, but it is not clear if they represent flows or intrusions. In the extreme southeast corner of the map at Cane Spring, bedded tuffs nonconformably overlie quartz monzonite and metarhyolite. The tuff is mapped to the south in the Mormon Flat Dam quadrangle (Ferguson and Gilbert, 1997), where it is equivalent to volcanic rocks dated at about 18.8 Ma.

STRUCTURE

The major structure in the map area is the Sugarloaf Fault. This structure curves from northwest-striking to north-striking and continues for many miles northward through the adjacent Adams Mesa and Maverick Mountain quadrangles at least as far north as Diamond Mountain. The change in strike from northwest to north is similar to other major basin-bounding faults in central Arizona (i.e., the Horseshoe Fault, faults in granite north of Bartlett Lake, and within the Tonto Basin and the Payson Basin). The fault has east-side-down displacement, tilting conglomerate and overlying basalt to the southwest. Where the fault is exposed along Mesquite Wash the quartz monzonite is crushed and brecciated and locally stained red with hematite. Quartz veins and hematite locally fill fractures in the brecciated rock. The quartz veins appear to fill fractures within the brecciated fault zone. Along Mesquite Wash an old eroded scarp dipping about 45 degrees northeast forms much of the footwall on the southwestern side. Younger Holocene alluvial deposits bury the fault in many places. A trench dug across the fault immediately west of where the highway crosses the fault (in the Adams Mesa quadrangle) revealed a thin, unfaulted Holocene alluvial

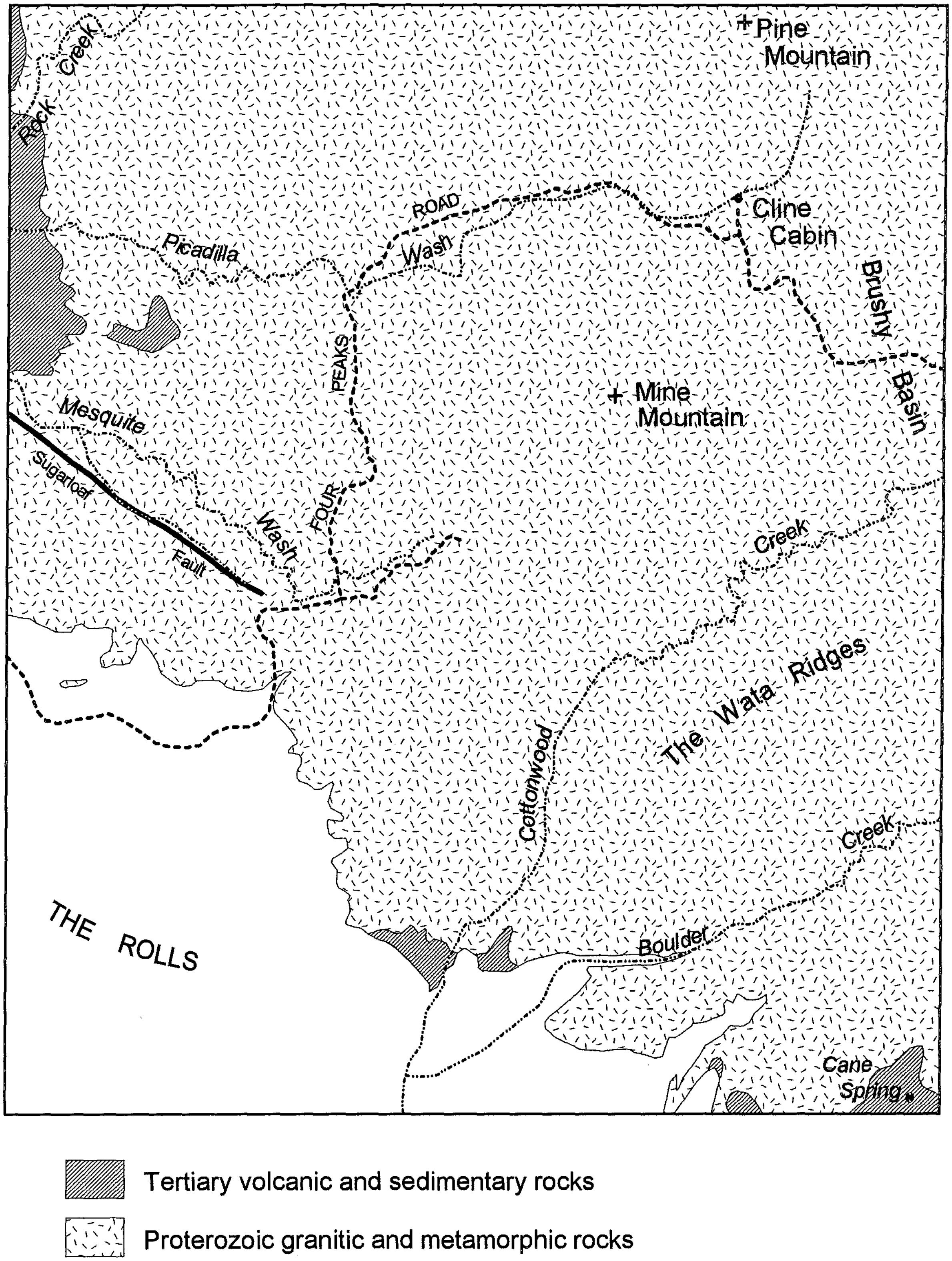

Figure 2. Index map showing place names and geographic locations in the Mine Mountain quadrangle.

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.

Small exposures of rhyolite flows in the south-central part of the study area along Cottonwood Creek are tilted to the southwest. There are likely one or more northwest-striking, northeast-dipping normal faults creating this tilt, buried somewhere underneath the basin-fill deposits. The only fault exposed in this area seems to have the opposite dip, and dropped the south side down. Opposing dips in bedded tuff in the extreme southeastern corner of the map indicate some type of deformation, but exposures are very small and no structures were seen.

Foliation in the quartz monzonite in the northwestern part of the quadrangle is weak to absent. Instead, the strain in this area was localized in a narrow east-northeast shear zone. Time restrictions prevented a thorough study of this zone.

Just over a mile south of this zone, and crossing the Four Peaks Road, is a smaller, more narrow shear zone. It is only a few meters wide and strikes west-northwest. Foliation is near vertical and cross-cuts the regional northeast-striking foliation trend.

MINERALIZATION

Mine at Mine Mountain: A horizontal adit at least about 50 feet deep was dug into a coarse-grained zone within a small intrusion of Ygm. No obvious mineralization was seen. A few wood planks and rusted water pipes remain.

Sugarloaf Fault: Locally, small quartz veins appear to have intruded the crushed quartz monzonite along the Sugarloaf Fault. The brecciated quartz monzonite is stained with hematite. The quartz veins are also fractured but not as much as the granitic rock. No other mineralization was seen.

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.

Ferguson, C.A., and Gilbert, W.G, 1997, Geology of the Mormon Flat Dam quadrangle, Maricopa County, Arizona: Arizona Geological Survey Open-File Report 97-14, scale 1:24,000, 3 sheets.

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.

Pearthree, P.A., and Scarborough, R.B., 1984, Reconnaissance analysis of possible quaternary faulting in central Arizona: Arizona Bureau of Geology and Mineral Technology Open-File Report 85-4.

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.

Shafiqullah, , M., Damon, P.E., Lynch, D.J., Kuck, P.H., and Rehrig, W.A., and Raymond, R.H., 1980, K-Ar geochronology and geologic history of southwestern Arizona and adjacent areas, in Jenny, J.P., and Stone, Claudia, eds., Studies in western Arizona: Arizona Geological Society Digest, v. 12, p. 201-260.

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., 1995, Geologic map of the Fountain Hills--Mount McDowell area, Maricopa County, Arizona: Arizona Geological Survey Open-File Report 95-16, scale 1:24,000.

Skotnicki, S.J., 1996a, Geologic map of portions of the Fort McDowell and McDowell Peak quadrangles, Maricopa County, Arizona: Arizona Geological Survey Open-File Report 96-11, scale 1:24,000.

Skotnicki, S.J., 1996b, 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., 1997a, Geologic map of the Adams Mesa quadrangle, Maricopa County, Arizona: Arizona Geological Survey Open-File Report 97-10, scale 1:24,000.

Skotnicki, S.J., and Leighty, R.S., 1997b, Geologic map of the Stewart Mountain quadrangle, Maricopa County, Arizona: Arizona Geological Survey Open-File Report 97-12, 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.

UNIT DESCRIPTIONS
FOR THE MINE MOUNTAIN QUADRANGLE
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Quaternary units

Qyc **Modern alluvium (<100 yr).** Unconsolidated sand and gravel in active stream channels. Deposits consist of stratified, poorly to moderately sorted sands, gravels, pebbles, cobbles, and boulders. These deposits are highly porous and permeable. Soils are generally absent.

Qy **Holocene alluvium (<10 ka).** Unconsolidated sand to small boulders reaching several tens of centimeters in diameter upstream but smaller and fewer downstream. These deposits are dissected as much as about 4 meters in tributaries where they enter Sycamore Creek. Qy deposits are characterized by stratified, poorly to moderately sorted sands, gravels, and cobbles frequently mantled by sandy loam sediment. On this 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 are not indurated with clay or calcium carbonate, Qy surfaces have relatively high permeability and porosity.

Ql **Late Pleistocene alluvium (10 to 250 ka).** Moderately sorted, clast-supported sandstones and conglomerates containing subangular to subrounded granitic, metamorphic, and volcanic clasts in a grussy 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 much pedogenic clay and some calcium carbonate, resulting in relatively low infiltration rates. Thus these surfaces favor plants that draw moisture from near the surface. Ql soils typically have Stage II calcium carbonate development. This unit is best exposed on the east side of Cottonwood Creek where it forms large, flat, vegetated terraces.

Qm **Middle Pleistocene alluvium (250 to 750 ka).** Moderately to poorly sorted, clast-supported sandstones and conglomerates containing subangular to subrounded clasts of granite, basalt, rhyolite, and metamorphic 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. Exposed as high terrace remnants on the east side of Cottonwood Creek.

Qo **Early Pleistocene alluvium (750 ka to 2 Ma).** Relatively thin (< 5 m-thick) deposits of moderately sorted, clast-supported sandstones and conglomerates containing mostly pebble- to cobble-size clasts of granite, quartzite, and rhyolite, in a sandy granitic matrix. Rests on top of high levels of Tertiary basin-fill deposits (map unit Tsy) at the southern edge of the map area. Qo soils are characterized by a relatively thin argillic horizon (<2 m) containing dark brown soil moderately rich in clay. Upper surface is relatively flat and most clasts are slightly varnished.

Tertiary Units

Tsy **Younger sedimentary basin-fill deposits (late Tertiary).** Tan-colored, moderately to poorly sorted, clast-supported sandstone and conglomerate. Finer-grained silt, sand, and pebbles are composed mostly of subangular granitic gruss. Coarser cobbles and small boulders are mostly subangular to subrounded quartzite and rhyolite clasts, Tertiary volcanic clasts, and locally granite. West of Cottonwood Creek ridge tops are mantled with abundant light grey quartzite and tan argillite. Excellent exposures along Cottonwood Creek reveal abundant quartz monzonite and quartzite clasts. Deposits along the lower reaches of Boulder Creek contain mostly grussy sandstone with a mantling cover of cobble-size metamorphic clasts.

Units in basin formed by Sugarloaf Fault

Tcb **Basaltic conglomerate (middle or late Tertiary).** Tan to light grey and brown, thinly to moderately bedded sandstone and conglomerate. The lower parts contain abundant basalt clasts 1-5 cm across, in a grussy matrix. The upper parts contain fewer basalt clasts. This unit is moderately consolidated and forms well-exposed, resistant tan-colored hills. These deposits may grade upward into the granitic-clast conglomerate or may grade laterally into it.

Tb **Basalt (middle Tertiary).** Mostly olivine basalt. The rock is typically fine-grained to massive, dark grey, and contains anhedral to euhedral 1-3 mm phenocrysts of olivine altered to serpentine, talc, and iddingsite. Locally, outcrops are vesicular, with vesicles filled with calcite and/or zeolite. The rocks comprise a sequence of thin flows several meters thick locally separated by red granitic paleosols and basaltic autobreccia.

Tc **Conglomerate (middle Tertiary).** Tan to slightly red-colored, poorly to moderately consolidated interbedded sandstone and conglomerate. The unit is clast-supported, inversely to normally graded (where grading exists), and consists almost entirely of granitic clasts and gruss. 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. Locally bedding is well defined by variations in cobble-size. This unit erodes into steep rounded hills covered by a thin lag gravel. Exposed in the northwest corner of the map.

Other Tertiary Units

Tt **Bedded tuff (middle Tertiary).** Bedding typically ranges in thickness from a few centimeters to several meters. The pumice-rich lower part includes a clast-supported pumice-clast breccia bed less than about 0.5 meters thick. Upward in the section the tuff is more lithic-rich, containing dominantly rhyolite clasts. Exposed in the southeast corner of the quadrangle where 20 to 30 degree dip-changes occur locally. This unit may represent an ash-flow or air-fall deposit that mantled the underlying irregular topography.

Trv **Rhyolite vitrophyre and vitrophyric breccia (middle Tertiary).** Rocks of this unit are dark grey to black, flow-banded and contain small red spherulites.

Trb **Rhyolite breccia (middle Tertiary).**

Tr **Rhyolite (middle Tertiary).** Along Cottonwood Creek the rhyolite is aphyric and exhibits highly folded flow-banding. Near Cane Spring three rhyolite intrusions intrude quartz monzonite. The northwest of the three is aphyric, whereas the other two are relatively crystal-rich and mapped as Trx.

Trx **Crystal-rich rhyolite (middle Tertiary).** Relatively crystal-rich, flow-banded rhyolite lava. Contains 1-2 mm anhedral to euhedral biotite, 1-4 mm subhedral clear to white sanidine, and clear quartz. Forms resistant, dark grey, intrusive knobs in the southeast corner of the map.

Tdi **Intrusive dacite (middle Tertiary).** Dark blue-grey. Resembles basalt from a distance but contains phenocrysts of fresh subhedral hornblende and biotite up to 3 mm wide, and light grey plagioclase, all in a grey aphanitic matrix. Crops out in one small, dike-like exposure that is partially buried by basin-fill sediments (map unit Tsy) in the southern part of the map area.

Tri **Intrusive rhyolite (middle Tertiary).** Light grey, almost aphyric rock containing rare anhedral to subhedral phenocrysts of sanidine and biotite. Exposed in two small dike-like intrusions about 2 to 3 miles southwest of Mine Mountain. Locally vitric and flow-banded.

Proterozoic Intrusive Rocks

Yi **Quartz-feldspar porphyry dikes (middle Proterozoic).** These dikes contain subhedral cloudy- to clear-grey quartz and light grey K-feldspar from 2-8 mm wide in a light grey aphanitic matrix. Contains rare biotite locally. Feldspar is commonly sericitized and weathers chalky white. Forms resistant ridges. All of the dikes strike northwestward. Intrudes map units Xgm and Xg.

Yfi **Aphanitic felsic dikes (middle Proterozoic).** These light grey aphanitic dikes locally contain rare, small quartz phenocrysts less than 1 mm wide. Commonly flow-banded and intrude map unit Xg. These dikes are not as widespread as the quartz-feldspar porphyry dikes of map unit Yi but both strike to the northwest.

Ygm **Non-foliated fine- to medium-grained granite (middle Proterozoic).** This granite is equigranular to locally porphyritic. It contains light grey to pink subhedral K-feldspar and plagioclase from 2-6 mm, clear to cloudy grey quartz 1-4 mm, and anhedral to subhedral fresh biotite commonly 1-3 mm but locally up to about 8 mm wide. Biotite occurs as single crystals and small books and is commonly partially altered to hematite. The hematite stains the quartz and gives the rock an overall light rusty orange color. This unit intrudes map unit Yg at Pine Mountain and the north side of Mine Mountain. Also, it intrudes as dikes in Brushy Basin near the northeast edge of the map. The small outcrop on the west side of Mine Mountain varies from medium- to coarse-grained. The unit weathers into rounded light-colored boulders.

Yg **Granite (middle Proterozoic).** Nonfoliated, coarse-grained granite containing abundant light grey to pink, subhedral K-feldspar phenocrysts, in a matrix of plagioclase, quartz and biotite. K-feldspar crystals are locally as long as 3 cm, but most are 2-2.5 cm long. Plagioclase phenocrysts up to 6 mm are light grey and commonly sericitized. Biotite (about 15% of the rock) occurs as anhedral to subhedral fresh black books 2-5 mm wide. Quartz is clear-grey. This rock is slightly less resistant than quartz monzonite of map unit Xg. Weathers into smooth rounded hills with large unbroken sheets and locally spheroidal boulders and grus in Brushy Basin. Locally intruded by aplite dikes a few centimeters thick. This unit is very similar to the coarse-grained granite in the northwest corner of the Adams Mesa quadrangle and in the Carefree area. This unit is probably about 1.4 Ga.

Xg **Quartz monzonite (early Proterozoic).** Foliated, coarse-grained, K-feldspar porphyritic quartz monzonite. Contains anhedral to subhedral, light grey to locally pink, equant K-feldspar phenocrysts, which are nowhere larger than 1.5-2 cm across. Light grey plagioclase and clear-grey quartz are 2-8 mm wide. Biotite occurs as felty clumps and is locally altered to chlorite. This unit forms most of the mass of the southwestern Mazatzal Mountains south of Boulder Mountain. Foliation is weak in the northern part of the quadrangle and strongest in the southeast corner of the map. The rock forms light grey rounded boulders in the north and rusty orange crumbly outcrops in the south. This unit forms the spheroidal boulder fields through which State Route 87 passes.

Xgp **Porphyritic quartz monzonite (early Proterozoic).** Same composition as Xg, except the rock contains 1.5-2 cm light grey K-feldspar phenocrysts in a fine-grained matrix. The rock is commonly darker grey to rusty orange. Near Pine Mountain it forms a northeast-striking band that is more strongly foliated than the surrounding quartz monzonite, and may be slightly older than Xg.

Xgm **Foliated fine to medium-grained granite (early Proterozoic).** Equigranular, fine- to medium-grained granite to quartz monzonite. Contains light grey to pink subhedral to anhedral K-feldspar, light grey plagioclase, cloudy-grey quartz, and about 5% biotite. Locally, the rock is porphyritic with light grey K-feldspar up to 1 cm (similar to Xg). Also locally contains foliated clots of fine-grained biotite up to 2 cm wide. Jointing is prominent. Breaks into angular fragments, not rounded boulders. Weathers rusty tan. At Mine Mountain this unit contains less biotite and quartz, and foliation is not as well-pronounced. Here also, biotite crystals are in a plane. The other crystals show no alignment.

<u>Proterozoic Metamorphic Rocks</u>

Xq **Quartzite (early Proterozoic).** Massive light green-grey, very fine-grained quartzite. Bedding is steeply dipping. Interbedded with Xr and intruded by Xg. Exposed in the southeast corner of the map near Cane Spring.

Xr **Rhyolite (early Proterozoic).** Contains 1-3 mm quartz and feldspar phenocrysts in a tan to pink aphanitic matrix. Locally contains light pink stretched pumice fragments up to about 25 cm long. Also locally contains epidote lenses. Bedding is parallel to the northeast-striking foliation. Exposed in the southeast corner of the map near Cane Spring.