Map Unit Explanation

Legend: Map Units for Tonto National Forest Geology

w — **Water**

Water

d — **Disturbed ground (recent)**

Heavily disturbed ground due to agriculture, extensive excavation, or construction of earth dams

Quaternary sedimentary deposits

Typically non marine clastic sedimentary rocks deposited in late Pliocene to Quaternary time, in depositional systems reflected in the modern geomorphology

Qal — **Alluvium**

Sand and gravel deposits along valley and canyon floors

Qtc — **Colluvium and talus (Holocene)**

Unconsolidated to weakly consolidated, very poorly sorted angular rock debris on hill slopes

Qls — **Landslides**

Landslides and other mass-movement or rock-avalanche deposits

River alluvium

Sandy and gravelly deposits of major streams, characterized by rounded cobbles and mixing of rock types from many sources

Qycr — **Modern river channel deposits (< 100 yr)**

Unconsolidated, rounded to subangular, moderately sorted to poorly sorted, clast-supported sand, cobbles, and small boulders. Low terraces typically covered by sand and silt. Minimal carbonate accumulation. Little vegetation in channels, bars and terraces may have abundant riparian vegetation

Qyc — **Active piedmont channel alluvium**

Unconsolidated, very poorly sorted sandy to cobble-like ephemeral piedmont channel deposits

Qyr — **Holocene river terrace deposits (0 to 10 ka)**

Equivalent to the Lehi Terrace of Pewe (1978). Consists mostly of unconsolidated, well-rounded pebble- to cobble-sized 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.

Qy3r — **Historical river terrace deposits (Late Holocene)**

Unconsolidated sand, gravel and silt deposits on low terraces inset below the abandoned early historical floodplain

Qy2r — **Historical river terrace deposits (Late Holocene)**

Silt, clay, sand and minor gravel deposits underlying the early historical floodplain

Qy1r — **River terrace deposits (Late to early Holocene)**

Historical river terrace deposits (Late Holocene)

Qi3r — **River terrace deposits (Late Pleistocene)**

Gravelly, sandy river terrace deposits up to 25 m above the active river channel

Qi2r — **River terrace deposits (Middle to late Pleistocene)**

Older, higher gravelly, sandy river terrace deposits

Qi1r — **River gravel terraces (Early to middle Pleistocene)**

Oldest, highest preserved gravelly, sandy river terrace deposits

Qor — **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, strongly indurated by caliche. An exposure on the northwest side of the confluence of Mesquite Wash and Sycamore Creek is 180 feet above the modern channel and contains some very large rounded boulders of basalt 1 to 2 meters across. Clasts exhibit strong desert varnish, and larger clasts are split and pitted.

Map Unit Explanation

Legend: Map Units for Tonto National Forest Geology

	Piedmont alluvium Locally derived sandy and gravelly sediment on piedmont areas
Qy	**Alluvium (Holocene)** No description given
Qy2	**Alluvium (Late Holocene)** Planar terrace deposits located along incised drainages, broad low-relief distal fan deposits lapping onto Holocene river alluvium, and infrequently active tributary drainage deposits
Qy1	**Alluvium (Early to late Holocene)** Broad, low-relief, undulating fan deposits exhibiting widespread, shallow braided drainage patterns
Qyi	**Early Holocene to late Pleistocene alluvium** Sand, gravel and silt associated with the youngest intermediate terraces
Qi3	**Alluvium (Late Pleistocene)** Relatively planar, reddish terraces mantled by angular to sub-angular pebbles to cobbles
Qi2	**Alluvium (Middle to late Pleistocene)** Broad planar fan terraces capping Quiburis basin fill deposits, inset into older, more well-rounded alluvial deposits, or lining significant piedmont drainages
Qi1	**Alluvium (Early to middle Pleistocene)** High-standing, moderately to well-rounded alluvial deposits exhibiting strong carbonate accumulation (where preserved) capping underlying Quiburis basin fill deposits
Qo	**Alluvial deposits (Early Pleistocene)** Not available
Qao	**Older alluvial deposits (Pleistocene to Pliocene)** Older alluvial deposits from non-AzGS source maps that do not use a classification of alluvial deposits that can be correlated with the Qo/Qi/Qy units used by AzGS. Slightly to moderately indurated conglomerate and sandstone. Conglomerates typically are poorly sorted cobble to boulder conglomerate, massive to poorly bedded, with low-angle cross beds and channels preserved. Sandstone occurs as thin, discontinuous lenses
QTls	**Landslide deposits (Pleistocene or Pliocene)** Poorly consolidated to unconsolidated, very poorly sorted mud to large boulders, characterized by a hummocky surface littered with boulders. Bedding or foliation in boulders (when present) varies greatly between outcrops. Contacts of landslide deposits range from sharp to gradational.
QTcb	**Boulder colluvium and talus deposits (Pleistocene or Pliocene)** Boulder-like colluvium and talus mantling slopes beneath resistant capping Apache Leap Tuff or basaltic lava flows. Non-indurated to poorly indurated deposits of cobbles to blocks of basalt or Apache Leap Tuff in a matrix of sandy clay. Clasts up to 10m long. Generally poorly exposed, and commonly mapped as bedrock on older maps. Apparently these are largely lag deposits of blocks and boulders mantling underlying rock units; in some areas includes probably landslide deposits. Unconformally overlies older units
QTds	**Basin Fill of Dripping Spring Wash (Pleistocene to Late Miocene)** Undivided alluvium (Qal), old alluvium (Qao), and conglomerate correlative with conglomeratic rocks of Lyon's Fork in the northern part of the valley of Dripping Spring Wash. Pediment veneer gravels incised in to valley fill, and possible multiple units of older conglomerate have not been differentiated in this area. The unit overlies tuffaceous sedimentary rocks of Hagen Ranch
r	**Bedrock (pre Quaternary)** Rock outcrop of uncertain age or affinity
	Gila Group and related sedimentary and volcanic rocks (Miocene to Pliocene) Units included in this section have not been classified stratigraphically, and are generic lithologic units awaiting more complete study.
Tsf	**Fine-grained sedimentary deposits (Late Tertiary)** No description given

Map Unit Explanation

Legend: Map Units for Tonto National Forest Geology

Tsl **Lacustrine deposits (middle Tertiary)**

Light gray to tan and white fine-grained sedimentary deposits composed of thinly bedded light gray to tan mudstone, carbonaceous mudstone, minor fine-grained sandstone, and white siliceous or dolomitic limestone (marl). Some layers contain abundant carbonate, particularly near the base of the section, but most rocks barely fizz with HCl, if at all. Claystones are more abundant upward and are locally tan-colored. Soft-sediment deformation is abundant. At the top flare structures intrude the overlying basalt. Behind the water tank in section 30, T. 6 N., R. 5 E., a 5 cm-thick crumbly tuff bed interbedded with mudstones is exposed about 3 meters below the basalt contact. Doorn and Péwé (1991) described plant stem and root fossils. This unit is equivalent to the White Eagle Mine Formation (Doorn and Pewe, 1991) exposed to the east in the Cave Creek quadrangle.

Gravelly sediment and sedimentary rocks of the Globe-Miami area (Gila conglomerate)

Several facies subdivided based on sub-basins in which sediment accumulated or is preserved

QTs **Sandy and conglomeratic clastic rocks (Miocene to Quaternary)**

Unit includes undivided conglomeratic and sandy sedimentary rocks generally occurring as deeply dissected remnants in mountainous areas. Deposits included in this unit are generally restricted in distribution and not associated clearly with any particular late Tertiary sedimentary basin, or have not been studied in sufficient detail to assign to other units

Tgpc **Clastic rocks of Pinal Creek Basin (Miocene to Pliocene)**

Alluvial deposits that are younger than the Apache Leap tuff, overlying older formations on an erosion surface of considerable relief. Pronounced angular unconformities with the underlying strata are common, and in many places, its stratified gravels abut steep slopes at the erosion surface. Faulting probably continued during accumulation of the deposits that are now exposed, and most outcrops show evidence of later faulting and deformation. The broader features of the deposits are typical of broad coalescing alluvial fans laid down by periodic floods and intermittent streams. The character and composition differ greatly, according to the source of the constituent materials and the amount of transportation and sorting they have undergone, the deposits ranging from completely unsorted and unconsolidated rubble of angular blocks as much as 15 feet in diameter to well-stratified deposits of firmly cemented sand, silt, and gravel containing well-rounded pebbles and cobbles.

The southwestern part of the deposit is part of a broad alluvial fan that formed on the northeast flank of the Pinal Mountains. The lower part of the fan is composed entirely of unsorted angular fragments of Pinal schist. Toward the top, there is a progressively increasing admixture of fragments of Madera diorite, and crude stratification can be recognized in some places. During the later stages in the building of this fan, the Schultze granite was uncovered, and much granite detritus was washed down from the west. Exploratory drilling a mile south of Bloody Tanks Wash shows that this fan was built up to thicknesses exceeding 4,000 feet.

A fan of entirely different character and composition formed on the opposite side of the Globe Valley, from detritus washed down from the mountains to the north and northeast. The parts of this fan that can be seen or have been penetrated by drill holes are composed of interfingering lenticular beds of gravel, sand, and silt, many of them firmly indurated by calcareous cement. Although formations from which the constituent materials could have been derived undoubtedly underlie much of this deposit, and outcrops of those formations are everywhere close at hand, nevertheless, most of the fragments are well rounded and apparently were transported considerable distances.

The fragments are mostly of rocks of the Apache group, Troy quartzite, limestone of Paleozoic age, dacite, and diabase. The relative proportions of the various types of fragments differ greatly from place to place. The sand is mostly dacitic or decomposed diabase, but grains from other rocks are generally present. Excellent exposures of this conglomerate can be seen along U.S. Highway 60-70, between Globe and Miami Wash and in the cliffs along the east side of Miami Wash, from the junction of the Apache Trail with U.S. Highway 60-70 to Burch siding.

In most areas the detailed character of the fan is obscured by a thin mantle of younger gravels that were formed largely by reworking of the original deposits. The streams that redistributed the surface material apparently flowed from the west for the gravels contain many fragments of mineralized schist and granite porphyry that must be from the leached capping of the Miami-Inspiration ore body.

The materials that compose the two major fans are blended in a broad, ill-defined zone that extends approximately along the east side of Russell Gulch and about under the Inspiration tailings dumps in Lost Gulch. On the west and northeast, the deposit is bounded by normal faults along which the conglomerate has been depressed. There is also a strong fault near the southern edge of the deposit, along which at least the older beds have been displaced. Wherever the attitudes of the bedding can be observed, the beds are seen to be nearly horizontal or dip gently to the southwest, except along the boundary faults, where the beds may be steeply inclined. It is doubtful, however, that any of the present attitudes represent initial dips. Very few dips can be measured in the very crudely stratified deposits of the southwestern fan.

The lower part of the fan on the northeast flank of the Pinal Mountains may well be of Whitetail age and may have been overlapped by the southern edge of the dacite sheet

Tgnm **Clastic sedimentary rocks of Needle Mountain (Miocene to Pliocene?)**

Small sedimentary basin southeast of Porphyry Mountain is of special interest because it illustrates on a relatively small scale the manner in which the Gila Group deposits accumulated. The outcrop was mapped in detail by C. M. Gilbert during the study of the Castle Dome area. He recognized eleven mappable units, differentiated on the basis of the composition of their rock fragments.

This body of conglomerate is probably somewhat younger that the major portion of the deposit that occupies Globe Valley, and its material is of more local origin. Fragments of Schultze granite are in all but the oldest unit, whereas in the thick deposit to the east, they occur only in the upper, or younger, part. The conglomerate accumulated in a small structural basin formed during the final stage in the uplift of the Castle Dome horst. The relationships of the various units indicate that the deposit was built up of a number of overlapping and coalescing alluvial fans that were washed into the basin from various directions.

The oldest fan was formed from detritus washed into the basin from the north and composed of fragments of dacite with very sparse local admixture of fragments off rocks of the Apache group. It is almost buried by younger fans that overlap it from the east, west, and south. The fan overlapping from the east is composed largely of mineralized schist and granite porphyry undoubtedly derived from the leached capping of the Miami-Inspiration ore body to the east. At approximately the same time this fan was forming at the east end of the basin, other fans were forming on the west and northwest sides. These fans are composed largely of dacite with some admixture of various other rocks. The oldest of the fans, at the west end, contains only dacite and schist. It interfingers with and is overlapped by the fan on the northwest side, which contains some fragments of schist, diabase, limestone, and rocks of the Apache group. Farther south it is overlapped by a composite of successively younger small fans that contain increasing proportions of schist and fragments of the granite on Manitou Hill, of which all the known outcrops are west and southwest of the basin. The youngest deposits probably at one time covered all the older units that are now exposed. They consist of two distinct units; the older of which is composed largely of dacite but contains appreciable amounts of Schultze granite, schist, diabase, rocks of the Apache group, and some fragments of flow-banded felsite derived from the earlier Tertiary (?) volcanic rocks. The fragments of Schultze granite and felsite indicate that the sources of the debris composing this unit were south and west of the basin. From 50 to 95 percent of the youngest unit is derived from Schultze granite; the rest is schist and a minor amount of dacite. The granite fragments average about 1 foot in diameter, but there are many blocks with dimensions of 6 to 10 feet; they undoubtedly were derived from the granite outcrops near the southern boundary of the conglomerate.

An interesting facies of this unit forms the pinnacles on the top of Needle Mountain. It is composed of angular blocks of Schultze granite and dacite embedded in a matrix of dacite sand so firmly cemented that a coarse boxwork of the matrix remains in place after the granite boulders have weathered out. The average diameter of the granite blocks is about one foot, but some blocks are as much as 30 feet in diameter

Tggs

Clastic sedimentary rocks of Goose Spring (Miocene to Pliocene(?))

The conglomerate of the northern part of the outcrop west of the Porphyry Mountain horst is composed mainly of unmineralized Schultze granite, schist, and dacite in about equal proportions; the conglomerate is intercalated with two or more basalt flows. Several exploratory drill holes in the area north of the Castle Dome tailings dump show that the conglomerate accumulated in a narrow northwestward-trending valley. In the central part of the valley, the conglomerate underlying the most extensive basalt flow is at least 1OO feet thick. The part of the conglomerate deposit south of the tailings dump is surrounded by outcrops of Schultze granite, and it is composed almost entirely of coarse angular granitic detritus.

This deposit is probably a remnant of the lower part of a much thicker mass that once covered all the surrounding area; they are in downfaulted blocks on opposite sides of the Porphyry Mountain horst block

Tghc

Clastic sedimentary rocks of Horrell Creek (Miocene to Pliocene(?))

A well-consolidated detrital deposit that overlies dacite. It is composed of dacite boulders, many of them several feet in diameter and so firmly cemented that, in some places along the Horrel Ranch road, cliffs of the conglomerate are being undermined by the more rapid erosion of the underlying dacite. Wherever the attitude of the contact between the conglomerate and the surrounding dacite can be observed, the dips are toward the center of the conglomerate body, indicating that the dacitic debris accumulated in the bottom of a narrow northwestward trending valley

Tgrs

Clastic sedimentary rocks of Rip Spring (Miocene to Pliocene(?))

Gravelly sediment and sedimentary rock. Not described separately by Peterson

Sedimentary and volcanic rocks of Chalk Mountain (Oligocene to Pliocene)

Sedimentary and volcanic rocks in a depositional complex centered on Chalk Mountain along the lower Verde River bounded to the west by the Cedar Mountain-Humboldt MOuntain-Brushy Mountain bedrock ridge, and to the east by the Mazatzal Mountains and drainage divide with Sycamore Creek.

Tlcb

Basalt of Lime Creek (Miocene)

Relatively thin (less than 10 meters thick) basalt flows containing 5-15% phenocrysts of olivine, pyroxene, and rare plagioclase. These flows are characteristically thin and discontinuous and locally show evidence of subaqueous emplacement, such as association with hyaloclastites and pillow breccia. Quartz- and calcite-filling amygdules are also very common in these lavas.

Dark gray to dark greenish-brown, massive to vesicular flows in the Valley of the Verde River and along the southern border of the area. Consists mostly of olivine basalt but contains minor amounts of andesite (Table 1), as on Lion Mountain. Vesicular basalt is common and generally is light- to medium-gray and deuterically altered. Olivine phenocrysts are ubiquitous but are mostly converted to iddingsite in the lighter-colored rocks. Pyroxene phenocrysts are rare. Red scoriaceous basaltic sands form rare but conspicuous interbeds. Interlayered with Tertiary sandstone (Ts) and younger conglomerate (Tyc) east of the Verde River and north of Chalk Mountain. Commonly forms steep slopes and cliffs in which individual flows are fairly distinct. Separated from older basalt (Tob) by Tertiary sandstone (Ts) and younger conglomerate (Tyc). Highest flow identified, 3 km north of Chalk Mountain, has a K-Ar age of 8.3±2.6 Ma. Maximum thickness about 110 m

Thkb

Basalt of H K Mesa (Miocene)

Younger basalt lava flows around H K Mesa along Verde River, based on mapping by Wrucke and Conway (1987). Overlies sandstone of Ister Flat.

Tcmc

Conglomerate of Chalk Mountain

Buff- to orange-weathering, weakly indurated, poorly sorted, pebble-cobble-boulder conglomerate with a granule sandy matrix. The unit is generally crudely to poorly stratified, and forms slopes and cliffs. Subrounded clasts are predominantly from underlying Proterozoic units. Clasts in Buck Basin are composed of quartz porphyry and granite (60%), Xm mafic rocks (30%), and chert and quartz (10%), and are set in a poorly sorted, coarse-grained arkosic sandstone matrix. South of Kentuck Mountain, however, the unit is an arkosic granule conglomerate, with scattered pebbles and cobbles of basalt and rare clasts of the megacrystic granite (Yg). South of lower Lime Creek at the east edge of the map an arkosic conglomerate is composed of granules, pebbles, cobbles, and boulders of granite (80%) and Tertiary basalt (20%). In the northwest part of the map along upper Walnut Creek the conglomerate is composed of Proterozoic clasts, including porphyritic rhyolite (50%), porphyritic dacite (25%), red jasper (10%), and felsic schist (5%). Near the mouth of Walnut Creek the upper part of the unit contains subequal amounts of subangular Xm and Tb pebbles and cobbles set in a lithic sandstone matrix. The conglomerate along the west-central edge of the map area consists largely of metabasite (Xm) and metaturbidite (Xs) clasts, but also rare clasts of the megacrystic granite (Yg). The abundance of tabular-shaped meta-argillite (Xs) clasts accentuates the pebble-cobble imbrication texture of the conglomerate in this area. Includes Older conglomerate unit of Horseshoe Dam quadrangle. Sandstone of Ister flat appears to have interleaved faces change relationship with the conglomerate units along Davenport Wash.

Tifs **Sandstone of Ister Flat (Miocene)**

Pale brown to light-gray, medium- to thin-bedded sandstone, pebbly sandstone, silty mudstone, and minor medium- to thick-bedded cobble conglomerate. The unit also includes some limestone sequences up to a few meters thick and some nonwelded tuff beds

Tlc **Limestone of Chalk Mountain (Pliocene or Miocene)**

White to light-gray, finely laminated, porous limestone and minor medium-gray to light-brown, thin-bedded chert. The limestone locally contains laminated stromatolite-like mounds a few' centimeters across. Limestone beds locally are broken into small overlapping slabs or brecciated into angular, centimeter size fragments separated by voids partly lined with secondary calcite. Contains sparse, silt-size quartz .grains. The finely laminated limestone beds accumulated as micritic lime mudstone, possibly as algal mats. The stromatolite-like mounds consist of bladed calcite deposited as coatings on mud lumps or pieces of fragmented limestone. Probably accumulated in shallow lake or playa subjected to frequent wave action and periods of desiccation. Forms prominent cliffs and steep slopes. May correlate with part ' of the Pliocene and Miocene Verde Formation of the Jerome area (Nations and others, 1981, p. 143-148). Thickness 130, m, top not preserved

Tbdm **Basalt of Davenport Mountain (Miocene)**

Light- to dark-gray and dark-brown massive vesicular flows of olivine basalt exposed from the Mazatzal Mountains west to the Verde River and along the southern border of the area. Has abundant olivine phenocrysts mostly converted to iddingsite. Pyroxene phenocrysts are present in most flows and are abundant in some. Contains sparse bytownite phenocrysts and rare partly resorbed quartz phenocrysts. Calcite amygdules and veins abundant in upper parts of the unit. Has conspicuous subordinate interbeds of red-brown to yellow-brown scoriaceous basaltic debris containing crystals of green pyroxene. Unit includes trachyandesite on Tangle Peak at the west border of the area and may include andesitic rocks elsewhere. Commonly forms gentle to steep slopes in which, individual flows are difficult to identify. K-Ar ages range from 12.3±0.8 Ma for rock high in the unit near the summit of Table Mountain in the south-central part of the map area to 16.1±0.15 Ma for a flow near the base of the unit 4.5 km north-west of Mazatzal Peak. Maximum thickness at least 400 m. This is unit Tob of Wrucke and Conway, 1987. Relationship to basalt lavas included in Basaltic rocks of Camp Creek to Sycamore Creek unit (Tbdm) (mapped as Tb by Wucke and Conway, 1987) is unclear, the units appear to be interleaved along the divide between Alder Creek and Sycamore Creek.

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

Sediments and Sedimentary rocks of Tonto Basin

Generally fine-grained poorly indurated basin fill in central part of basin is deeply dissected and overlain by several generations of piedmont veneer and floodplain deposits of Tonto Creek. Both the older and younger deposits coarsen to conglomerate, locally massive boulder conglomerate, near the basin margins. In the northern part of the basin, basalt lava flows are interbedded in the basin-fill deposits

QTtp **Piedmont veneer deposits of Tonto Basin (Quaternary to Pliocene(?))**

Piedmont veneer deposits mantling basin fill, and locally bedrock, in Tonto Basin. Age of surfaces and deposits poorly constrained. Vegetated, irregular piedmont surfaces. The surfaces are deeply incised at their lower end by gullies containing younger alluvial (Qa) bottoms. The clasts in this unit are characteristically very coarse-grained, angular, and locally derived from Proterozoic granitoids of the nearby Mazatzal Mountains. Piedmont gravels to the east of Tonto Creek are capped by sub-rounded to rounded clasts of Sierra Ancha lithologies

QTtc **Alluvial Terraces of Tonto Creek (Quaternary to Pliocene(?))**

Terraced alluvial deposits consisting of clast-supported, massive to thick-bedded, very weakly indurated boulder and cobble conglomerate, medium-bedded pebbly sandstone, typically light-orange colored, and mud-rich sediment. Includes several terrace levels, not mapped as distinct units; some of these may be cut into older muddy basin fill deposits

Thcb **Basaltic lava flows of Horse Canyon (Miocene?)**

Basaltic lava flows interbedded in basin fill sediments in the northern part of Tonto basin, north of Horse Canyon, east of Kayler Butte. No good description of rock available. Lava onlaps onto pre-Tertiary rocks at basin margin. Outcrop pattern suggest gentle SW dip, and that there are 2 flows with the upper one repeated by a fault, or three small flows

Ttb2 **Basalt lava flow 2 of Tonto Basin (Miocene)**

Basalt lava flow interbedded in basin fill deposits, northern Tonto Basin. see Mayes 1990

Ttb1 **Basalt lava flow 1 of Tonto Basin (Miocene)**

Lower basalt lava flow interbedded in basin fill deposits of northern Tonto Basin. See Mayes 1990

Tscb **Basalt lava of State Creek (Pliocene to Miocene)**

Basalt lava flow interbedded in basin fill deposits of northern Tonto Basin. May be equivalent of Basalt lava flows 1 and 2 (Ttb1, Ttb2) that crop out about 2 km to east

Tmtb **Mudstone of Tonto Basin (Miocene)**

Mudstone and siltsone, with rare thin-bedded laminated to ripple cross-laminated fine-grained sandstone. The mudstones are chiefly red, but locally (near the mouth of Sycamore creek, they are light green. In the lower part of the unit, sandstones are rare to absent. Instead, <1 to 4 meter-thick sequences of gypsum interbedded with thin beds or laminae of gray to light green mudstone and gypsum are present, comprising up to 10% of the unit. The gypsum beds are thicker and more abundant to the south, and they pinch out just to the north of the map area. The unit has both gradational and sharp upper contacts with the younger conglomerate. The nature of its lower contact is unknown, but it is thought to overlie and interfinger laterally with the older conglomerate of map unit Tco.

Tstb **Basin-fill deposits of Tonto Basin**

Consists of lower sandy gravel, pebble to boulder size clasts, poorly sorted, angular to moderately rounded, clast lithologies indicate local source area. This facies grades laterally and vertically into alternating packages of sandstone and gravel, pebble to boulder size clasts, moderately sorted, subangular to subrounded, with clast lithologies indicating more distant origin. Both of these facies grade towards basin center into mudstones and fining upward sandstone/siltstone couplets with minor interbedded limestone, sandstone, tuff, marl and gypsum

Tcp **Conglomerate of Packard Spring**

Along the Mazatzal Mountain front where it overlaps the basin-bounding Payson fault, the post-tectonic conglomerate is a massive, extremely coarse-grained (up to 4 meters), angular-clast diamictite with clasts of local derivation. Farther east away from the Payson fault, the conglomerate is finer grained containing sub-angular to sub-rounded granitic clasts. The conglomerate is poorly indurated and rarely exposed. In areas between the Mazatzal Mountain front and Tonto Creek it appears to be composed mostly of locally derived fanglomerate. The unit overlies the mudstone (map unit Tm) with sharp unconformity at Chalk Spring and with angular unconformity south of Cottonwood Creek. Although composed chiefly of locally derived granitic clasts, the post-tectonic conglomerate also contains lenses of well-rounded, extra-basinal clast, cobble conglomerate near Tonto Creek. These rounded conglomerates probably represent an axial, ancestral Tonto Creek alluvial facies. The upper contact between the post-tectonic conglomerate and Quaternary terraced alluvium (QTt) and pediment terraces (QTtc) can be very difficult to identify because of poor exposure and similarity of composition. The post-tectonic conglomerate is essentially flat-lying throughout the map area.

Tlmb **Basalt of Lion Mountain (Miocene)**

Dark gray to dark greenish-brown, massive to vesicular lava flows, mostly of olivine basalt but contains minor amounts of andesite. Vesicular basalt is common and generally is light- to medium-gray and deuterically altered. Olivine phenocrysts are ubiquitous but are mostly converted to iddingsite in the lighter-colored rocks. Pyroxene phenocrysts are rare. Red scoriaceous basaltic sands form rare but conspicuous interbeds. Commonly forms steep slopes and cliffs in which individual flows are fairly distinct.

Tlmt **Tuff of Lone Mountain (middle Tertiary)**

At Lone Mountain this light gray to white lithic tuff contains rare, anhedral to subhedral biotite, sanidine, and minor quartz, all less than 2 mm wide. Also contains gray pumice up to 1 cm wide. Lowermost 5-8 meters is thinly bedded, the base of which is rich in basalt clasts. The uppermost 15-20 meters is mostly massive to thickly bedded. The unit is exposed in the southwest part of the study area where it is interbedded locally with both conglomerate and basalt. It is also exposed as a thin band above conglomerate at Lone Mountain in the northwest part of the quadrangle. Locally well-indurated and forms slopes to small ridges.

Tlob **Basalt of Lone Mountain (middle Tertiary)**

Contains about 10% anhedral to subhedral 1-4 mm wide phenocrysts of iddingsite after olivine in a dark gray aphanitic matrix. Weathers into dark resistant hills. This unit contains several different flows, exposed best at Lone Mountain. The different flows were not mapped as different units, but were differentiated into early and middle Miocene west of the map area in the Cave Creek quadrangle (Leighty and Skotnicki, 1996). Doorn and Péwé (1991) reported two K-Ar ages from basalts underlying and overlying the white lacustrine beds at the White Eagle Mine, in the Cave Creek quadrangle. The two ages are, respectively, 15.4 Ma and 13.42 ± 0.35 Ma

Tlmc **Conglomerate of Lone Mountain (middle Tertiary)**

Contains abundant angular to subrounded, mostly pebble- to cobble-size clasts derived from map unit Xs, all in a rusty red granite grus matrix. The matrix is siliceous and contains no carbonate. Moderately consolidated. Forms dark, rounded slopes and hills. At Lone Mountain the unit grades eastward into deposits containing large rounded boulders of coarse-grained granite (map unit Yg) and smaller angular, fine-grained granite boulders and cobbles and minor Xs clast. Northwest of Lone Mountain the unit contains interbedded sandstones containing light gray, low-density felsic volcanic clasts.

Tcv **Volcaniclastic conglomerate (middle Tertiary)**

Thinly bedded scoria. This unit contains mostly subangular sand- to pebble-size clasts of red and purple scoria in a tan, silty, carbonate-rich matrix. The unit is interbedded with granitic conglomerate (map unit Tc) in the northeast corner of the map area. It is generally poorly consolidated and crumbles easily into smooth slopes. Locally, it may be either sedimentary or pyroclastic in origin. Where unequivocally pyroclastic the rock contains large, fresh, angular cobble-size clasts of coarse-grained granite.

Map Unit Explanation

Legend: Map Units for Tonto National Forest Geology

Tthr — Tuffaceous sediments of Hagen Ranch (Miocene)

Tuff and tuffaceous sandstone interbedded in basin fill deposits of northern Dripping Springs Valley. White to very light grey color

Tbmc — Conglomerate of Brushy Mountain (middle Tertiary)

Conglomerate along the south side of the Carefree granite from Lone Mountain to the Verde River. This unit is almost everywhere composed of tan-colored, thin- to medium-bedded sandstones locally interbedded with conglomerates. The sandstones contain angular granitic gruss. The conglomerates contain granitic gruss and larger angular cobbles of granite and quartz. Locally clasts of basalt are abundant and are commonly concentrated in conglomeratic lenses several centimeters thick. Basalt clasts are most common in this unit about 1 mile northwest of Bartlett Dam, although they still comprise a very minor percentage of the unit. The lower parts of the conglomerate contain abundant cobble-size clasts of fine-grained granite (map unit Ygf). Directly west of Bartlett Dam, in the road-cut and on the south side of the Verde River two small exposures reveal a deep red, clast-supported conglomerate containing subrounded to well-rounded pebble- to small-boulder-size clasts of fine-grained granite, metarhyolite, biotite schist, quartzite, foliated granite, and rare basalt, all in a red grussy matrix. Both the sandstones and the lower conglomeratic unit have been intruded by basalt dikes. As a whole this unit (Tc) is very similar to sandstones and conglomerates mapped to the east, south of Sunflower (Skotnicki, 1992).

Tsn — Needle Rock Formation (Middle Tertiary)

Clast-supported conglomerates and debris flows composed almost entirely of subrounded clasts of basalt ranging from pebble-size to 0.5 meters across, all in a sandy tan matrix of quartz, feldspar, and basalt. Matrix is carbonate-rich. Medium-bedded. Bedding is visible up close but is best seen from a distance. Finer-grained beds are mostly normally graded. Coarser-grained beds are both normally and inversely graded. Bedding is steeper near bedrock contacts. No faults were seen in this unit in the field but a couple strong lineaments were observed in aerial photos in the steeply dissected lower reaches of Indian Spring Wash. In T. 5 N., R. 6 E., section 1, the dissected basin-fill deposits contain much granitic grus in the matrix. It is not clear if these deposits are the upper part of the Needle Rock formation or if they are part of Tsy that has overlapped Tsn

Tbmb — Basalt of Brushy Mountain (middle Tertiary)

Light gray to dark blue-gray sequence of mafic flows ranging in composition from basalt to basaltic andesite. Commonly vesicular with vesicles filled with zeolites and/or calcite. The rock commonly contains subhedral 1-2 mm phenocrysts of olivine altered to red opaques, pyroxene, and plagioclase. Locally, pyroxene crystals are up to 5 mm long and are unaltered and dark green. Thin hornblende phenocrysts 1-3 mm long are visible locally. This sequence contains massive , fine-grained flows, dark red-purple weakly to thickly bedded basalt breccia and scoria, and thin interbedded sandstones 20-50 cm thick containing basalt and granitic sand. The unit forms dark gray resistant hills. The individual flows show much variation in color and type and it may be possible to map the volcanic rocks in much more detail with more study. A sample from downstream of Bartlett Dam was dated at 14.78 + 0.40 Ma (K-Ar, whole-rock, Shafiqullah and others, 1980). This unit groups basalt lavas overlying and southwest of the Carefree granite between Cave Creek and the Salt River. The lavas are probably correlative with similar units NE of the Carefree granite, including the basaltic rocks of Davenport Mountain, and the basaltic rocks of Sycamore Creek.

Tbbs — Basalt of Black Mesa, Superstition Mountains (Miocene)

Lavas contain a few percent plagioclase, pyroxene and olivine (typically altered to iddingsite) phenocrysts. Lavas in Hackberry Mesa locally contain nepheline phenocrysts. At Hackberry Mesa, three flows are interleaved with volcaniclastic conglomerate (Tcv). The younger two are barely exposed along the southern edge of the map. Near Tortilla Flat, a thin basalt flow occurs at or near the base of the Tcv unit, and in the Willow Springs area, a basalt flow caps the Tcv unit.

Tcep — Conglomerate of Edwards Park

Poorly preserved, extra-basinal, rounded-clast conglomerate found locally along the ridge crest of the Mazatzal Mountains near Edwards Park. Preservation of these conglomerates at different levels suggest that in some areas, the ridge crest represents a channelized alluvial surface. Relationship to the other conglomerates is unknown

Tclb — Basalt of Canyon Lake (Miocene)

Lavas contain a few percent plagioclase, pyroxene and olivine (typically altered to iddingsite) phenocrysts. Lavas in Hackberry Mesa locally contain nepheline phenocrysts. At Hackberry Mesa, three flows are interleaved with volcaniclastic conglomerate (Tcv). The younger two are barely exposed along the southern edge of the map. Near Tortilla Flat, a thin basalt flow occurs at or near the base of the Tcv unit, and in the Willow Springs area, a basalt flow caps the Tcv unit.

Tsy — Younger sedimentary deposits (Late Tertiary)

Light tan basin-fill deposits. In the northwest the unit contains abundant subrounded basalt pebbles to cobbles and rare small boulders in a granite grus matrix. On the west side of the Verde River south of Camp Creek the deposits contain subrounded pebble- to cobble-size clasts of basalt, coarse-grained non-foliated granite, light to dark gray fine-grained quartzite and quartz arenite, and gray phyllite with abundant dark gray albite(?) porphyroblasts 1-2 mm wide, all in a tan granite grus matrix. In the southeast corner of the study area the unit contains subrounded to subangular sand- to small boulder-size clasts of (in decreasing abundance) basalt, fine- to medium-grained granite, and coarse-grained granite, all in a granite gruss matrix. Deposits are tan-colored, thin to medium bedded, and contain carbonate in the matrix

Tsm **Middle sedimentary basin-fill deposits (late Tertiary)**

Very light tan to light grey, moderately consolidated, thinly bedded, clast-supported sandstones and conglomerates. Largest clasts are about 30 cm in diameter, but sand, gravel and small cobbles are by far the most common. There is very little silt in the matrix. Finer-grained beds are composed mostly of subangular granitic sand and gravel. Coarser beds contain subrounded, gravel- to cobble-size clasts of basalt, metamorphic clasts, and granite, but basalt clasts are by far the most common. Brown to red crystal-rich dacite clasts are also abundant. The unit crumbles easily yet forms high-standing, rounded hills. The matrix is carbonate rich and locally forms well-consolidated caliche laminae. Contains small lenses of silt several centimeter to a meter or so wide, some of which appear broken and may have been reworked into clasts.

Tclf **Conglomeratic sedimentary rocks of Lyon's Fork (Miocene)**

Conglomeratic sedimentary rocks deposited on Apache Leap Tuff and underlying tuffaceous sediments of Hagen Ranch, at the northern end of the Dripping Spring Valley. Sediments are folded in broad syncline with an axis parallel to the valley trace. Locally tilted 15-25 degrees. No good lithologic description available, but probably the unit is typical of other conglomeratic sedimentary rocks generally lumped with the Gila Conglomerate

Tspr **Pemberton Ranch Formation (Late Tertiary)**

Light tan silty lacustrine deposits. Very thinly bedded and fissle, with bedding most visible on weathered surfaces. This unit is only exposed in the southeast corner of the study area where it is overlain by younger basin-fill deposits (map unit Tsy) and Quaternary sedimentary deposits. One mile southeast of Needle Rock two middle Pleistocene river terraces have preserved underlying exposures showing basalt-rich conglomerates of the Needle Rock Formation fining upward into pebbly sandstones, sandstones, and then siltstones of the Pemberton Ranch Formation. Locally the siltstones contain lenses of sandstone and pebbly conglomerate

Tsw **White sedimentary rocks of Lime Creek**

Light colored sedimentary rocks

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.

Tsqv **Clastic sedimentary rocks of Queen Valley (Miocene)**

Medium to thick bedded volcaniclastic, boulder sized debris-flows, conglomerates, pebbly sandstones, and medium-grained sandstones. Clasts are derived mostly from the immediately underlying rhyodacite of Whitlow Canyon (Trd) or tuff of Comet Peak (Tcp), and the sandy matrix is typically tuffaceous. Named for exposures in and around the community of Queen Valley. Some of the sandstone exposed below the uppermost basalt lava in the southeast corner of the basin are interpreted as eolian

Tbbc **Clastic sedimentary rocks of Bloody Basin**

Clastic sedimentary rocks, non resistant, low relief.

Tcnr **Clastic sedimentary rocks of upper New River**

In aerial imagery, appears as smooth rounded hills. White weathering areas may be marly or tuffaceous

Tssb **Conglomerate of Superior Basin (Middle Tertiary)**

Moderately to well indurated conglomerate consisting of sub-rounded to subangular cobbles to boulders. Sparse planar sandy pebble to cobble conglomerate beds and, near the base of the unit, tuffaceous sandstone beds define bedding orientation. Under-lies deeply (5-10 m) incised surfaces, which are littered with boulders weathered from the de-posit. Largest boulders are up to about 2 m in diameter. Clasts consist of Pinal Schist, various granitoids (Yr, Xyg), Apache Group, Paleozoic carbonate and clastic strata, massive white vein quartz, and Tertiary volcanic rocks. Intra-unit dash-dot contact at east edge of southern part of map area marks base of conglomerate that contains conspicuously more detritus derived from the Apache Group, principally Dripping Spring Quartzite, giving slopes on the unit a reddish-tan color as opposed to the gray color typical of Tcg

Tss **Sandstone of Superior Basin (Middle Tertiary)**

Tan to pale brown, poorly sorted and poorly bedded medium to fine grained sandstone that grades stratigraphically upward into conglomerate of map unit Tcg. Con-tact placed at base of area where conglomerate constitutes greater than 50 % of outcrop

Tbsb **Basalt of Superior (Late Miocene to Middle Miocene)**

Very fine-grained basalt lava flows with salt and pepper groundmass, containing about 1% crystals of black pyroxene(?) and olivine altered to iddingsite in subequal amounts. Platy weathering in many outcrops. Vague flow lamination are visible on some weathered surfaces. Weathered surfaces commonly have 'elephant hide' look. Conformably overlies Tc, unconformably overlies older units. Overlying units not exposed.

Tssc **Conglomerate of Seven Springs Creek (Miocene to Pliocene?)**

The valley of upper Camp Creek and upper Seven Springs Creek is underlain by moderately indurated, buff-colored conglomerate. The lower part of the unit is composed of crudely stratified pebble-cobble conglomerate with a poorly sorted, coarse-grained, sandy to granule arkosic

sandstone matrix. This part of the unit weathers to arkosic gruss. Clasts are subrounded and compositions variable, but are approximately 30% basalt, 30% granite, and 20% felsite.
The upper part of the unit (mapped separately as Tcyl on Humboldt Mountain Quad) contains abundant basaltic detritus and overlies basalt lava flows. The lower conglomerate grades upward over 10-30 meters into a crudely stratified, basaltic conglomerate with 90% subangular to subrounded granules, pebbles, cobbles and rare boulders of basalt and 10% finer-grained (pebble-granule) granitic clasts. The unit forms rubbly slopes of basalt cobbles and boulders. Between Juans Canyon and upper Cave Creek in the northwest part of the Humboldt Mountain quadrangle the upper conglomerate consists of cobbles of porphyritic YXd (85%), purple slate (10%), and metabasite (5%).

Tkmb

Basalt of Kentuck Mountain (Miocene)

A lower basalt unit that unconformably underlies basalts of Chalk Mountain or Hickey Formation (Tbh). In Buck Basin, these lavas overlie and interfinger with lavas and tuffs derived from two massive plugs of latitic composition (Leighty, 1997). These lavas probably correlate with the lower Chalk Canyon Formation, which ranges in age from Latest Oligocene to Earliest Miocene (23 to 17 Ma). The lavas are typically porphyritic, with olivine + clinopyroxene phenocrysts in a fine-grained groundmass. Intergranular biotite is commonly present. Lower flows are typically altered and amygdaloidal. These basaltic lavas are largely alkaline to transitional in composition. Exposures along Bronco Creek and the East Fork of Bronco Creek contain subporphyritic, biotite-bearing olivine basalt that probably flowed into topographic low areas. Southwest of Kentuck Mountain, several porphyritic olivine+ clinopyroxene basalt flows bracket a tuffaceous sedimentary sequence (Conglomerate of Kentuck Mountain, Tkmc).

Tcxh

Mixed volcanic and epiclastic, monolithic to heterolithic breccia, conglomerate, sandstone, and tuffaceous rocks

A mixed unit consisting of volcanic and epiclastic, monolithic to heterolithic breccia, conglomerate, and bedded, unwelded tuff. The breccia and conglomerate is typically massive or thick-bedded, and the tuff medium- to thin-bedded. The unit is preserved along a south-dipping erosional unconformity between pre-caldera rocks (Tb, Td) and post-Superstition Cauldron lava (Tq, Try). Clasts of all of the older lava types have been identified in the breccia, but Superstiton Tuff (Ts) has not. The clast population is similar to those found within the Superstition Tuff mesobreccia unit (see Ferguson and others, 1997), and these two units are interpreted to be correlative

Middle Tertiary sedimentary and volcanic rocks

Generic category for mostly non marine clastic sedimentary and volcanic rocks deposited on post Laramide Erosion surface. Ferguson and Trapp (2001) redefined the Gila Group in the Superstition volcanic field to encompass all volcanic and volcaniclastic (compiler's note—their usage of 'volcaniclastic' apparently includes any volcanic-lithic clastic rock) rocks that overlie the Apache Leap Tuff. The post-volcanic conglomerates of the Superstition volcanic field were referred to as Gila conglomerate or Gila Conglomerate by early workers (Ransome, 1903; 1904; 1919; 1923; N. P. Peterson, 1954; 1961; 1963; N. P. Peterson et al., 1954; D. W. Peterson, 1960; Nelson, 1966) who correlated these deposits with the Gila conglomerate of Gilbert (1875). In Gilbert's (1875) type area in eastern Arizona, the Gila Conglomerate is currently defined as "unlithified to lithified, dominantly clastic sediments deposited in closed basins" by Richter et al., 1983; Houser et al. (1985). Richter et al. (1983), and Houser et al. (1985) defined the base of the Gila Conglomerate as the top the conglomerate of Bonita Creek, a distinctive volcanic and volcaniclastic unit, and the uppermost flow of this unit has been dated at 18.2 + 0.05 Ma (Enders, 2000; Ferguson et al., 2000). Although referred to as a "Conglomerate" in its type area by Richter et al. (1983), and Houser et al. (1985) other workers refer to this unit as the Gila Group (e.g. Heindl, 1962; 1963; Cather et al., 1994). We prefer the term group since, as we define it, the Gila Group. includes abundant volcanic rocks. The upper contact of the group is defined as the transition from closed basin sedimentation to incision related to the onset of through-going drainage of the ancestral Gila River system.
As redefined by Ferguson and Trapp (2001), the Gila Group includes felsic volcanic rocks that interfinger with multiple units of locally derived, basin-filling, lithified to unlithified conglomeratic units. They formally defined these units as the Coffee Flat Mountain and Picketpost Mountain formations.
As we define it in the Superstition volcanic field, the Gila Group includes post-cauldron breccias within Superstition Cauldron, and many other sequences of sedimentary rocks within half graben basins throughout the volcanic field. Many of these sedimentary sequences preserve fanning dip sequences in the Basin and Range portion of the volcanic field.
In areas where older volcanic rocks are absent, sedimentary rocks of the Gila Group can be distinguished from the older, pre-volcanic Whitetail Formation because the younger rocks are volcaniclastic. At the southern edge of the Superstition volcanic field, the formal unit Big Dome Formation (Cornwall and Krieger, 1975a), herein defined as part of the Gila Group, contains abundant clasts of the Apache Leap Tuff.

Tv

Volcanic rocks, undivided (Pliocene to Miocene)

Volcanic rocks, undivided (Pliocene to Miocene)

Siliceous volcanic rocks of Saddle Mountain

Siliceous lava flows, breccia and inferred related tuff and tuffaceous rocks, overlap on basement rocks in Mazatzal mountains, interbedded in basaltic lava flows of Davenport Mountain to north and ... to south

Tsmp

Pyroclastic rocks of Saddle Mountain (Miocene)

White to tan tuff, tuff breccia, and breccia in highly variable amounts interbedded with Tertiary younger basalt near Lion Mountain in the southern part of the area. At Lion Mountain the unit forms beds 50 m thick that contain angular blocks of various types of siliceous rocks up to several meters across. At Saddle Mountain the tuff locally contains abundant clasts of Proterozoic rocks and lies beneath siliceous breccia of Saddle Mountain (Tsmb)

Tsms **Siliceous lava flows of Saddle Mountain (Miocene)**

Medium- to dark-brown, holocrystalline to locally glassy flows near Saddle Mountain, close to the south border of the area. Andesine, biotite, and hornblende phenocrysts are similar to phenocrysts in nearby siliceous plugs. Biotite and hornblende are party to totally altered and are most altered in darkest brown rocks. Flows occur both 'above and below siliceous breccia (Tsb). Gradations occur from massive holocrystalline through flow-banded, yuggy rock into glassy rock and frothy, light-colored , pumice. Flows in contact with northeastern body of intrusive siliceous rock (Tis) between Lion Mountain and Saddle Mountain may grade into the intrusive rock. Flows capping Saddle Mountain aggregate 250 m in thickness

Tsmb **Siliceous breccia of Saddle Mountain (Miocene)**

Medium to dark-brown, largely monolithologic breccias in the vicinity of Saddle Mountain, near the southern border of the area. Consists of clasts similar to the siliceous lava flows of Saddle Mountain (Tsms). Thickness about 60 m

Tsmi **Intrusive siliceous rocks of Saddle Mountain (Miocene)**

Gray to tan and dark-brown dacite to rhyolite porphyries. Forms several plugs on and east of Lion Mountain. Consists of plagioclase and subordinate hornblende and biotite phenocrysts in a matrix of devitrified glass and rarely of glass. Plagioclase phenocrysts are blocky euhedral to subhedral crystals and broken fragments of complexly twinned and, in some rocks, oscillatory zoned andesine and subordinate oligoclase. Plagioclase in a few rocks is spongy because of included myriad blebs of glass. Hornblende consists of brown prisms that locally enclose biotite, which also occurs separately as equant books. Hornblende and biotite exhibit varied stages of alteration. Accessory minerals are magnetite, apatite, and zircon. Mostly massive but locally flow banded except at Squaw Butte where all but the highest rock is banded. The K-Ar age of one plug east of Lion Mountain is 5.3±0.2 Ma, and for the plug at Squaw Butte it is 8.9±2.6 Ma

Sedimentary and volcanic rocks of Sycamore Creek (Oligocene to Pliocene)

Sedimentary and volcanic rocks in a depositional complex along Sycamore Creek from Mesquite Wash northward to near the crest of the Mazatzal Mountains.

Tbcc **Basaltic rocks of Camp Creek to Sycamore Creek (Middle Tertiary)**

Basaltic lava flows with generally gentle dip overlying Proterozoic rocks in a broad volcanic center between Camp Creek and Sycamore Creek. Light gray to dark blue-gray sequence of mafic flows ranging in composition from basalt to basaltic andesite. Commonly vesicular with vesicles filled with zeolites and/or calcite. The rock commonly contains subhedral 1-2 mm phenocrysts of olivine altered to red opaques, pyroxene, and plagioclase. Locally, pyroxene crystals are up to 5 mm long and are unaltered and dark green. Thin hornblende phenocrysts 1-3 mm long are visible locally. This sequence contains massive , fine-grained flows, dark red-purple weakly to thickly bedded basalt breccia and scoria, and thin interbedded sandstones 20-50 cm thick containing basalt and granitic sand. The unit forms dark gray resistant hills. The individual flows show much variation in color and type and it may be possible to map the volcanic rocks in much more detail with more study. A sample from downstream of Bartlett Dam was dated at 14.78 + 0.40 Ma (K-Ar, whole-rock, Shafiqullah and others, 1980).

Tcbb **Biotite basalt of Cottonwood Basin (Miocene)**

Vuggy, dark gray basalt (biotite lamprophyre) with up to 25% biotite that is only moderately resistant to weathering and form low, rounded outcrops (Conway, 1995). Includes lava flow and associated breccia. Crustal xenoliths present in some places.

Tcss **Sandstone and conglomerate of Sunflower**

Moderately to poorly sorted conglomerate, sandy conglomerate and conglomeratic sandstone. Various conglomerate, conglomeratic sandstone, and sandstone units mapped along Sycamore creek and valley followed by Payson highway to crest of Mazatzal Mountains

Tkjc **Volcaniclastic sandstone and conglomerate of Kitty Joe Canyon (Miocene)**

Basalt- and scoria-dominated sandstone and conglomerate that in part includes reworked felsic tuff. Well exposed between the Black Ridge and Kitty Joe Canyon areas. In the Kitty Joe Canyon area this unit includes up to 5% clasts of Proterozoic rocks. Map units from Reno Pass OFR 04-03.

Tbml **Latite of Blue Mountain(middle Tertiary)**

Light tan to blue-gray lavas containing about 5-10% very small phenocrysts of biotite and plagioclase up to 1 mm wide. Some areas are low density and crumbly, particularly near base. Other areas are dense and resistant. The rock contains abundant, well-rounded to subangular, dark brown lower-crustal xenoliths from 1 to 30 cm wide (see text for descriptions). Clasts of felsic volcanic rock in conglomerate near Browns Ranch: Clasts contain 40-50% phenocrysts of subhedral to euhedral biotite, slightly altered to hematite, and about 5% green olivine--both about 5 mm wide in a pink-tan aphanitic matrix. Biotite crystals are preferentially flattened into parallel planes forming a trachytic fabric.Contains subangular to subrounded xenoliths of coarse-grained brown biotite, coarse-grained brown amphibole, red garnet, green pyroxene, and basalt, all up to 5 cm wide. Same as felsic rock in hills southeast of Carefree in the Cave Creek quadrangle, and may be related to rocks at Blue Mountain.

Twct **Tuff of Wildcat Hill (middle Tertiary)**

Unit is bedded and contains phenocrysts of anhedral to subhedral clear quartz up to 4 mm, and minor biotite, in a purple-pink aphanitic matrix. There it contains abundant clasts of crystal-rich felsic lava containing subhedral quartz, chalky white plagioclase, and minor biotite, in a light grey to pink matrix. Relationship to tuffs associated with basalt lavas and conglomerate to NE and west is unclear.

Map Unit Explanation

Legend: Map Units for Tonto National Forest Geology

Twcf **Felsic to intermediate volcanic rocks of Wildcat Hill (middle Tertiary)**

Almost aphyric lava with very small phenocrysts of biotite and feldspar less than 1 mm wide. Forms resistant hills 2-4 km southeast of Wildcat Hill, where it intrudes tuff and granite, and forms resistant dikes. Weathers light tan.

Tcf **Coffee Flat Mountain Formation (Miocene)**

Post Apache Leap Tuff felsic lava flows and associated tuff and pyroclastic rock in the superstition Mountains

Tcru **Upper rhyodacite lava unit, Coffee Flat Mountain Formation (Miocene)**

Rhyodacite lava

Tcfu **Upper rholite, Coffee Flat Mountain Formation (Miocene)**

Aphyric lava flow that overlies intracauldron Apache Leap Tuff in the south-central Superstition Cauldron, and considered a valid subdivision of the Coffee Flat Mountain Formation (Ferguson and Trapp, 2001). Light gray to purple, aphanitic, highly brecciated lava with a trace of small (<1mm) biotite phenocrysts. The lava is mixed with lithic-rich tuffaceous zones. Unit is restricted to the Geronimo Cave area of Peralta Canyon (Ferguson and Skotnicki, 1995).

Tcft **Tuff member, Coffee Flat Mountain Formation (Miocene)**

Includes air-fall, water-laid, and ash-flow tuff, bedded to nonbedded, fine- to coarse-grained, poorly to well-sorted. Generally zeolitized, pale grayish yellow. May be intimately intermixed with rhyolite and rhyodacite lava flows. 500 ft thick. Middle Tuff (Ttm) of Peterson and Jenks (1987). Tuffs related to, and underlying the upper rhyolite lava (Tru). The tuff contains a phenocryst assemblage similar to that of the underlying Peralta Canyon member of Superstition Tuff, but because it is also very rich in rhyolite lava clasts it was mapped separately. Unit is restricted to the Geronimo Cave area of Peralta Canyon.

Trdz **Zeolitized rhyodacite, Coffee Flat Mountain Formation (Miocene)**

Bleached white rhyodacite. Difficult to distinguish from tuff member associated with lava flows.

Tcrl **Lower rhyodacite lava and intrusive rocks, Coffee Flat Mountain Formation (Miocene)**

rhyodacitic hypabyssal intrusions and lava flows

Talt **Apache Leap Tuff**

Apache Leap Tuff undifferentiated; a crystal-rich (40-50%), plagioclase, embayed quartz, sanidine, biotite-bearing ash-flow tuff. The unit includes large areas of ash-flow tuff previously referred to as Canyon Lake member of the Apache Leap Tuff, and a small area along the southeast edge of map previously referred to as Siphon Draw member of the Apache Leap Tuff. The tuff ranges from unwelded to densely welded, and it rarely contains more than a few percent lithic fragments. Pumice fragments are also sparse and generally difficult to see in outcrop. The base and top of this unit are locally, crudely thick-bedded, but the unit generally appears massive. A lower vitrophyre is present in the Boulder Canyon area. Flow-banding is recognized in a few places along Boulder Canyon trail just south of Canyon Lake. Locally near the top, especially in the Willow Springs and Tortilla Flat areas, accretionary lapilli-rich intervals are present

Tav **Apache Leap Tuff vitrophyre**

Apache Leap Tuff vitrophyre. Thin bands of vitric matrix welded tuff that occur near the base of the unit along Boulder Creek

Talz **Mesobreccia and bedded breccia, Apache Leap tuff**

Apache Leap Tuff mesobreccia; a heterolithic, Apache Leap Tuff matrix, clast- and matrix-supported mesobreccia. Maximum clast size is about 5 meters, except for one >15m block of dacite lava which was mapped as a separate block. The clasts are composed of a wide variety of mafic to felsic lava, including basalt, crystal-rich dacite, porphyritic dacite, and rhyodacite (Td, Tdp, Trd), crystal-poor and crystal-rich rhyolite (Trp, Trx), and Whitlow Canyon type rhyodacite (Tw). The phenocryst mineralogy of these lava clasts can be matched directly with those of the older lava flows which crop out below Apache Leap Tuff to the north of the cauldron margin

Talx **Megagreccia, Apache Leap Tuff (Miocene)**

Megabreccia, consisting of large blocks of older volcanic and crystalline rocks.

Tafl **lower Flatiron Member, Apache Leap Tuff (Miocene)**

Apache Leap Tuff

Tafu **upper Flatiron Member, Apache Leap Tuff**

Apache Leap Tuff, uppermost cooling unit.

Talm **Miners Needle Member, Apache Leap Tuff (Miocene)**

This unit is named for a package of several (2-5) thin, welded or poorly welded flow units that crop out through the middle of Miners Needle (in the Weavers Needle Quadrangle). The flow units are bounded by sharp contacts.

Talp **Peralta Member, Apache Leap Tuff**

See Ferguson et al., 1995

Talh **Hieroglyphic Member, Apache Leap Tuff**

see Ferguson et al 1995 (Florence Junction)

Superstition Group (Late Oligocene to Miocene)

The Superstition Group is a new term used to describe the main mass of volcanics that underlies the Apache Leap Tuff throughout the Superstition volcanic field. The group has a lower contact that is demonstrably time-transgressive and an isochronous upper contact in areas where the Apache Leap Tuff is present. In the main part of the volcanic field Superstition Group encompasses three formations: Government Well Formation, Tule Canyon Formation, and Whitlow Canyon Formation, and possibly two other informal units. Towards the margins of the field the Superstition Group is either undivided or divided into informal units of limited extent. The type area of the Superstition Group is the Superstition Mountains. It ranges in thickness from 0-2,000 meters.

Twcr **Rhyolitic lava of Willow Creek (Miocene)**

Quartz-phyric and quartz absent rhyolitic lava

Trb **Brecciated rhyolite lava undifferentiated**

Brecciated rhyolite lava undifferentiated. Breccias of crystal-rich (Trxb) and crystal-poor rhyolite lava (Trpb) are also recognized. In most cases this unit consists of basal, flow-front, foreset avalanche autobreccia, but it may also include other types (such as carapace breccia) in some areas.1

Trx **Crystal-rich rhyolite lava (20-7% phenocrysts)**

No description given

Tsri **Hypabyssal rhyolitic intrusive rocks of Superstion group (late Oligocene to Miocene)**

Intrusive, rhyolite, in part continuous with extrusive lava flow and/or dome equivalent rocks

Tqbx **Quartz latite lava breccia**

Includes crystal rich variety along Tortilla Creek, and breccias beneath the lava flows forming Geronimo Head

Tqv **Crystal -rich quartz latite vitrophyre**

No description given

Td **Dacitic lava flows (Oligocene or Miocene)**

Crystal-rich 30-60% plagioclase, biotite, + Tdp hornblende-bearing lava. A wide variety of colors and degrees of vitric preservation Tdt and microcrystalline matrix appearance are displayed by a thick pile of dacite lava Tdb that occurs at or near the base of the volcanic pile. The lava ranges from more mafic, or andesitic, to more felsic or rhyodacitic. Pyroxene basalt is present in the upper part of Horse Mesa. In the Horse Mesa area pyroxene basalt and dacite flows containing abundant dioritic magma clots are generally the youngest in the thick pile of dacite lavas of that area. Tdp--Locally moderately crystal-rich (15-30%) porphyritic dacite lava can be mapped. These flows are characteristically more sparsely porphyritic than other dacite and rhyodacite in the area, and are locally sparsely quartz phyric. Phenocrysts of blocky, euhedral plagioclase and biotite are set in a dark groundmass. Tdt--Interbedded with dacite lava are dacitic, crystal-rich, typically dacite lava clast-rich lapilli tuff. The unit is generaly poorly welded, or unwelded ash-flow tuff. The tuff is typically massive, although locally medium- to thick-bedded. Tdb--A thick sequence of dacite tuff breccia (interpreted as block and ash-flow material) caps the eastern part of Horse Mesa. Locally the contact between this breccia and tuff (Tdt) is gradational.

Tsbr **unit of Buzzards Roost (Miocene)**

Overlies Whitlow Canyon Formation. Upt to 150 m thick. 18.6 Ma. Moderately crystal -rich rhyodacit lava containing sanidine, plagioclase, and biotite phenocrysts.

Twcu **Whitlow Canyon Formation (Early Miocene)**

The Whitlow Canyon Formation consists of a distinctive suite of crystal-poor to moderately crystal-rich (2-15% phenocrysts), lavender-colored, rhyodacitic lava and lesser amounts of nonwelded tuff. It ranges in thickness from 0 to 300 meters. The formation appears to have a slightly time-transgressive lower contact and an isochronous upper contact. Its lower and upper contacts are defined as the first and last appearance of lava with the distinctive phenocryst assemblage: plagioclase, sanidine, embayed quartz, biotite. The type section, near the confluence of Tule Canyon and Whitlow Canyon in the southern Superstition Mountains, consists of massive coherent facies lava 210 meters thick.

Twc **Whitlow Canyon Formation (Early Miocene)**

Gray or lavender-colored, moderately crystal rich (10-15%), and crystal-poor (< 5%) lava containing sanidine, plagioclase, embayed quartz, and biotite. Feldspars are typically equant, euhedral and fairly large (up to 0.5cm), and the quartz phenocrysts are also large (0.5 to 1.0 cm) and characteristically embayed. Along the south side of Canyon Lake, it is dark purple in color and it locally consists of alternating phases of crystal-rich and crystal-poor lava with complex, sharp, interfingering contacts. Along the upper reaches of Saguaro Lake the lava is light-colored. The lavas are voluminous and areally extensive south of the Superstition Cauldron (Ferguson and Skotnicki, 1995).

Trdv **Rhyodacite vent deposits and hypbyssal intrusive rocks (Oligocene or Miocene)**

No description given

Ttcu **Tule Canyon Formation (Early Miocene)**

The Tule Canyon Formation consists of a distinctive sequence of crystal-poor (0-10% phenocrysts) rhyolite lava and non-welded tuff that ranges in thickness from 0 to 800 meters. The unit replaces several previously described units, principally the rhyolite of First Water (Sheridan and Prowell, 1986) and parts of the Geronimo Head Formation (Stuckless and Sheridan, 1971). The formation's upper and lower contacts are defined as the last and first appearance of crystal-poor rhyolite lava or tuff, and these contacts appear to be nearly isochronous. The formation also contains rare, thin basaltic lava flows. The type section, near the headwaters of Tule Canyon in the southern Superstition Mountains, is 535 meters thick. The section consists of three tuff units interleaved with three lava flows.

Ttcr **Crystal-poor rhyolite lava, Tule Canyon Formation (Miocene)**

Crystal-poor rhyolite lava (7-1% phenocrysts)

Ttc **rhyolite lava flows, Tule Canyon Formation**

mostly crystal poor rhyolite

Ttcb **Basalt lava flow, Tule Canyon Formation (early Miocene)**

A thin olivine basalt that occurs within the rhyolite tuffs and lavas of the Tule Canyon Formation

Ttra **Aphyric rhyolite lava, Tule Canyon Formation (Miocene)**

No description given

Tgw **Government Well Formation (Oligocene to Miocene)**

The Government Well Formation is a rock-stratigraphic unit consisting of mafic and intermediate lava, and associated non-welded tuff, tuff breccia, and volcaniclastic rocks that ranges in thickness from 0 to 1,500 meters. The Government Well Formation overlies and locally interfingers with non-volcaniclastic sedimentary rocks of the Whitetail Formation and is overlain by rhyolitic lava and tuff of the Tule Canyon Formation. The lower contact is defined as the first appearance of volcanic rocks that dominate (>70%) the stratigraphic sequence, and in most areas, these rocks are basaltic. The upper contact is defined as the first appearance of crystal-poor rhyolite lava or tuff, and this contact appears to be isochronous throughout the main part of the field. The formation is divided into informal lower and upper divisions with the first appearance of dacitic lava defining the base of the upper division. The lower division consists of basaltic lava, but basalt is also present sparingly in the upper division. The upper division of the Government Well Formation is characterized by crystal-rich dacitic lava containing phenocrysts of plagioclase and biotite, + hornblende, pyroxene, and quartz. Sanidine phenocrysts are notably absent throughout the formation. The upper division is further subdivided into suites of lava based on distinctive phenocryst assemblages. At its type section along the Apache Trail near Government Well in the northern Superstition Mountains, the formation is 1570 meters thick (280 meters of lower division and 1290 meters of upper division).

Tgdb **Dacite lava breccia, Government Well Formation (Oligocene or Miocene)**

Dacite lava breccia with matrix ranging from autoclastic, to tuffaceous or epiclastic and interpreted as lava autobreccia, block and ash-flows or lahars respectively. The lahars occur chiefly in Horse Mesa and Bronco Butte areas. Locally the contact between this breccia and the dacite tuff unit (Tdt) is gradational

Tgar **Rhyodacite lava flows, Government Well Formation (Oligocene to Early Miocene)**

Includes several separately mapped rhyodacite lava units included in the Government Well Formation by Ferguson and Trapp (2001).
Apache Gap type rhyodacite lava (Suneson, 1976). Crystal-rich (30-60%) lava containing phenocrysts of plagioclase and biotite. Sanidine and quartz are rare to absent. This unit is differentiated from the underlying dacite lava on the basis of lighter color and its tendency to have more vitric matrix, and from the porphyritic dacite lava (Tdp) on the basis of higher phenocryst content and because the rhyodacite does not contain quartz.
Lower rhyodacite lava of Ferguson and Skotnicki (1995)

Tgwd **Dacite of Government Well (Miocene)**

Crystal-rich (30-60%) lavas containing plagioclase, biotite, + hornblende. A wide variety of colors and degrees of vitric preservation and microcrystalline matrix appearance are displayed by a thick pile of dacite lavas that occurs at or near the base of the pre-caldera volcanics. In general, the lavas appear more mafic or andesitic towards the base and more felsic or rhyodacitic towards the top, but in terms of diagnostic field characteristics (phenocryst petrology), they are virtually indistinguishable. In the Horse Mesa area of the easterly adjacent quadrangle (Gilbert and Ferguson, 1997) some of the flows contain abundant dioritic magma clots, and these flows are generally the youngest in the thick pile of dacite lavas of that area. Thick sequences of dacite autobreccia and tuff breccia (interpreted as block and ash-flow material) were locally differentiated as dacite breccia (Tdb), and in some areas the contact between these breccias and tuffs (Tdt) is gradational.

Map Unit Explanation

Legend: Map Units for Tonto National Forest Geology

Tdp **Quartz-phyric dacite (Oligocene or Miocene)**

Moderately crystal-rich 15-30%) porphyritc dacite flows that are characteristically more sparsely porphyritic than other dacite and rhyodacite lavas in the area. These lavas are also locally sparsely quartz phyric. Phenocrystes of blocky, euhedral plagioclase and biotite are set in a dark groundmass

Tgdt **Crystal-rich dacitic tuff, Government Well Formation (Miocene)**

Poorly to unwelded lapilli tuffs, typically containing abundant dacite lava clasts, and chiefly plagioclase and biotite phenocrysts. The unit is typically massive, although locally medium to thick bedded

Tgdi **Hypabyssal dacite intrusions, Government Well Formation (Late Oligocene to Miocene)**

fine-grained dacite.

Tbrb **Basalt of Blue Ridge, Government Well Formation (Miocene or late Oligocene)**

Lavas containing a few percent plagioclase, pyroxene and olivine (typically altered to iddingsite) phenocrysts. The unit is present in two areas. North of Salt River thin flows directly overlie granitic rocks in the footwall of a major south-side-down fault. Farther south, basalt lavas overlie arkosic conglomerate (Tc) and underlie a thick pile of dacite lava (Td). In the southerly adjacent Goldfield quadrangle, basalt is interbedded with the same dacites (Tdc of Skotnicki and Ferguson, 1995), and at two localities in this map area, thin basalt occurs in association with the rhyodacite of Apache Gap (Trda)

Tgbs **Basaltic sandstone and pyroclastic rocks, Government Well Formation (Oligocene or Early Miocene)**

Pyroclastic deposits consist of evenly bedded scoria and/or fall-out lapilli tuff. Epiclastic rocks commonly are dark-red, pebbly sandstone.

Tgwb **Basalt lava of Government Well Formation (middle Tertiary)**

Basaltic flows and flow breccias with 1-3% 1-3mm pits contain-ing iron oxides that probably represent relict olivine, and 1% 2-4 mm dark green clinopyrox-ene(?). Thick accumulation on the NW side of lower Millsite Canyon apparently filled a paleo-valley. Aphyric vesicular basalt at east edge of map rests concordantly on Mescal Limestone and is possibly, but not likely, middle Proterozoic. These lavas are probably correlative with the Government Well Formation of Ferguson and Trapp (2001)

Tgbc **Coarse grained basalt or basaltic andesite, Government Well Formation (Oligocene or Early Miocene)**

Mafic lavas containing 2 to 10 mm wide phenocrysts of light gray plagioclase, dark green pyroxene (or olivine?) and red opaque minerals. Unit is differentiated from other mafic lavas (Ta or Tb) in only two areas: 1) south of Milk Ranch where it overlies a finer grained basalt lava along a discontinuous, bedded, lithic tuff (Tt), and 2) in a prominent saddle directly east of Quarter Circle U Ranch

Tqut **Tuff of Quarter Circle U Ranch, Government Well Formation (Oligocene or Early Miocene)**

Crystal rich, poorly welded and locally lithic rich rhyodacite ash flow tuff containing phenocrysts of embayed quartz, feldspar, and biotite. Very similar in appearance to poorly or moderately welded Superstition Tuff, and it may correlate with parts of the Hieroglyphic member or the Apache Leap Tuff.

Tgwa **Andesite of Government Wells Formation (Late Oligocene or Early Miocene)**

Andesitic lava flows, Interbedded with dacitic and rhyodactic lava flows. Typically contain less than 10% plagioclase and lesser amounts of altered mafic minerals (probably pyroxenes or amphiboles)Includes upper andesite of Ferguson and Skotnicki (1995): Crystal poor andesitic lava flow containing between 5% and 10% plagioclase phenocrysts and minor amounts of mafic minerals (pyroxene?). Characterized to some degree by a vitric zone along its contacts which is commonly altered to a light greenish color.

Trxx **Very crystal-rich felsic lava**

Very crystal-rich (15-20%), plagioclase, biotite-bearing felsic lava that occurs between the precaldera rhyolite and dacite lavas of the La Barge Canyon area. The lava occurs in the same stratigraphic position as the rhyodacite of Apache Gap, and because it has similar phenocryst mineralogy, the two lavas may be time-equivalent.

Tsdr **Rhyodacite of Stewart Mountain Dam (Middle Tertiary)**

Crystal-rich lava containing about 40-50% subhedral to euhedral biotite, sanidine, and minor quartz in a tan-pink matrix. Underlies rhyolite lavas. Forms the steep cliffs south of Stewart Mountain Dam

Tpmr **Rhyodacite lava of Pass Mountain (Miocene)**

Rhyodacite lava

Tgwt **Tuff and tuffaceous rocks of Horse Mesa Dam complex (Miocene)**

Orange-tan, light grey to yellow, crystal-poor, lithic-rich tuff. Crudely to thinly bedded. Contains 1-3 mm anhedral phenocrysts of quartz, biotite, and sanidine. Also contains abundant, moderately to poorly sorted subangular to subrounded clasts of pumice, rhyolite, dacite, basalt, and granite. Locally, the unit is interbedded with thin (0.5-2 meters), indurated sandstone beds containing pumice and lithic clasts. Interbedded with rhyolite flows of map unit Tr

Map Unit Explanation

Tdh **Hornblende-rich dacite (Middle Tertiary)**

A small body of fine-grained, hornblende-rich dacite (?) at the west end of El Recortado that appears to be cogenetic with a large mass of dacite (Td). Both the dacite and this hornblende-rich dacite may be in part hypabyssal in this area.

Tcsb **Basalt lava of Cabtree Spring (Miocene)**

Basalt lava containing variable amounts of plagioclase, pyroxene and olivine (typically altered to iddingsite) phenocrysts. Basalt lava generally is found at the base of the volcanic pile, but north of Apache Lake basalt crops out above a sequence of dacite flow breccia (Tdb). Basalt flows are commonly massive, or brecciated, but locally include bedded scoria and lapilli tuff

Tp **Porphyritic dikes (Tertiary)**

Dikes of chiefly rhyodacite and rhyolite composition; well-formed phenocrysts of feldspar, quartz, and mafic minerals. Locally highly brecciated; locally altered. Some dikes as much as 200 ft wide

Twcg **Gravel of Walnut Canyon (Middle Miocene)**

Poorly to moderately consolidated gray to buff
conglomeratic strata, ranging from sandy conglomerate to sedimentary breccia. Bedding is poorly defined, and the conglomerate is generally massive. Lenticular(?) sedimentary breccia bodies are monolithologic, and consist of clasts of Oracle-Ruin Granite (Yg), Tea Cup Granodiorite (TKg), or Apache Leap Tuff. Outcrops of breccia derived from Apache Leap Tuff along the lower part of the canyon east of White Canyon may be proximal equivalents of breccia sheets in this conglomerate unit. The Older Gravel unit (Tgo) of Creasey et al [1983] and conglomerate in the eastern part of the Mineral Mountain Quadrangle mapped as Tpg and Tog by Theodore et al. [1978], are correlated with the gravel of Walnut Canyon. Conglomerate in SW SE sec. 32, T2S, R12E (UTM 3674370N487250E) is mostly massive with some possible rock avalanche breccia, and consists almost exclusively of Pinal Schist clasts, which are typically 20-50 cm diameter and unsorted. Bedding is very crude. Along strike to north, sparse clasts of Dripping Spring Quartzite are present in the lower part of the conglomerate where it overlaps a fault contact (Telegraph Canyon thrust) between Pinal Schist and Dripping Spring Quartzite, thus revealing local derivation of clasts. Sparse clasts of Pioneer Shale are also present at base of the conglomerate unit where it overlies Pioneer Shale. These conglomerates underlie the tuff of White Canyon, and have dips that are most similar to post-Apache Leap strata. Conglomerate mapped as Tc that overlies Apache Leap Tuff along Arnett Creek in the north-central part of the Teapot Mountain quadrangle may be gravel of Walnut Canyon. Stratigraphic terminology used here is that proposed by Dickinson [1995].

Trhc **Volcanic rocks of Haunted Canyon (Early Miocene or Oligocene)**

Heterogeneous formation, with many lateral and vertical changes in rock type; some changes aorupi, oiners gradational. Rock types commonly intimately intermingled. Overlies pre-middle Tertiary rocks, overlain by Apache Leap Tuff.
Includes: Rhyolite that has a light- to medium-gray aphanitic groundmass with scattered phenocrysts of quartz, plagioclase, sanidine. biotite, and magnetite. Flow banding distinct to indistinct, locally highly contorted. Locally partly altered to clay minerals, calcite, and chlorite to form a grayish-yellow felsite
Perlite has black glass groundmass with well-defined perlitic cracks; locally color varies to brown, gray, red, or green. Scattered phenocrysts of quartz, plagioclase, sanidine, biotite, magnetite, and zircon. Flow banding generally distinct. Glass has undergone variable amounts of devitrification ranging from thin films of microlites along perlitic cracks to completely devitrified grayish-yellow felsite with relict perlitic cracks. Lithophysae and other spheroidal structures are common along surfaces between rhyolite and perlite Tuff. Typically a fine-grained to aphanitic, vitroclastic mixture of devitrifed shards, lithic ash, scattered phenocrysts, pumice lapilli, and small xenoliths. Composition, structure, and texture widely variable; tuff ranges from well consolidated to friable, and from well bedded to unbedded. Generally grayish yellow, light gray, light brown, or white.
Breccia: (a) Pumice bombs and angular lithic fragments in a coarse-grained, poorly sorted clastic matrix. Commonly interbedded with tuff. (b) Angular fragments of felsite and rhyolite in a groundmass of jumbled, heterogeneous volcanic debris
Andesite and trachyte: Medium-gray, dark-gray, to dark-brown aphanitic rock, with felted mass of tiny plagioclase laths in a cloudy cryptocrystalline aggregate, with scattered phenocrysts of plagioclase. Unit thickness 0 to 1300 feet approximately

Volcanic rocks of Chalk Canyon Formation and Hickey Basalt

regional unit

Tbh **Basaltic lava, Chalk Canyon and Hickey formations**

A thick succession of basaltic lavas interleaved with volcaniclastic sedimentary rocks (Tvs), welded (Tdt), and nonwelded tuffs (Tt). The flows range in thickness from a few meters to over 50 meters, but average about 10 meters. The sequence is divided into two formations based petrologic differences and their association or lack of association with interbedded tuffaceous rocks. The lower unit's (Chalk Canyon Formation) basalts are interleaved with abundant tuffaceous rocks, whereas the upper unit (Hickey Formation) occurs as a single, unbroken, amalgamated sequence. Texturally, the Chalk Canyon Formation lavas are olivine and clinopyroxene porphyritic, with intergranular biotite in a generally fine-grained matrix. Matrix of the Hickey Formation lavas tend to be more intergranular with coarser-grained plagioclase, finer-grained clinopyroxene and an overall more diktytaxitic texture. The Chalk Canyon basalts are largely alkaline to transitional in composition, whereas the Hickey Formation basalts are subalkaline (olivine subalkali basalt and basaltic andesite)

Tccs **Basaltic lava scoria, Chalk Canyon Formation (Late Oligocene to Miocene)**

Bedded scoria associated with Chalk Canyon Formation basalt lava flows. The scoria deposits have sharp contacts with adjacent, subjacent and superadjacent lavas and gradational contacts with laterally adjacent nonwelded tuff (Tt) and volcaniclastic sedimentary rocks (Tvs). The scoria deposits are interpreted as part of cinder cones around vents

Map Unit Explanation

Legend: Map Units for Tonto National Forest Geology

Tdt — Dacitic tuff (Chalk Canyon Formation)

Welded to nonwelded predominately air-fall tuffs, typically thin- to medium-bedded. Phenocrysts of plagioclase and biotite + quartz make up 10-15% of the tuffs which occur as one and locally two units interleaved with basalt flows south of Quien Sabe Peak, and also as a single unit along the north slope of Elephant Mountain. The eastern tuffs were probably derived from a single plug near the head of Rackensack Canyon in the easterly adjacent Humboldt Mountain quadrangle (Gilbert and others, 1998). The western tuffs were probably derived from nearby dacite plugs either along the southern margin of the map area or plugs to the southwest (Leighty, 1998). These tuffs are part of the Chalk Canyon Formation (Gomez, 1978)

Tdb — Dacite lava breccia (Chalk Canyon Formation?)

Autobreccia or vent breccia of the dacite lava (Td)

Tvs — Volcaniclastic sandstone, conglomerate, mudstone, and marl, Chalk Canyon Formation (Tertiary, Proterozoic)

Thin to medium-bedded pumiceous and basaltic volcaniclastic sandstone with minor amounts of conglomerate, mudstone, and marl, and nonwelded tuff. The unit is intimately interleaved with the basalt lava (Tb) unit, and is locally gradational with the nonwelded tuff (Tt) map unit. Nonwelded tuffs are ubiquitous, comprising up to 10% of the unit, but are too thin to map separately. The conglomerates contain mostly Tertiary basalt, but also Proterozoic crystalline clasts. Mudstones and marls occur chiefly in the southwest, high in the Tertiary section along Elephant Mountain and Black Mesa. Locally, the finer grained sediments are heavily bioturbated with vertical and horizontal cm-scale burrows and root casts. These sedimentary rocks are part of an interbedded sequence of tuffs, sandstones and basaltic lavas which make up the Chalk Canyon Formation (Gomez, 1978)

Ttcc — Nonwelded tuff, Chalk Canyon Formation

Thin to medium-bedded air fall tuff, ash-flow tuff and rare surge deposits, locally interbedded with subordinate volcaniclastic rocks. The tuffs are generally light-colored and crystal-poor. In general the older tuffs are sanidine and quartz bearing, whereas the younger tuffs are more dacitic in composition, containing only plagioclase and biotite phenocrysts. The tuffs are part of an interbedded sequence of tuffs, sandstones and basaltic lavas which make up the Chalk Canyon Formation (Gomez, 1978)

Tcs — Chalk Canyon formation (Miocene)

Sandstone, conglomerate, mudstone, calcareous in some areas, underlies Hickey basalt lava flows

Tcsc — Chalk Canyon Formation, sandstone-conglomerate facies (Miocene)

Dominantly medium- to thick-bedded conglomerate, sandstone, and pebbly cobbly sandstone.

Tcl — Chalk Canyon Formation, fine-grained facies (Miocene)

Variably calcareous mudstone, silty mudstone, and thin- to medium-bedded strongly silicified white carbonate. Carbonate.

Tx — Sedimentary Breccia (Early Miocene to Eocene) and Lower Paleozoic

Shattered rock and monolithologic breccia depositss. Lett in parenthesis indicates source rock type. (p) Pinal Schist; (a) Apache group and lowr Paleozoic strata.

Tch — Chaos (Miocene or Oligocene)

Rock bodies in which superposed faulting has mixed units on a 5-50m scale with such complexity that relationships cannot be shown on the map. Area mapped in north-trending fault zone NE NW SW sec. 25, T2S R12E consists of Apache Group, diabase, and lower Paleozoic units. Contacts with more intact rock bodies are faults.

Tmmc — Conglomerate, breccia, and sandstone of Mount McDowell (middle Tertiary)

Interbedded red-colored, matrix-supported breccia, and clast-supported conglomerate, sandstone, and minor siltstone and limestone. Breccia layers are matrix-supported, very-poorly sorted, weakly to non-bedded, and contain outsized clasts up to 10 meters across, and probably represent debris flows. Conglomerates and sandstones are locally normally graded. Locally interbedded with and intruded by mafic volcanic rocks. Shafiqullah and others (1980) obtained a K-Ar/whole rock age of 18.01 ± 0.80 Ma from an 'autobrecciated flow' (which may be a sill) within the red beds. They also reported an age of 18.70 ± 0.44 Ma from a mafic volcanic clast. Clasts include: medium- to coarse-grained granite/quartz monzonite (probably from map unit Xgc); dark grey to dark brown metarhyolite (with white 1-4 mm subhedral K-feldspar and clear rounded quartz); muscovite granite; biotite schist; white vein quartz; banded gneiss/schist; foliated, tan to light green and brown phyllite/meta-argillite; dark grey to black quartzite; dark grey metaconglomerate; black hornblendite; grey welded tuff (rare); fine- to medium-grained leucogranite (possibly from map unit Yf); granite porphyry (possibly from map unit Ti); quartz porphyry; light green quartz-muscovite schist (probably metarhyolite); grey, quartz-rich, flow-banded rhyolite (rare, probably Tertiary); basalt/trachyte (contains iddingsite after olivine or pyroxene, plagioclase, quartz, biotite+hornblende altered to hematite, and zeolite); biotite lamprophyre.

Tmmm — Mafic volcanic rocks of Mount McDowell (middle Tertiary)

Dark to medium grey fine-grained volcanic rocks containing 1-3 mm nonhedral to subhedral phenocrysts of olivine and/or pyroxene mostly altered to iddingsite, clear quartz, and various amounts of biotite and/or hornblende in a dark aphanitic matrix. The abundance and occurance of phenocryst types is quite variable between outcrops. A few contain almost exclusively olivine and/or pyroxene. Some contain all four phases. Most contain at least olivine and/or pyroxene and quartz. Several outcrops are clearly intrusive and others are clearly depositional. Some exposures are both and for others it is not clear. Therefore all of these rocks were mapped together. Generally, this unit forms resistant knobs and hills, though locally the rock is crumbly. The dikes also contain quartz.

Tco

Older Conglomerate

No description given

Tc1

Nonvolcaniclastic conglomerate and sandstone around Skull Mesa

Pebble-cobble to boulder conglomerate and pebbly sandstone containing clasts of Proterozoic granitoid and metamorphic rocks exclusively. Generally thick-bedded but also medium-bedded. The conglomerates are chiefly clast-supported, and locally display well-developed clast imbrication. The unit consists almost exclusively of conglomerate in the south, while pebbly sandstones are more abundant to the north. Group contiguous conglomerate mapped on New River Mesa and Humboldt Mountain quads in the Skull Mesa area as one unit, separate from other conglomerate mapped as Tc on east side of Seven Springs Wash

Tc2

Arkosic conglomerate of Goat Mountain

No description given

Tbcs

Conglomerate and breccia of Baldy Canyon (Oligocene or Miocene)

The bottom part of this unit is composed of weakly bedded, moderately to poorly sorted deposits that resemble debris flows. The deposits contain angular to subrounded clasts of metarhyolite (map unit Xr) from pebbles to rare boulders, and less abundant clasts of diorite (map unit Xd) and subrounded to rounded boulders of purple quartzite and sandy conglomerate, all in a tan sandy matrix. Most of the unit above the lower part contains very poorly sorted, subangular to subrounded pebbles to boulders (up to 3 meters) of foliated coarse-grained granite (map unit Yg), in a sandy, non-bedded matrix. The uppermost ridges are capped with a lag containing all the clasts mentioned as well as boulders of purple quartzite.
Breccia present in unit on south side of Baldy Canyon, includes rocks mapped as older conglomerate (Tco) of Four Peaks and Tonto Basin Quads.

Whitetail formation (Early Miocene to Late Eocene(?))

Generally pre-volcanic clastic sedimentary rocks, locally with some interbedded gypsum or tuff. Rock avalanche deposits are interbedded in some areas. Overlies pre-middle Tertiary nonconformity, overlain by volcanic rocks. Characterized by rapid facies changes and evidence of some depositional tectonic activity. Bedding is generally well defined, and strata typically have a reddish hue

Twbr

Rhyolite of Bulldog Canyon (Oligocene or Miocene)

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.

Twrc

Tuffaceous conglomerate, rhyolite of Bulldog, Whitetail Formation (Oligocene or Early Miocene)

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.

Tw

Whitetail conglomerate (Middle Tertiary)

Poorly sorted, crudely bedded to massive conglomerate containing subrounded to subangular clasts up to 40 cm diameter of Apache Group rocks and Paleozoic carbonates and quartzites. Reddish brown sandy matrix is poorly cemented

Twp

Conglomerate, Pinal schist-clast (Miocene)

Massive, angular clast conglomerate consisting of clasts of Pinal Schist. Commonly associated with probable rock avalanche deposits; matrix is lithic sand to mudstone, apparently composed of disaggregated Final schist; matrix or clast supported, weakly to moderately indurated; blocks are up to about 3 m in diameter. Interpreted to include talus, coarse alluvium and debris-flow deposits. Generally, found at the base of Whitetail Formation; contact with underlying Pinal Schist gradational through shattered schist; contact commonly faulted. Upper contact gradational into other facies of Whitetail Formation. Contact on shattered Final Schist along Walnut Canyon 4 km southwest of Teapot Mountain is difficult to locate in detail; shattered schist grades into schist breccia, then bedded monolithologic conglomerate over about 5 m

Twcc **Conglomerate, carbonate clast (Miocene to Eocene)**

Massive conglomerate in which rounded pebbles to boulders of various Paleozoic carbonate and clastic units are predominant clast types; bedding difficult to discern except in sparse sandstone lenses. Conglomerate beneath Apache Leap tuff, located at SE NW sec. 26, T2S, R12E (UTM 3676490N 491650E) is massive and bedded with clasts of Paleozoic and Apache Group carbonate and quartzite. Sub-angular to subrounded clasts are 2-20 cm, locally up to 1 m in diameter. Lack of Pinal Schist and Madera Diorite is striking and suggests that this conglomerate was deposited before normal faulting uncovered these crystalline rocks. Conglomerate grades into other facies of the Whitetail Formation vertically and horizontally

Twm **Fine-grained member (Miocene to Eocene)**

Light gray to red brown laminated mudstone with interbedded, very thin beds of fine-grained sandstone. In southwestern part of map area contains lenses of pebble to cobble conglomerate; some of these contain only angular clasts of Pinal schist, others contain granite (Yg and TKtc), Pinal schist, and carbonate or quartzite clasts from the Apache Group or Paleozoic section. Final schist-clast conglomerate is predominant in exposures in Walnut Canyon upstream of confluence with White Canyon. Contacts are gradational into other facies of Whitetail Formation

Twe **Gypsum and mudstone (Miocene to Eocene)**

Buff siltstone to mudstone with associated evaporite minerals. Outcrops of evaporite component typically highly disrupted because of mobility of anhydrite and salt, and original sedimentary structures have not been observed. Gypsiferous Whitetail mudstone is present in the map area along the Grayback normal fault in the southwest part of the map, and along the north side of Walnut Canyon about 0.8 km upstream of its confluence with White Canyon. Contacts not exposed;
probably grades into other facies of Whitetail Formation

Twss **Sandy facies (Miocene to Oligocene)**

Arkosic to feldspathic sandy clastic rocks associated with conglomeratic rocks. Overlies pre-middle Tertiary unconformity, interbedded locally with some tuff or tuffaceous clastic rocks, generally overlain by volcanic rock

Ts **Sandstone conglomerate ?**

Unknown Unit no description given

Ta **Andesitic lava flows(Miocene)**

Generic unit for scattered andesitic lava units that have not been incorporated into regional stratigraphic framework.

Tm **Mafic volcanic rocks (middle Tertiary)**

Dark to medium grey fine-grained volcanic rocks containing 1-3 mm nonhedral to subhedral phenocrysts of olivine and/or pyroxene mostly altered to iddingsite, clear quartz, and various amounts of biotite and/or hornblende in a dark aphanitic matrix. The abundance and occurance of phenocryst types is quite variable between outcrops. A few contain almost exclusively olivine and/or pyroxene. Some contain all four phases. Most contain at least olivine and/or pyroxene and quartz. Several outcrops are clearly intrusive and others are clearly depositional. Some exposures are both and for others it is not clear. Therefore all of these rocks were mapped together. Generally, this unit forms resistant knobs and hills, though locally the rock is crumbly. The dikes also contain quartz.

Tl **Hornblende latite or andesite lava**

Hornblende porphyritic, light to dark gray latite or andesite lava, locally including lava breccia and minor hypabyssal rocks

Tfv **Felsic volcanic rocks (Pliocene to Oligocene)**

Rhyolite to dacite lavas and related rocks.

Tt **Felsic tuff (Pliocene to Miocene)**

Felsic tuff (Pliocene to Miocene)

Tbi **Intrusive basalt**

Dikes of basaltic rock. May include some late Cretaceous dikes. Generally associated with Tertiary volcanic rocks

Tfi **Felsic intrusive rocks (Oligocene or Miocene)**

Undifferentiated felsic composition igneous dikes

Tii **Intermediate composition hypabyssal intrusive rocks (Middle to late Tertiary)**

Various dacitic to andesitic hypabyssal intrusive rocks, commonly porphyritic.

Tbu **Basalt lava flows (Oligocene or Miocene)**

Basalt lava flows of uncertain affinity. In northern part of compilation area, includes basaltic rocks between those clearly associated with the Hickey and Chalk Canyon formation and the Chalk Mountain basin. These are medium- to dark-gray olivine basalt, consisting of flows 2-40

m thick that contain olivine phenocrysts 1-2 mm long, commonly altered to iddingsite and, in some flows, conspicuous phenocrysts of a dark-green pyroxene in an intergranular groundmass. Flows high in the unit capping the eastern part of Polles Mesa, located-in the northeastern-part of the area, contain abundant conspicuous augite phenocrysts 2-6 mm in size. Deeply embayed quartz phenocrysts and large blocky plagioclase crystals locally are abundant in lower third of the unit. Vesicles are common and locally are partly-lined with a zeolite; calcite amygdules and-.veins are abundant. Contains locally conspicuous interbeds of basaltic sand and scoria. Forms cliffs and steep slopes. High cliffs are especially prominent on the north side of the East Verde River and along Fossil and Hardscrabble Creeks, near the northern border of the area. K-Ar ages range from 9.9±0.5 Ma in the Limestone Hills to 13.4±0.8 Ma at the base of the unit on the East Verde River, 2.5 km east of the confluence with the Verde River. Thickness at least 430 m
Includes undescribed flows in the northern part of the Mormon Flat Dam 24K quadrangle.

Tkmc **Conglomerate of Kentuck Mountain (Oligocene or Miocene)**

Buff- to orange-weathering, weakly indurated, poorly sorted, pebble-cobble-boulder conglomerate with a granule sandy matrix. The unit is generally crudely to poorly stratified, and forms slopes and cliffs. Subrounded clasts are predominantly from underlying Proterozoic units. South of Kentuck Mountain, the unit is an arkosic granule conglomerate, with scattered pebbles and cobbles of basalt and rare clasts of the megacrystic granite (Yg). The conglomerate along the west-central edge of the Humboldt Mountain quad consists largely of metabasite (Xm) and metaturbidite (Xs) clasts, but also rare clasts of the megacrystic granite (Yg). The abundance of tabular-shaped meta-argillite (Xs) clasts accentuates the pebble-cobble imbrication texture of the conglomerate in this area.

Tcsv **Volcaniclastic conglomerate and sandstone of Hackberry Mesa**

Volcaniclastic conglomerate, pebbly sandstone, sandstone, silty mudstone, and sedimentary breccia. These strata range from plane-bedded and cross-stratified to massive, and from thin- to thick-bedded. Most of the strata are clast-supported, and the beds internally stratified; and these are interpreted as fluvial deposits. Locally, thin- to medium-bedded laminated siltstones and mudstones are abundant, some of which may be lacustrine deposits. Massive, matrix supported, medium and thick-bedded diamictites are locally abundant, and these rocks are interpreted as debris-flow and hypoconcentrated flood flow deposits. The lowermost strata at Hackberry Mesa include extremely thick-bedded, and very coarse-grained (over 3 meter clasts) sedimentary breccia

Teb **lamproite of Elephant Butte (Oligocene or Miocene)**

Intrusive, moderately crystal poor, dark gray colored, biotite rich lava. This rock is referred to as a lamproite because of its very abundant and coarse-grained (locally greater than 2cm wide) biotite phenocrysts. Unit is restricted to the Elephant Butte area where it consists of a plug and a northeast striking dike intruding Proterozoic rocks just to the east of the west side down Elephant Butte fault. Relationship to other Tertiary units is unknown. An exposure of Tt (generic tuff) may be related.

Trdx **Rhyodacite clast sedimentary breccia (Miocene)**

A widespread monolithic breccia with tuff matrix that occurs above intracauldron Apache Leap Tuff in the northwestern part of the Superstition Cauldron. Based on the distinctive phenocryst mineralogy of the clasts, the unit is believed to be derived from Whitlow Canyon Formation rocks that were exposed along the cauldron margin. This interpretation is supported by an 18.7 Ma date from a lithic tuff directly overlying this unit at Black Mesa (Superstition Mts.) (McIntosh and Ferguson, 1998) which matches the age of the Whitlow Canyon Formation in the area. (Ferguson and Trapp, 2001) Same as the rhyodacite breccia of Skotnicki and Ferguson (1995), described as yellow to grey rhyodacite lava containing about 5% 1-3 mm subhedral phenocrysts of biotite, plagioclase, and quartz. This unit forms a 0-8 meter-thick lens below lithic tuffs below Black Mesa. Towards the southwest end of Black Mesa the lava has been strongly altered to light grey porcelanite, in which the only phenocrysts visible are clear quartz.

Tbs **Tuff and volcanic-lithic sandstone (Miocene)**

Dark red brown, volcanic-lithic sandstone composed of basaltic cinders, some possible basaltic tuff, interbedded with and overlain by white, bedded tuff and tan, poorly indurated, volcanic-lithic sandstone. White tuff beds contains sparse 1 mm diameter feldspar and tiny biotite crystals, and abundant basaltic lithic fragments. Exposed in stream cuts along west side of Highway 177 about 5.5 km northwest of Teapot Mountain. Conformably overlies basalt lava flows (Tb).

Volcanic rocks of the Cochran - Picketpost Mountain area

Mostly rhyolitic lava flows with associated tuffaceous rocks in the north, and abundant hypabyssal rhyolite in the southern part of the complex around Cochran and the Gila River

Trpp **Felsic volcanic rocks (Miocene)**

Felsic lava flows, with associated vitrophyre, autobreccia, and tuff. Colors vary from dark gray to black for massive vitrophyre to white, light gray, or yellow in devitrified or deuterically altered parts of flows. Flow banding, amygdule, and brecciated zones are common. Rocks typically have phenocrysts of quartz, two feldspars, and sparse biotite or hornblende; tiny magnetite crystals are a common accessory. Quartz ranges from euhedral to resorbed. Phenocrysts make up to ~40% of rock in some units. Contacts with associated hypabyssal intrusions or endogeneous dome complexes are difficult to locate. Chemical analyses in Creasey et al., 1983 indicate the lavas in the western part of the map area are rhyolite. Interbedded with associated pyroclastic deposits of unit Ttw, and intruded by hypabyssal rhyolite of unit Tri. Overlain by conglomerate (Tc)

Tql **Quartz latite (middle Tertiary)**

Described by Peterson (1966) as lava flows and a shallow vent-filling intrusion that forms the top of Picketpost Mountain and a small plug on the northwest flank. Quartz latite is flow banded to brecciated and contains 25 to 30% phenocrysts of plagio-clase, quartz, biotite, sanidine, and minor hornblende. (See Peterson [1966] for detailed descrip-tion). Biotite from this unit yielded a K-Ar date of 18.4 0.5 Ma (Shafiqullah et al., 1980).

Ttw **Tuff of White Canyon (Miocene)**

White to light gray very thin- to thin-bedded tuff associated with Picketpost Mountain volcanics. Little or no evidence of reworking after deposition. Sparse conglomerate horizons are present near the base. Battle Axe Butte is a volcanic center that was one source of these tuffs. This unit forms resistant mesas and ridge tops. Contains 1-2 mm crystals of quartz, feldspar, and minor biotite and magnetite in a fine-grained ash matrix. Sparse 1-3 cm lithic fragments are present. Equivalent to older tuff (Tto) of Creasy et al. [1983]. Subdivided by Keith [1983] into 4 sub-units, apparently based on topographic breaks. These are numbered with subscripts on the map but are not described separately. In the central part of the basin in the western part of the Teapot Mountain quadrangle, is interbedded with rhyolite lava, and intruded by hypabyssal rhyolite. Paraconformity on gravel of Walnut Canyon (Tgw); unconformably overlies all older units. Deposited on landscape with appreciable local relief.

Twcb **Basaltic lava of Woods Canyon (Miocene)**

Dark gray basalt, basaltic or andesite lava flows, typically vesicular, and associated with red, scoriaceous deposits. Purplish to greenish gray, aphanitic to very finegrained amygdaloidal basalt lava flows; consists of a mat of tiny (-0.015 mm) plagioclase needles, magnetite, and alteration products comprising carbonate, epidote, chlorite, clay, and hematite. Crops out in west-central part of map area. May be equivalent to basalt upper unit (Tb). Mostly overlies gravel of Walnut Canyon (unit Tgw) conformably, but overlaps gravel of Walnut Canyon to unconformably overlie Pinal Schist at the NW tip of its exposure.

Ttpp **Tuff associated with Picketpost Mountain volcanics (Middle Tertiary)**

Massive and bedded tuff that may contain phenocrysts of biotite, quartz, sanidine, and hornblende and variable amounts of volcanic lithic fragments. Locally spheroidal weathering and typically weathers to tan to orangish brown color. Tuff in central part of map area that underlies aphyric perlitic rhyolite contains up to 40% lithic fragments that include Pinal Schist and quartzose sandstone. Where base of tuff is exposed on SW Picketpost Mountain, base of section is biotite-rich lithic tuff with interbedded breccia units composed of clasts of pre-Tertiary units. Base of section dips 30 to 40 , but dip decreases rapidly up section (over about 10 m), an lithic tuff grades rapidly up into buff, gently-dipping, lithic-poor massive and bedded tuff

Tfp **Crystal poor felsic volcanic rocks (Middle Tertiary)**

Flow-banded maroon felsite, with very few phenocrysts. May include intrusive and extrusive rocks

Tcri **Intrusive rhyolite of Cochran (Miocene)**

Mostly fine-grained, contains some glass near the contacts. Discrete plugs form peaks where they intrude extrusive rocks of Picketpost Mountain formation. Large hypabyssal irregular intrusive masses underly the complex in the Cochran area north and south of the Gila River. Scattered lithologically similar dikes and bodies in Pinal Schist of western part of mineral Mountain block are interpreted to be related.

fe **Ferruginous alteration zone**

Characterized by reddish or orange staining of rock by iron oxide minerals, typically associated with silicification of rock.

q **Hydrothermal quartz (Proterozoic, Laramide, or middle Tertiary)**

White "bull" quartz forming prominent outcrops. No metallic minerals detected.

Tgwc **Granitoid of Wood Camp Canyon (Late Oligocene)**

Fine grained aplitic to granophyric groundmass consisting of 40% quartz and 60% feldspar, contains 2-3 mm diameter quartz phenocrysts, 4 mm long blocky K-feldspar phenocrysts and 1-2 mm anhedral plagioclase grains altered to chalky clay or sericite. Trace of biotite in 1 mm diameter books. Contact with Pinal Schist in well exposed in Reevis Trail canyon at the south end of the pluton. The contact is sharp with a few thin dikes of granite cutting the schist. Identified as the Wood Camp Canyon aplitic granite by Shafiqullah et al. (1980) who derived a K-Ar biotite date of 18.35 0.4 Ma from this unit

Tdf **Felsic dikes (Middle or early Tertiary or Cretaceous)**

Very light gray groundmass with 5-7% crystals. Crystals include ~70% 2-3 mm diameter blocky plagioclase, 15% 1 mm diameter quartz, and 15% 1 mm diameter indiscernible altered mafic mineral.

TXdd **Unfoliated diorite dikes (Tertiary to Early Proterozoic)**

Unfoliated diorite dikes (Tertiary to Early Proterozoic). Intrude Alder Group in Slate Creek shear zone area.

Laramide igneous rocks

Intrusive rocks of Late Cretaceous to Early Eocene age

TKq **Quartz monzonite dikes (Tertiary or Cretaceous)**

Fine grained. Contains 5-10 volume percent biotite

Tmmd **Hypabyssal dacitic rocks of Mineral Mountain (Paleocene)**

Hornblende porphyritic gray dikes and small masses, locally strongly altered.

Tmmg **Hypabyssal granodiorite of Mineral Mountain (Paleocene)**

Mostly medium- to fine-grained, porphyritic biotite-hornblende granodiorite, but grading laterally into granodiorite porphyry. Includes several small masses of slightly porphyritic hornblende granodiorite in the SE sec. 3 and in the S sec. 2, T. 3 S., R. 11 E., containing about 5 volume percent phenocrysts of well-rounded quartz. The olive-brown hornblende crystals in these bodies of rock are strongly chloritized, and some hornblende crystals are altered along their rims to tightly intergrown chlorite, epidote, and calcite

Tgm **Granite Mountain Porphyry (Paleocene)**

Texturally variable equigranular granodiorite to granite porphyry. Typically, groundmass is holocrystalline, phanerocrystalline, finegrained, and aplitic, and is sprinkled with black shiny biotite crystals to produce light salt-and pepper effect. Grain size of groundmass increases in the central part of the stock, and texture changes to seriate with medium to coarse grain size. In the Sonora Quadrangle Cornwall, Banks and Phillips (1971) report composition of 43-52% plagioclase, 22-29% quartz, 15-30% potassium feldspar, 5-10% biotite and 0.5-1% magnetite. Ranges in composition from granodiorite to quartz monzonite. Plagioclase is chiefly in tabular phenocrysts 4-12 mm long; quartz is anhedral and occurs as both phenocrysts and in the groundmass. Sparse K-feldspar phenocrysts are up to 30 mm long, and with inclusions of plagioclase, quartz, biotite and magnetite. K-feldspar is also present as small anhedral crystals associated with quartz in the aplitic groundmass. Small outliers of this unit along Walnut canyon, north of the main body, are medium-grained (2-3 mm) equigranular biotite granodiorite composed of 50-60% plagioclase, 20-25% K-feldspar, 20% quartz and 2-4% biotite in 1-2 mm diameter columnar books. Dikes of aplitic granite are abundant along the contacts between these bodies and enclosing Final Schist. Shattered dike-like bodies of this rock near the fault bounding the southwestern end of the Whitetail conglomerate contain abundant pyrite altered to limonite along fractures. Includes one large stock and three smaller peripheral masses that presumably join the large stock at depth. Intrudes Pinal Schist.

Ttm **Teapot Mountain Porphyry (Paleocene)**

Salt and pepper gray granitic porphyry; gray groundmass with white or pink feldspar crystals. Groundmass is holocrystalline, micro-crystalline, and granophyric. Phenocrysts make 60-70% of roc, and in order of abundance include plagioclase (2-5 mm), dipyramidal quartz (5-10 mm), biotite (-2 mm), potassium feldspar (10-50 mm), and opaque oxides. Large K-feldspar phenocrysts are generally sparse, locally they are spectacularly large and euhedral. The groundmass is chiefly granophyric aggregate of quartz and feldspar. Rock is characteristically altered; plagioclase to sericite, clay and carbonate, biotite to chlorite, sericite and leucoxene and K-feldspar to carbonate and clay. Crops out in small irregularly shaped intrusive masses along a NE-trending zone. Intrudes Final Schist and Granite Mountain porphyry, cut by rhyodacite porphyry dikes.

TKsg **Schultze granite (Early Tertiary or Late Cretaceous)**

TKsg, stock of porphyritic biotite-quartz monzonite grading locally into porphyritic granite TKgp granite porphyry dikes and sills not obviously connected with the main stock may include some unrelated dikes in the southeastern part of the quadrangle

TKsp **Schultze Granite Porphyry**

The Schultze granite was named by Ransome (1903, p. 67) for Schultze ranch on U.S. Highway 70, about 3 miles southwest of Miami. The granite mass has the form of an irregular stock and crops out along the southern boundary of the Inspiration quadrangle and in the northern part of the adjacent Pinal Ranch quadrangle. The rugged, prominently jointed granite outcrops are an impressive feature of the landscape along U.S. Highway 70 from Miami -west-ward to Pinal ranch, a distance of about 7 miles.

The outcrop area covers about 20 square miles and is roughly crescent shaped, with the convex side to the north. Around the greater portion of its boundary, the granite is in contact with Pinal schist. In detail the contact is generally irregular. Where the general trend of the boundary is parallel to the bedding of foliation of the schist, the contact is very irregular; many short tongues of granite extend into the schist, and there are commonly septa of schist included in the granite along the contact. Where the general trend of the boundary crosscuts the bedding of the schist, the contact may be regular, as if. controlled by an old fault, or it may have angular irregularities and form. serrations whose alternate sides are roughly parallel to the bedding of the schist.

The topography of the granite areas from a distance appears to be characterized by broad valleys and rounded hills, but at close range it is seen to be extremely rugged. The illusion is largely due to the very uniform light color of the rock and to the lack of sufficient vegetation to accentuate the topographic details. Generally, the granite is not deeply weathered. Except on the flatter slopes and in the bottoms of valleys and washes, the outcrops are swept almost free of detritus, and consequently they support only scanty vegetation. The prominent joint system of the granite mass, which is conspicuous along U.S. Highway 70 through Bloody Tanks Wash, causes a rough blocky surface to form by a process of natural quarrying.

The joint system comprises two major sets of fractures, which are remarkably uniform in attitude throughout the granite outcrops, and several minor sets of more local prominence.

The fractures of the most prominent set strike north-east and dip southeast. Many of them can be followed continuously for 40 or 50 feet; and nearly every one contains a veinlet, from 1 to 3 mm wide, of cross-oriented muscovite generally accompanied by a little quartz. The strikes range from N. 25° E. to due east, but most are within the range from N. 55° to N. 75° E. The dips range from 50° to 75° SE., but are most commonly about 65° SE. A very minor set of fractures, which also contain muscovite veinlets, strikes N. 65° to 85° W. and most commonly dips 55° to 75° SW.

Of secondary prominence is a set of open fractures without muscovite veinlets that strike north to northwest and dip 60° NE. to vertical. A less prominent set of open fractures strikes northwest and dips steeply southwest. Northeastward-trending fractures having northwest dips are rare but may be prominent in local areas. In some places, there are a few northeastward-trending fractures -with low northwesterly dips, generally less than 40°.

The average strikes and dips of the various sets of joint fractures differ slightly from place to place. For example, in the western part of the granite mass the average strike of the muscovite veinlets is probably about N. 70° E., whereas in the eastern part, the average strike is noticeably more northerly, probably about N. 50° E.

Fractures of the various sets are not uniformly spaced throughout the granite mass; zones in which the fractures are so closely spaced as to resemble sheeting alternate with parallel zones in which the fractures are widely spaced. Thus, no single small area is likely to show a true composite of the joint system. For example, at a given point, of observation, joints of a minor set may be abnormally abundant and those of a major set poorly represented or entirely lacking. The spacing of the joints ranges between wide limits, but the common range is probably from 1 inch to 3 feet.

Joints of the various sets of fractures intersect one another and cut pegmatites, aplite dikes, and quartz veins without causing noticeable onsets; and they commonly bisect the mineral grains of the granite without displacing the two halves.

The joint pattern apparent in the Schultze granite is clearly a regional feature and has been recognized in all the massive rocks of the district. It is well developed in the quartz monzonite of the Porphyry Mountain mass (Peterson, Gilbert, and Quick, 1951, p. 55-61) and the dominant set of fractures that contain the mineralized veinlets of the Castle Dome copper deposit is essentially parallel to the muscovite veinlets in the Schultze granite. There are also unmineralized fractures in the Castle Dome area that are similar in attitude to the open fractures in the Schultze granite, but it is difficult to determine which fractures of this set were formed at the same time as the mineralized fractures and which are related to younger faults of similar trend. The same joint system can be recognized in the diabase east of the quartz monzonite and in the granite porphyry and granodiorite bodies south of Porphyry Mountain. Some outcrops of the Precambrian granite on Manitou Hill show a system of joints like the most prominent set in the Schultze granite;
and where the two rocks are in contact, muscovite vein-lets continue from one into the other.

The dominant set of fractures, which contains muscovite veinlets in the Schultze granite and the mineralized veinlets in the quartz monzonite of the Castle Dome area, is essentially parallel to the dominant structural trend of the Globe-Miami district.

Outcrops of Schultze granite are generally grayish yellow. The rock is porphyritic with large orthoclase phenocrysts ranging from 10 to 80 mm in length. The proportion of orthoclase phenocrysts differs greatly from place to place, forming as much as 15 percent of the rock locally but generally less than 2 percent. Hand specimens of the rock are nearly white and speckled with flakes of black biotite. White feldspar, quartz, and biotite can be recognized in the groundmass with the unaided eye. The mineral grains of the ground-mass range mostly from 0.2 to 2 mm in diameter, but some quartz and orthoclase grains are as much as 6 mm in diameter.

TKma Aplite or pegmatite dikes (Early Tertiary or Late Cretaceous)

aplite to pegmatite dikes associated with Laramide plutons

TKs Solitude Granite

A distinctive light-colored granite of Late Cretaceous or Early Tertiary age crops out 3 miles south of Miami, near the head of Solitude Gulch, for which the rock was named (Ransome, 1903, p. 65). Only the northwest end of the mass lies within the mapped area (pl. 1). The outcrop of the Solitude granite is almost white, with a faint yellowish tinge; it is so much lighter in color than the neighboring, grayish-yellow Schultze granite, that the two rocks are readily distinguishable, even when viewed from several miles away.

The Solitude granite within the mapped area is largely muscovite granite. Southeastward it grades into true granite, containing about as much biotite as muscovite. Surfaces of the broken rock are rough and granular. Quartz, feldspar, and silvery white muscovite are readily recognized with the unaided eye. Brownish alteration halos commonly surround the muscovite grains. The texture is characteristically nonporphyritic, medium grained, and equigranular.

The minerals seen in thin sections are quartz, turbid orthoclase, albite, muscovite, and a little microcline. The feldspars tend to be intergrown in anhedral clusters, which are interspersed with clusters of anhedral quartz grains. Muscovite occurs as aggregates of large ragged flakes and also as minute flakes scattered , through the feldspar clusters. The very sparse accessory minerals are rutile, sphene, bluish prisms of tourmaline, and occasional grains of limonite that probably are pseudomorphs after pyrite. The rock south of the mapped area, contains biotite in addition to muscovite. In general, the minerals of the rock show very little or no alteration by weathering.

An outcrop of intrusive rock, whose maximum dimensions are about 1,200 by 1,800 feet, is separated from the northwest end of the outcrop of Solitude granite by a band of schist about 600 feet wide. In hand specimens the rock appears to be a fine-grained aggregate of quartz, feldspar, and biotite. It has a nondescript yellowish-gray color, much darker than that of the neighboring outcrop .of Solitude granite. It includes very abundant, large and small fragments of schist, many of which have been partly assimilated by the magma. Thin sections show clusters of quartz grains, mostly 0.2 to 0.5 mm. in diameter and ragged flakes of muscovite in a groundmass apparently composed of microcrystalline orthoclase, minute flakes of muscovite, and abundant larger flakes of biotite. A few grains of andalnsite were recognized in a heavy- | minerals concentrate of the rock.

The rock of this small outcrop is unlike any of the other intrusive rocks of the district but has some characteristics in common with the nearby Solitude granite. The abundant schist inclusions throughout the mass and the presence of andalusite suggest that it may be a hybrid rock resulting from the assimilation of schist by magma, probably by some of the parent magma of the Solitude granite. It is therefore tentatively correlated with the Solitude granite.

There are very few data from which the age of the Solitude granite can be determined. The main mass intrudes the Pinal schist, and Ransome (1903, pi. 1) showed it in normal contact with Madera diorite for about a quarter of a mile along its southern boundary but apparently was unable to determine the relationships at this place, because exposures are poor. At the time, Ransome (1903, p. 78) described the Solitude granite he regarded all the granitic rocks of the Globe area as Precambrian in age but thought the Solitude granite to be younger than the Madera diorite, because it lacks the foliated texture of the latter.

The small outcrop near the northwestern end of the main mass is intruded by diabase, probably of the same age as the other bodies of diabase in the district, and along its northwest side, it is in contact with the Schultze granite, but the exposures are so poor that the relationships are not clear. However, it is cut by narrow porphyry dikes that seem to be offshoots of the Schultze granite, and if the rocks and the Solitude granite are of the same age, the Solitude granite is thus older than the diabase and the Schultze granite. The Solitude granite could have been intruded at any time from early Precambrian to early Tertiary, but it lacks the gneissic or foliated texture that is evident in all the lower Precambrian rocks except the Ruin granite. For this reason only, it is regarded as one of the early intrusions of the series assigned to the Late Cretaceous or early Tertiary orogeny.

TKqm **Porphyritic quartz monzonite of Silver King Mine (Late Cretaceous or Early Tertiary)**

Phenocrysts of quartz, K-feld plagioclase, 1-3 mm in diameter, make up 10-15 percent of the rock. Finely crystalline groundmass is co quartz, feldspar, and mafic minerals. Cavities with filling or druses common. Forms several small, irregular bodies, probably intruded at shallow depth.

TKgg **Granodiorite of Gold Gulch (Late Cretaceous or Early Tertiary?)**

A long narrow body of biotite granodiorite crops out along Gold Gulch, south of the Castle Dome mine. It is bounded by Pinal schist on the south and by a large mass of Lost Gulch quartz monzonite and small bodies of granite porphyry on the north. At the east end it tapers to a dike, ending about 1,500 feet east of the Castle Dome concentrator. The west end is an intrusive breccia composed of small blocks of granodiorite included in quartz monzonite porphyry. The character of the breccia seems adequate proof that the granodiorite is older than the Lost Gulch quartz monzonite.

Several bodies of granite porphyry have been intruded along the contact between the granodiorite and the Lost Gulch quartz monzonite, and the intrusive breccia has been intruded by a small body and several thin dikes of granite porphyry. During the study of the Castle Dome area, the granodiorite was assigned to the Tertiary intrusive rocks, but its age is uncertain. It may be of early Precambrian age and related to the Madera diorite or to the complex of dioritic rocks intruding the Pinal schist.

In hand specimens, the typical granodiorite is a light-gray medium-grained almost equigranular rock. Plagioclase, quartz, and black biotite are the only minerals that can be recognized. A facies with noticeably porphyritic texture occurs in some places near the margins of the body.

In thin section the plagioclase grains are seen to be subhedral and range from 0.5 to 3 mm in diameter. They are generally zoned and have the composition of oligoclase (An2o to An30). Some orthoclase is present, but it is always subordinate to plagioclase and nowhere composes more than 20 percent of the rock. Biotite, in small ragged books generally less than 1 mm across, forms about 5 percent of the sections. The accessory minerals are apatite, magnetite, zircon, and sphene. Although in hand specimens the rock looks to be perfectly fresh, most of the biotite is partly altered to chlorite, and the central part of some plagioclase grains is replaced by sericite and calcite.

TKhc **Quartz Monzonite of Haunted Canyon (Late Cretaceous or Early Tertiary)**

Phenocrysts of euhedral plagioclase and perthitic potassium-feldspar and anhedral quartz in a very fine' grained groundmass of quartz and feldspar. Accessory biotite, epidote, magnetite, sphene, and apatite. Phenocrysts average 3 to 5 mm and reach 1 cm. Groundmass grains average about 0.1 mm, and grade down to cryptocrystalline size at chilled borders. Quartz phenocrysts deeply embayed; some show re-crystallized borders. Alteration has permeated the entire mass, with albitization of the plagioclase, bleaching and removal of biotite, and formation of epidote, chlorite, and iron oxides. Miarolitic cavities are commonly lined with epidote crystals. A few cavities are filled with a single crystal of euhedral quartz which may reach an inch in length. Groundmass locally shows granoblastic textures. Fresh and weathered surfaces light brown to pale yellowish brown. Forms cliffs and steep slopes

TKdp **Diorite Porphyry of Barnes Peak (Late Cretaceous or Early Tertiary?)**

Diorite porphyry occurs as thin sills, dikes, and small irregular masses intruding Apache Group and Paleozoic strata from Superior to the Globe Hills, but is most common in the western part of the Inspiration quadrangle. Name proposed here is for series of sills at the base on the Pioneer Formation in the lower slopes of Barnes Peak. The rock is generally deeply weathered and crops out only in the most favorable places. The most extensive outcrops are in the lower part of the Pioneer formation or along the base of the Scanlan conglomerate. A small dike that cuts Troy quartzite and Martin limestone crops out on Buffalo Hill in the Globe quadrangle, and other small dikes and sills cut Troy quartzite and diabase in the area north of Globe. West of Porphyry Mountain an irregular mass near the west boundary of the inspiration quadrangle invades Martin and Escabros limestones, and farther north there are many thin sills intruded between the Pioneer formation and Ruin granite, either above or below the Scanlan conglomerate. Contacts between diabase and the Pioneer formation are a common locus of diorite porphyry intrusions.

The general color of the diorite porphyry is that of the very light-gray to medium-gray, microcrystalline groundmass. The phenocrysts are crystals of white or yellowish-gray plagioclase, as much as 5 mm long. The only other mineral recognizable in hand specimens is hornblende, in minute greenish-black prisms.

In thin section, the rock is seen to be highly altered. The euhedral and subedral phenocrysts are probably of oligoclase, but are much altered to aggregates of calcite, sericite, chlorite, and clay. The hornblende phenocrysts are almost completely replaced by chlorite, calcite, and limonite. The accessory minerals are apatite, sphene, magnetite, and probably biotite. The microcrystalline groundmass appears to be largely sodic plagioclase but may possibly contain quartz and orthoclase. Some of the diorite porphyry contains small phenocrysts of quartz.

The dike that crops out on Buffalo Hill contains many embayed quartz grains and euhedral phenocrysts of orthoclase as much as 10 mm long. This rock may be a facies of granite porphyry rather than diorite porphyry.

The diorite porphyry is clearly younger than the diabase. Several fragments of it have been found in the Whitetail conglomerate northwest of Continental Spring. The dike in diabase north of the Old Dominion "A" shaft is mineralized with pyrite and chalcopyrite on the tenth level of the mine. The diorite porphyry is tentatively regarded as having been intruded soon after the diabase.

TKgd **Granodiorite (Tertiary or Cretaceous)**

No description given

TKqa **Aphanitic border fades, Quartz Monzonite Porphyry**

Border of quartz monzonite porphyry body. Similar to porphyritic facies except phenocrysts are small or absent, and groundmass grades finely crystalline to aphanitic. Transition to porphyritic facies is gradational to abrupt.

TKmm **Quartz monzonite of Mineral Mountain (Early Tertiary or Late Cretaceous)**

K-Ar ages of 123.6 m.y. and 65.3 m.y. were obtained from primary hornblende and primary biotite. respectively, separated from a sample collected from locality in the S sec, 20, T. 3 S., R. 11 E.

Map Unit Explanation

TKkd quartz diorite of Silver King Mine (Late Cretaceous or Early Tertiary)

Small Stock intrusive into Precambrian and Paleozoic rocks. Medium- to fine-grained, generally hypid-iomorphic granular, locally grades to panidiomorphic granular. Consists mostly of euhedral to subhedral plagioclase and variable amounts of euhedral hornblende, pyroxene, and biotite; interstitial quartz ranges from trace to 15 percentThere are two major but intergradational rock types: one is medium grained and contains 10-20 percent mafic minerals and 10-15 percent quartz; the other is fine grained and contains 20-40 percent mafic minerals and trace to 10 percent quartz. Common in both types are irregular masses of coarsegrained rock containing euhedral hornblende as much as 4 cm long or euhedral pyroxene as much as 2 cm wide. Plagioclase shows slight to moderate alteration to sericite and clay, and mafic minerals are altered to uralite, epidote, biotite, and chlorit

Kd Quartz diorite of Arnett Creek (Late Cretaceous)

Quartz diorite of Arnett Creek identified by Balla (1972) and dated at 73.5 2.3 Ma by K-Ar on biotite (Balla, 1972)

Kt Tortilla Quartz diorite (Late Cretaceous)

Light to medium gray, fine-grained, hypidiomorphic granular quartz diorite. Average crystal size is about 0.5 mm, with sparse plagio-clase crystals up to about 3 mm long. Rock consists of euhedral to subhedral labradorite (40-60%), equant, subhedral pyroxene (0-15%), hornblende (-5%) as reaction rims on pyroxene and as anhedral crystals associated with biotite, biotite (10-20%) in ragged anhe-dral crystals, anhedral interstitial quartz (10-15%) and K-feldspar (up to 15%). Accessory minerals include 1-2% magnetite, sparse to abundant sphene, common apatite, and sparse zircon. Weak alteration is pervasive, with plagioclase replaced by clay, sericite and epi-dote, and hornblende and biotite replaced by chlorite and epidote. Several separate small intrusions southeast of the Ray mine, total outcrop area is about 2.6 square km. Intrudes Madera Diorite (Xm) and coarse-grained porphyritic granite (Yg); cut by Laramide dikes.

Kbx Breccia (Late Cretaceous)

Locally flow-banded breccia composed of fragments of volcanic rocks, diorite. Pinal Schist, and Middle Proterozoic coarse-grained granite in a semicircular mass about 1.2 km east of The Spine (UTM 497000E, 3665500N). Quartz and feldspar crystals in volcanic rock clasts are generally rounded (comminution?). Matrix is medium to dark gray and very fine-grained to aphanitic, with scattered 1-4 mm diameter xenocrysts(?) of quartz and feldspar. Matrix is similar to very-fine-grained phases in diorite core (Kd) of breccia. Lenses and pods of marble present in breccia are partially or completely altered to epidote-actinolite skam; sparse vitreous quartzite clasts are also present. The marble and quartzite association suggests derivation from Paleozoic or Apache Group units, but some of the carbonate may be secondary. Sulfide mineralization (pyrite) is associated with the skam inclusions. Interpreted as intrusive breccia [Creasey et al., 1983] associated with diorite (Kd). Laramide dikes cut breccia. Intruded into or overlies Proterozoic coarse-grained granite (Yg), contact appears sharp. Contact with diorite (Kd) is gradational.

Ktgd Granodiorite phase (Late Cretaceous)

Border(?) phase of Tortilla Quartz Diorite adjacent to Copper Butte fault north ofGila River. Rock has lighter color, and contains more quartz and biotite than the main phase. Quartz forms equant 2-3 mm grains in this unit, contrasting with interstitial quartz between plagioclase crystals in the main phase. Contacts with main phase of Tortilla Quartz Diorite are irregular, abrupt gradation over 1-3 m.

Kgmd Diorite and diorite porphyry of Granite Mountain (Late Cretaceous)

Several small intrusions in the vicinity of Granite Mountain on the west side of the Ray Mine. Consist of texturally variable fine-grained diorite and diorite porphyry. Diorite porphyry phase has fine-grained to very fine-grained aplitic groundmass of anhedral plagioclase, quartz, K-feldspar, biotite and hornblende, with phenocrysts of plagioclase (40-50%) in crystals about 1 mm long and clusters of crystals up to about 3 mm in diameter, and aggregates of hornblende, pyroxene and sparse biotite (15-25% of rock). Aggregates are mostly hornblende with a reaction rim of biotite or pyroxene with a reaction rim of hornblende. Accessory minerals include magnetite (1-2%), common sphene and rare apatite. Small body of diorite forms core of intrusive(?) breccia (Kbx) about 1.2 km east of The Spine. This body consists oftexturally variable fine-grained, equigranular diorite consisting of 2-20% mafic minerals, mostly hornblende with some biotite, in a ground-mass of anhedral to subhedral plagioclase. Quartz and K-feldspar are sparse or absent. Locally grades into a dark gray, microcrystalline diorite. Intrudes Pinal Schist. Relationship to Granite Mountain Porphyry not described. Smaller body associated with breccia (Kbx) appears to form matrix of breccia and contact with breccia is gradational.

Pzs Paleozoic strata (Paleozoic)

Undivided sandstone, dolostone, and limestone of Paleozoic age.

Pn Naco Formation (Pennsylvanian)

Light-gray, tan, and yellow, thin bedded, non-resistant shale limestone and shale. Fusulinids and brachiopods are common. Local terra rosa weathering residuum 0-30 m thick at base of section consists of red silty clay and a chaotic mixture of red clay and limestone blocks. Incomplete section exposed in upper Pine Creek. Thickness about 30 m

Me Escabrosa Limestone (Mississippian)

Gray to blue-gray massive crystalline limestone in beds up to 3 m thick. Crinoid columnals abundant; corals abundant in some beds. Forms prominent, cliffy outcrops. Some parts contain abundant chert. Black chert bands prominent near base of formation. Minor interbedded silty or marly limestone. Top is variably developed karst zone with clasts of limestone in a red-brown clay matrix. Keith [1983] describes an upper unit he named the Eskimin-zin formation that overlies karsted horizon at the top of the Escabrosa Limestone; this unit (0-110 feet thick) consists of pink to yellowish orange unfossiliferous fine-grained to aphanitic dolomite. -Lower contact with thinner bedded, generally slope-forming Martin Formation is sharp and usually clear. Upper contact with Naco formation is subtle change to more ledgy outcrop.

Dm

Martin Formation (Upper and Middle? Devonian)

Medium-gray, fine- to medium-grained, thin- to medium-bedded, commonly laminated dolomite and subordinate limestone. Contains scattered angular quartz silt. Basal beds emit fetid petroliferous odor when broken. Chert nodules occur throughout the member and are particularly common in the lower half. Abundant bryozoans, corals, and brachiopods locally in upper part of the member. Weathers medium- to light-gray locally with yellow, red, or brown hues. Forms slopes with ledges. Incomplete section in Limestone Hills is about 65 m thick Beckers Butte Member (Upper or Middle? Devonian)-Pale red-purple to pale red, locally reddish brownish-orange, dolomitic sandstone and minor medium-gray aphanitic dolomite at top-Sandstone is fine- to medium-grained, commonly containing 5-20 percent scattered rounded quartz grains 1-2 mm across. Bedding poorly expressed but generally thin and locally emphasized by lenticular laminations of very coarse quartz grains and chert fragments. Pebble conglomerate 2.5 m thick at base contains clasts of rhyolite, quartzite, and chert. Light-gray, medium-grained, well-indurated sandstone as much as 1.2 m thick occurs at top of sandstone part of the member. Aphanitic dolomite at top consists of thin beds and is about 1 m thick. Thickness 0-11m

Cb

Bolsa Quartzite (Middle Cambrian)

Maroon-gray feldspathic sandstone. Grit and pebble conglomerate at the base grade up into medium- to fine-grained sandstone with siltstone partings up section. Planar tabular cross beds are common in quartzite beds in the lower part. Brick-red to light gray, fine- to medium-grained, well sorted and bedded sandstone. Abundant iron oxide gives rock red color. Commonly preserved in channels cut into underlying rock units. Lithologic distinction from Troy quartzite is cryptic; depositional contact on top of diabase is only sure way to distinguish units. Bolsa-Abrigo transition is a gradation into dark gray, maroon and gray-green sandy shale with a few thin, locally bioturbated siltstone beds. Disconformably overlies Precambrian rocks, typically on a deeply weathered zone. Unconformably on Proterozoic diabase (Ydb) or Troy Quartzite. Contact with Martin formation is abrupt transition to carbonate deposition.

_Ytb

Troy or Bolsa Quartzite (Middle Proterozoic or Cambrian)

The most extensive outcrops of Troy quartzite in the district are in the Globe quadrangle, northeast of Globe and near the northeast corner. The Troy also crops out in the gorge of Pinto Creek, near the west boundary of the Inspiration quadrangle; on the west side of Gold Gulch, 4,000 feet west of Porphyry Mountain; and in several small outcrops about a mile and a quarter south of Barnes Peak. Elsewhere in the district, the Troy was completely removed during an interval of erosion that preceded the deposition of the Martin limestone of Late Devonian age.

An erosional disconformity separates the Troy quartzite from the underlying rocks of the Apache group, and there may be some angular discordance of the strata where the Troy has been deposited as a blanket on an erosion surface of considerable relief. The Troy exposed in the gorge of Pinto Creek was deposited on the eroded surface of Dripping Spring quartzite, and in one place, the basal conglomerate fills a channel that cuts through the Barnes conglomerate into the Pioneer formation. In the area southeast of Black Peak, in the Globe quadrangle, the Troy was deposited on the basalt that overlies the Mescal limestone, but in the northeastern part of the quadrangle, it rests on Dripping Spring quartzite.

Wherever the base of the Troy is exposed, it is marked by conglomeratic beds that differ greatly in character from place to place. In the exposures along Gold Gulch and Pinto Creek in the western part of the district, the basal part is a massive coarse conglomerate as much as 40 feet thick. It is composed of large angular blocks from the Pioneer formation, Barnes conglomerate, and Dripping Spring quartzite and many small rounded pebbles derived from the Barnes conglomerate in a matrix of dark reddish-brown sandstone. The rock is so firmly cemented that the outcrops form prominent cliffs.

The coarse basal conglomerate grades upward into dark reddish-brown pebbly sandstone and slabby argillaceous sandstone containing round elongate forms that resemble worm borings. These upper beds resemble the uppermost part of the Troy in other areas of Arizona, in which the section is more complete. Along Pinto Creek, the Troy is from 160 to 200 feet thick. It lies on the eroded surface cut on Dripping Spring quartzite and Pioneer formation and is overlain by the basal beds of the Martin limestone.

In the mineralized area north of Globe, the basal conglomerate of the Troy quartzite is known as the Buffalo conglomerate, so named from the prominent exposures of the conglomerate along the west side of Buffalo Hill. It was a well-known marker zone in the underground mine workings.

The Troy quartzite on Buffalo Hill overlies a thick diabase sill that was intruded into the basal conglomerate. At the north end of the hill, the conglomerate is about 80 feet thick and probably represents a complete section. At the south end, only the upper 10 to 20 feet of the conglomerate is present, and along the middle part of the west side the conglomerate is entirely cut out by the diabase.

The basal bed of the conglomerate at the north end of the hill is a coarse rubble, 7 to 10 feet thick, of angular and subangular blocks of quartzite and chert breccia intermixed with rounded pebbles and cobbles of quartzite and chips of gray, black, and red chert. Some of the quartzite blocks at the bottom of the bed are as much as 5 feet in diameter.

Overlying this basal bed of very coarse unsorted fragments is a unit, 35 feet thick, composed of lenticular beds of conglomerate interfingering with layers of coarse-grained 'grayish-red argillaceous sandstone. The sandstone layers are generally pebbly and commonly crossbedded; the conglomerate beds have no distinct matrix and consist of a heterogenous aggregate of materials ranging in size from coarse sand to cobbles and subangular fragments as much as 10 inches in diameter. Toward the top of this unit the rock fragments become progressively smaller and more rounded, and the sandstone layers are thicker and more homogeneous.

The uppermost 35 feet forms a unit of well-stratified grayish-red conglomeratic sandstone interbedded with layers of grayish-red quartzite, 6 to 12 inches thick. The conglomeratic beds have a distinct matrix, and the pebbles and fragments are generally less than an inch in diameter. At the top, this unit grades abruptly into crossbedded quartz sandstone that is typical of the Troy quartzite.

Many of the fragments in the conglomerate beds are of very coarse grained quartzite unlike any of the rocks of the older sedimentary formations. Some of the fragments are of breccia or conglomerate composed largely of flat chips of light-gray to black chert resembling some that weather out of the cherty beds of the Mescal limestone. The presence of these fragments, whose source is uncertain, suggests that there may have been some, probably local, accumulation of sediments during Early and early Middle Cambrian time. It is quite possible that remnants of these early sediments are represented by some of the conglomeratic beds at the base of the Troy in the northeastern part of the Globe quadrangle.

In the northeastern part of the Globe quadrangle, where the most extensive outcrops of Troy quartzite occur, the conglomeratic basal beds show. greater evidence of sorting and wave action than elsewhere in the district. The first material deposited was mainly re-worked debris

derived from the basalt flows of the Apache group and the Mescal limestone. Fragments derived from the quartzite units of the Apache group are relatively rare in the lowest beds, but they become progressively more abundant toward the top of the conglomerate. Although sections differ somewhat in detail, the general characteristics of the conglomerate are similar. The following section was measured at the top of a hill, just west of the road that is 9,000 feet south of the northeast corner of the Globe quadrangle. It is fairly typical of the basal part of the Troy Quartzite in this area.
The unit at the base of the section shows the greatest local differences in composition and character. In most outcrops it contains numerous fragments of vesicular basalt and generally a few pieces of Mescal limestone. Some fragments of Dripping Spring quartzite are generally present. In some outcrops the basal bed is composed largely of flat pieces of light-gray to black chert, ranging from a quarter to three-quarters of an inch in thickness, that lie in a sandy matrix with their flat sides parallel to the bedding. On the surfaces of weathered outcrops the chert fragments stand out in bold relief, as do the chert fragments on the weathered surfaces of certain cherty beds of the Mescal limestone from which these fragments undoubtedly were derived.

With the exception of the basal conglomeratic beds, the Troy quartzite is rather uniform in character and composition throughout the eastern part of the district. The lower part is typically brownish-gray medium- to coarse-grained crossbedded sandstone or quartzite composed of closely packed rounded grains of glassy quartz. Locally it may contain a small amount of arkosic or argillaceous material, but rarely as much as the Dripping Spring quartzite, which, it resembles more closely than any other rock in the district.
Beds are from 3 to 6 feet thick but are distinct only near the base of the formation. Some beds are separated by a single layer of pebbles, others by thin layers of siltstone that commonly show ripple marks or rain marks. A few scattered pebbles are found in most beds, and lenses of pebbly sandstone are fairly common. Upward in the section, bedding and crossbedding become less distinct or are entirely absent.
In the upper parts of the thickest sections, layers of thin-bedded slabby quartzite from 25 to 50 feet thick alternate with the layers of typical massive quartzite. Medium shades of brown, gray, or green are characteristic of the thin-bedded layers.

The Troy quartzite was deposited on an erosion surface of at least moderate relief. The underlying strata may have been slightly warped, but if so, the deformation was too slight to produce a recognizable angular unconformity. An interval of erosion occurred after deposition of the Troy quartzite, and by the time the Martin limestone was laid down in Late Devonian time, all the Troy had been removed from a large part of the district. Therefore, the total original thickness of the formation is not known. The maximum thickness of the Troy that remains cannot be determined with certainty because the amount of faulting that affected the continuity of the outcrop is not known. Undoubtedly there are many more faults that displace the outcrops than are shown on the map. Areas of quartzite breccia that probably indicate faults are common, but the continuity of these zones cannot be established because of the thin mantles of talus that obscure most outcrops of quartzite. Thicknesses of at least 400 feet of Troy quartzite can be determined with reasonable certainty, and the maximum thickness may well be as much as 700 feet.

As yet, no fossils have been found in the Troy quartzite of the Globe-Miami district, but in the Mescal Mountains, 14 miles south of Globe, Stoyanow (1936, P. 475) found Middle Cambrian brachiopods near its top. Still farther south, the Troy is overlain by the strata which he named the Santa Catalina formation and which he (1936, p. 480) correlates with the Marjum formation, of upper Middle Cambrian age, of the House Range section in Utah. Stoyanow's Santa Catalina formation is in turn overlain by the Abrigo formation which is of Late Cambrian age, according to Stoyanow. Thus on the basis of Stoyanow's work, "o part of the Troy quartzite is younger than Middle Cambrian.

Ya **Apache Group, Troy Quartzite, and diabase (Middle Proterozoic)**

Undivided in structurally complex zones.

Ydb **Diabase (Middle Proterozoic)**

Dibased dikes, sills, and irregular intrusive bodies of greenish-black, fine- to medium-grained diabase that intrude Apache Group and Troy quartzite.

Yt **Troy Quartzite (Middle Proterozoic)**

Rusty-red, pink and tan, medium- to coarse-grained and
grit-sized, moderately to poorly sorted, locally massive quartzite. Beds are 0.3 to 1.5 m thick. Pebbly conglomerate lenses and beds and individual pebbles of quartz or chert are present throughout the unit. Pebble conglomerate at base contains clasts of underlying basalt (unit Yb). Does not part prominently along bedding surfaces; bedding is delineated by grain size variation in sandstone. Troughy and planar tabular crossbedding is common. Sandstone lacks prominent pinkish feldspar grains characteristic of Dripping Spring Quartzite. Intruded irregularly by diabase sills (Ydb). Disconformably overlies basalt (Yb) or Mescal Limestone. Bolsa Quartzite or Martin Formation overlie disconformably.

Yb **Basalt, Apache group (Middle Proterozoic)**

(MAXIMUM 320 FT)-Dark-gray to dark-brown aphanitic rock composed of microscopic plagioclase tablets partly altered to clay and calcite, and pyroxene and olivine largely altered to opaque oxides, serpentine, calcite, iddingsite, and other products. Locally vesicular and amygdaloidal. Some layers are volcanic breccia consisting of angular basalt blocks in a matrix of basaltic lava.

Ym **Mescal Limestone (Middle Proterozoic)**

(350 FT)-Medium-gray to light-brown to white dolomite and limestone; generally thin-bedded with undulating to even bedding planes. Texture generally aphanitic or fine grained, locally medium or coarse grained, crystalline. Black to light-brown variegated chert abundant in some beds as uneven layers alternating with carbonate or as irregular nodules. Near base is layer of poorly exposed breccia of angular cherty dolomite fragments in a matrix of silty, locally calcareous, dolomite. Near top an algal member contains abundant wavy concentric structures characteristic of stromatolites. Locally near intrusive bodies of diabase in southern part of quadrangle, seams of chrysotile asbestos occur parallel to bedding

Yds **Dripping Spring quartzite (Middle Proterozoic)**

Light-gray to light brownish-gray, medium- to coarse-grained, feldspathic quartzite; shows distinct separation into beds which are thinly laminated and locally cross bedded only the lower part of the formation is present. Included with the Dripping Spring at its base, for convenience in mapping is the Barnes conglomerate which in this area ranges from a thin layer of coarse feldspathic sandstone containing a few scattered pebbles to a 6-foot-thick bed of closely packed ellipsoidal pebbles of hard vitreous quartzite, white vein quartz, and red jasper

Yp **Pioneer Formation (Middle Proterozoic)**

Scanlan Conglomerate Member (generally 1-4 ft, locally as much as 18 ft)-Well-rounded to subangular pebbles of white quartz, locally abundant, and angular pebbles and granules of schist in a matrix of grayish-red-purple, very coarse grained, poorly sorted rock chips and arkosic sandstone.
Arkose member (155 ft)- Arkose and feldspathic quartzite and sandstone, light-brown to dark-brown to dusky-red-purple, medium- to thin-bedded. Sandy beds separated by thin beds of siltstone and shale. Number and thickness of siltstone beds increase upward so that upper part of member contains equal amounts of arkose and siltstone.
Siltstone member (135 ft)-Thin-bedded siltstone, shale, and fine-grained arkose, dusky-purple and dusky-red, speckled by light-brown to greenish-yellow spots. Siltstone and shale are tuffaceous. Typically weathers to small, flat, angular flakes. Total 305 feet thick

Ypt **Tuff in Pioneer Formation (middle Proterozoic)**

Pale tan to pale gray, hard, massive, very fine grained siliceous hornfels. Contains sparse 1-2mm feldspar phenocrysts. This resistant unit forms a prominent ledge in outcrop where it is present. The bed is 2-5 m thick in the Whitford Canyon area, thinner or absent in the western part of the map area.

Proterozoic granitic rocks (Proterozoic)

Foliated, variably foliated, and non foliated plutonic and hypabyssal rocks of Proterozoic age.

Ygcf **Carefree granite (Middle Proterozoic)**

Light tan- to orange-weathering, porphyritic granite with megacrysts of K-feldspar up to 5.0 cm across set in a coarse-grained granitic groundmass. Border phase textures and dikes of Yg in Xm in southeast part of quadrangle are commonly fine- to medium-grained and equigranular

Yog **Oracle granite (Middle Proterozoic)**

Light brown to light gray porphyritic biotite granite; contains 2-8 cm diameter phenocrysts of K-feldspar in a coarse-grained groundmass of plagioclase, quartz, K-feldspar and biotite. Accessory apatite, zircon, magnetite and rare sphene are present. Weathers rapidly to grus. Thin aplite-pegmatite dikes are common. Intrudes Final Schist, and intruded by various Laramide plutons and dikes. Contact with Final Schist east of The Spine is a mixed zone with abundant screens and xenoliths of schist in granite near contact. Overlain by Apache Leap Tuff (Tal) and Whitetail conglomerate on erosional unconformity with significant relief.

Ygr **Ruin Granite (Middle Proterozoic)**

Quartz monzonite coarse-grained, porphyriteic; eudhedral phenocrysts 2-8 cm of perthite pink microcline in a coarse grained hypidiomorphic-granular groundmass of sodic plagioclase, microcline, quartz, and biotite, with accessory sphene, magnetite, apatite, and zircon. Locally grades to fine-grained, non-porphyritic quartz monzonite. Scattered pods of aplite and graphic granite. Transected by a few veins of white quartz and of pegmatite. Outcrops light brown, light gray, grayish yellow. Generally forms slopes, locally forms cliffs

Ympg **McDowell Pass granite (Middle Proterozoic)**

Medium- to fine-grained leucocratic granite containing 1-5 mm phenocrysts of pink K-feldspar, grey to pale yellow clear quartz, less abundant grey plagioclase, and biotite. The biotite is in most places a silvery color and locally may be muscovite. Equigranular to slightly K-feldspar porphyritic. The rock is light pink on fresh surfaces and light tan on weathered surfaces. It forms resistant knobs and dikes immediately east of McDowell Pass. The unit is nowhere foliated, appears fresh, and intrudes a more mafic, medium-grained granitoid (map unit Xgc). Intrusive contacts are well-exposed in road cuts of State Route 87 at McDowell Pass. Locally, epidote is abundant along intrusive contact. The unit is cut by 2-5 cm-wide aplite viens and white quartz veins. Although a sample was probably taken from this granite to obtain a date at 1,395 ± 0.45 Ma (Stuckless and Naeser, 1972), the investigators lumped this sample (sample 8145) with a granitic rock near Apache Lake (sample AP-202) in order to determine the Rb-Sr isochron. The composition of this single sample indicates that it could not be older than about 1,400 Ma because that would require an Sr87/Sr86 initial ratio of less than 0.700, and it could not be younger than about 1,340 Ma because that would require an initial Sr87/Sr86 ratio of greater than about 0.7110. Field work by this author suggests that these two plutons were not co-genetic. Therefore the analyzed sample of the granite near Arizona Dam Butte does not significantly constrain its age. This pluton is very fresh-looking and probably peraluminous.Name possed by Skotnicki (unpublished).

Ygrp **Pegmatite, two-mica granite (Middle Proterozoic)**

No description given

Ygf **Fine- to medium-grained granite (Middle Proterozoic)**

This granite is mostly equigranular but locally sparsely K-feldspar porphyritic with light tan K-feldspar phenocrysts up to 2.5 cm long. Contains anhedral to subhedral crystals of clear quartz, biotite, K-feldspar, and plagioclase. Generally weathers slightly darker than the coarse-grained granite and erodes into smaller, angular blocks instead of large spheroidal boulders. Weathered surfaces have a sugary granular texture. The rock is intruded by coarse-grained granite and cut by aplite dikes

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 dikes observed near The Boulders strike to the northwest. Intrudes quartz monzonite (map unit Xg) and is intruded by the medium-grained granite (map unit Ygm)

Yfi **Fine-grained dike (Middle Proterozoic)**

One dike west of the Sugarloaf Fault that is light grey, aphanitic, and non-foliated. Other smaller dikes of similar composition are present, particularly in the road cuts along State Route 87, but were not mapped.

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

Ymmm **Two-mica granite of Mineral Mountain (Middle Proterozoic?)**

Generally a medium-grained leucocratic granite containing less than 5 volume percent primary white mica and biotite, and about 50 to 65 percent potassium feldspar and 5 to 15 percent plagioclase Locally contains secondary biotite, a separate of which from NW sec. 32, T. 3 S., R. 11 E., yields a K-Ar age of 66.7 m.y.

YXeo **El Oso Granite (Middle or Early Proterozoic)**

This granite is given the informal name of El Oso Granite for the El Oso Road which bisects the pluton. This coarse-grained granite contains abundant, pink, subhedral to euhedral K-feldspar phenocrysts, in a matrix of subhedral plagioclase, quartz, and biotite. K-feldspar crystals are locally as long as about 3 cm, but most are 2-2.5 cm long. Plagioclase phenocrysts up to 6 mm are light gray and commonly sericitized. Biotite (about 15% of the rock) occurs as anhedral to subhedral fresh black books 2-5 mm wide. Quartz is clear-gray. This rock is slightly less resistant than the granite of map unit Xg. In the Brushy Basin the rock weathers into large unbroken sheets and spheroidal boulders, as well as grus-covered hills. East of the divide it mostly weathers into grus-covered slopes. The unit is mostly nonfoliated, except near the contact with diorite (map unit Xd) about 2 miles east of Four Peaks

YXmp **Hornblende pegmatite (Middle or Early Proterozoic)**

No description given

YXmg **Granite on Manitou Hill**

A number of irregular elongate masses of granite crop out along a zone that extends northeastward from near the head of Powers Gulch in the northwestern part of the Pinal Eanch quadrangle through Manifcou Hill to a point south of Jewel Hill in the Inspiration quadrangle. All intrude the Pinal schist, are elongate parallel to the general foliation of the schist, and are probably thick sills.

The granite is yellowish gray and is fine to medium grained. It is composed essentially of quartz, orthoclase, muscovite, and a little plagioclase and biotite. The plagioclase is sodic oligoclase, Magnetite and zircon is accessory, and both are rare.

Crude foliation has been developed in the granite by the crushing and elongation of the quartz and feldspar and by the orientation of mica. This foliation is clearly of metamorphic origin, as it is everywhere parallel to the regional schistosity and is not related to discordant contacts of the granite bodies. However, most of the metamorphism of the Pinal schist preceded the intrusion of the granite, for on Manitou Hill, unoriented inclusions of schist occur in the granite.

The field relationships show that this granite, though younger than the Pinal schist, is older than the Schultze granite for the latter intrudes it at several places. It is believed to be of early Precambrian age because it has undergone some metamorphism and, in places, contains numerous quartz veins which appear to have been produced during the same period of mineralization that produced the glassy-quartz veins in the Pinal schist which undoubtedly were the source of the quartz pebbles of the Scanlan conglomerate (p. 13).

YXd **Medium-grained, equigranular diorite (Middle or Early Proterozoic)**

Crumbly weathering, biotite-rich dioritic granitoid

YXbf **K-feldspar porphyric granite of Bagley Flat (Middle or Early Proterozoic)**

Variably foliated, sparsely K-feldspar porphyritic granite, quartz monzonite or quartz monzodiorite. Foliations are consistently east to northeast-striking and steeply to moderately north-dipping. Foliation is interpreted as tectonic. C-S fabrics and shear sense were recognized locally. Named for outcrops around Bagley Flat on the south side of Saguary Lake; other major outcrop are is north of Mormon Flat Dam. Overlain by volcanic rocks of Superstition Group

Map Unit Explanation

Legend: Map Units for Tonto National Forest Geology

YXuf **Felsic granitoid of Usury Mountains (Middle or Early Proterozic)**

Northeast trending lense of felsic granitoid intrudes coarse grained granitoid of Usury Mountains (Skotnicki and Ferguson, 1996, AZGS OFR 97-08). Weakly foliated

YXdf **Fine-grained diorite of Grays Gulch (Middle or Early Proterozoic)**

A finer grained variety of the diorite (YXd) map unit

YXgg **Goldfield granite (Middle or Early Proterozoic)**

Heterogeneous, light gray granitoid containing 1-3 cm subhedral phenocrysts of pink orthoclase and phenocrysts of milky gray quartz, white subhedral plagioclase, and clumps of subhedral biotite (Skotnicki and Ferguson, 1995)

YXff **Fine-grained granitoid of Fountain Hills (Middle or Early Proterozoic)**

Contains 1-5 mm phenocrysts of light grey feldspar, milky-grey quartz, and minor biotite and muscovite in a very fine-grained pale grey, sugary matrix. In the southern end of the McDowell Mountains the rock is weakly to strongly foliated and resembles metarhyolite. Slightly farther to the north the lighter nonfoliated to weakly foliated granite clearly intrudes darker strongly foliated and lineated metarhyolite. At the southeastern end of the McDowell Mountains the fine-grained granite is complexely intertwined with the coarser-grained granite (map unit Yxg). It is not clear which is older.

YXfg **Felsic Granitoid of Fountain Hills (Middle or Early Proterozoic)**

Medium-grained to coarse-grained, leucocratic, K-fedspar porphyritic granite to quartz monzonite containing phenocrysts of subhedral white plagioclase, 1-4 mm black to dark green felty masses of biotite, grey to slightly pink 1-2 cm subhedral K-feldspar, and about 2-5% milky grey quartz. Less than 2% of the unit is foliated (estimated). Forms resistant, boulder-covered hills and ridges at the southeastern end of the McDowell Mountains. The rock is locally fresh and contains pink K-feldspar phenocrysts, but most weathered surfaces crumble easily into sandy grus. Resembles the Ruin Granite near Globe.
This unit includes outcrops of foliated felsic granitoid in the McDowell Pass area. Skotnicki (1995) describes this rock as fine- to medium-grained leucocratic granite containing 1-5 mm phenocrysts of pink K-feldspar, grey to pale yellow clear quartz, less abundant grey plagioclase, and biotite. Foiation is defined by alignment of biotite crystals.

YXpc **Porphyritic granitoid of Peralta Canyon (Middle or Early Proterozoic)**

porphyritic granitoid underlying pediment along south side of Superstition Mountains.

YXfm **Mafic granitoid of Fountain Hills (Middle or Early Proterozoic)**

Medium-grained, equigranular quartz monzonite containing 1-5 mm phenocrysts of subhedral white feldspar (probably plagioclase), about 2% grey milky quartz, and abundant dark green clumps of biotite. Dark grey-green on fresh and weathered surfaces. Does not appear foliated. Forms lens-like bodies within map unit YXfg and probably intrudes it.

YXge **Granitoid of Edwards Spring (Middle or Early Proterozoic)**

Non foliated reddish orange potassium feldspar rich fine-grained to megacrystic granitoid. Contains minor muscovite. Pluton apparently includs early fine-grained phase an da later porphyritic to megacrystic phase. (Wessels 1990)

YXcp **Granitoid of Comet Peak (Middle or Early Proterozoic)**

Equigranular, medium-grained, biotite-bearing granite found only directly southeast of Comet Peak. Intrudes Pinal Schist.

Xvrg **Granitoid of Verde River (Early Proterozoic)**

Pink to red fine to coarse-grained mostly equigranular granitoid, Verde River Red Granite Batholith of Anderson (1989). Includes Sheep Mountain Granophyre between Humboldt Mountain and the Verde River, and rocks mapped as Payson granite SE of Humboldt Mountain on the west side of the Verde River

Xdgv **Diamond Rim Intrusive Suite (Early Proterozoic)**

Red, brown, ./and tan, leucocratic, miarolitic granophyre. Has quartz and alkali feldspar phenocrysts in a micrographic groundmass. Maffic minerals are Xgc largely altered to hematite and muscoyite. Contains red to brown, fine-grained, equigranular aplite that occurs as discrete bodies and as masses that grade into granophyre. Mapped In small bodies that intruded the East Verde River Formation as sheets and irregular bodies north and northeast of North Peak near the north end of the Mazatzal Mountains and in an extensive sheet above Payson Granite (Xdpg) on Cypress Ridge in the south-central part of the area. Also occurs widely as unmapped sheets on Payson Granite between upper City Creek and the west end of the Limestone Hills. The flat-lying basal contact of a large sheet on Payson Granite can be followed for several kilometers high on the canyon walls of Wet Bottom Creek south of the Limestone Hills. The texture varies from micrographic, grading into spherulitic, to porphyro-aphanitic. Granophyre north of North Peak is overlain uncomformably by Deadman Quartzite (Xmd)

Xgsc **Granophyre of Sheep Creek**

1.3 km northwest of Loin Mounatian, near the southern border of the area. Has a granular and crude micrographic groundmass and a few percent each of quartz, plagioclase, and orthoclase phenocrysts 2-

6 mm in diameter. Plagioclase is partly sericitized and saussuritized. Contains a few percent of skeletal amphibole largely altered to chlorite and biotite. Accessory constiutents are opaque oxides, apatite, allanite(?)" and zircon(?). Possibly related to porphyritic granite (Xpg) or to Payson Granite (Xdpg) and Green Valley Hills Granophyre (Xdgv). This unit or a larger body to which it is a cupola may have caused the hornfelsic metamorphism of the micaceous sandstone (Xams)

Xgnr **Granitoid of New River Mountains (Early Proterozoic)**

Nonfoliated, medium to coarse-grained granite. Probably related to the New River felsic complex (1700Ma)

Madera superunit (Early Proterozoic)

Group of dioritic to granitic rocks that intrude Pinal Schist in the outcrop region between the Oracle and Ruin batholiths. Typically the intrusions are subconcordant, foliated to non foliated, and generally fine to medium grained

Xdm **Madera diorite of Pinal Mountains (Early Proterozoic)**

Gray, mostly medium-grained, biotite-quartz diorite; locally contains abundant epidote

YXrt **Granitic rocks of Reevis Trail Canyon (Early or middle Proterozoic)**

Equigranular, unfoliated, medium to fine grained granite or granodiorite with local marginal aplitic zones. Generally contains 7-10% mica, including both biotite and muscovite, but their relative abundance varies greatly. More muscovite-rich granite, common south of Queen Creek, appears to have assimilated more Pinal Schist and is generally associated with gradational assimilation zones and broader contact aureoles. The northeast-trending elongate body in the northeast part of the map area generally has sharp contact with a few screens of schist near the contact, and no apparent contact metamorphic aureole. The granite near the contacts in this pluton is slightly foliated

YXma **Madera diorite of Alamo Canyon (Early or middle Proterozoic)**

Several small (500-1000 m outcrop diameter) bodies of generally equigranular diorite intruding discordantly in Pinal Schist in the NE part of the Mineral Mountain Quadrangle. Typically rock is fine to medium grained dark gray equigranular diorite, composed of hornblende or pyroxene and plagioclase

YXgw **Granodiorite phase, granitic rocks of Reymert Wash (Middle or early Proterozoic)**

Similar to granitic phase, but contains more abundant biotite and has slightly darker color index

YXrw **Granitoid phase, granitic rocks of Reymert Wash (Middle or early Proterozoic)**

Equigranular, unfoliated, medium to fine grained granite or granodiorite with local marginal aplitic zones. Generally contains 7-10% mica, including both biotite and muscovite, but their relative abundance varies greatly. More muscovite-rich granite appears to have assimilated more Pinal Schist and is generally associated with gradational assimilation zones and broader contact aureoles. The granite near the contacts in this pluton is slightly foliated. West of Reymert Wash, this phase contains abundant partially digested inclusions of Pinal Schist

YXha **Hornblendite of Alamo Canyon (Early or middle Proterozoic)**

Fine to coarse grained hornblendite, consisting of 70-90% hornblende with anhedral plagioclase, and common secondary(?) epidote. Rock is black. Interpreted to be related to Madera Superunit based on proximity to granitic rocks of Reymert Wash

Xrcm **Mafic(?) phase, dioritic rocks of Rogers Canyon (Early Proterozoic)**

No description given in Peterson (USGS OFR). Compiler's guess is that this is a more mafic phase of a typical Madera superunit pluton

Xrcd **Dioritic rocks of Rogers Canyon (Early Proterozoic)**

Light-gray, mostly medium-grained, biotite-quartz diorite; locally contains abundant epidote

Xaqd **Quartz diorite of Arnett Creek (Early Proterozoic)**

Medium-grained, medium to dark gray, biotite-homblende quartz diorite; subdivision of Madera Diorite made by Keith [1983]. Hornblende is present throughout the unit as blocky or stubby equant crystal clusters. Intrudes Pinal Schist, depositionally overlain by Pioneer Formation. Keith [1983] reports that biotite granodiorite (Xagd) intrudes this unit.

Xagd **Equigranular biotite granodiorite of Arnett Creek (Early Proterozoic)**

Equigranular biotite granodiorite, grain size typically 2-4 mm. Subdivision Madera Diorite made by Keith [1983]. Contains 4-6%, locally up to 20%, biotite. Some phases contain hornblende in elongate prisms. Only locally foliated, especially near contacts with Pinal Schist. Intrudes Pinal Schist Keith [1983] reports that this unit intrudes quartz diorite (Xaqd).

Xlgg **Lost Gulch Quartz Monzonite (Early Proterozoic?)**

Ransome (1903, p. 75-78) gave the name Lost Gulch monzonite to a complex of intrusive rocks cropping out in the vicinity of Lost. Gulch, south of Sleeping Beauty Peak and west of Pinal Creek (pi. 1). Only in the northern part of the area mapped by Ransome (1903, pi. 1) as Lost Gulch monzonite does the rock, which actually is a quartz monzonite, conform to his description. Approximately all the southern half of the area is underlain by Pinal schist, Willow Spring granodiorite, and the rocks of the Precambrian dioritic complex. In the present report, the name Lost Gulch quartz monzonite is applied to the body of quartz monzonite near Lost Gulch and to other bodies of petrographically similar rocks of the same age elsewhere in the district.

The quartz monzonite of the Lost Gulch area forms a roughly triangular outcrop having an extent of a little less than 2 square miles. On the northwest, northeast, and east sides this outcrop is bounded by faults; the south boundary is an intrusive contact -with Pinal schist and its intruded dioritic complex.

Other areas of similar rocks occur 5 miles to the southwest in the Porphyry Mountain area (pl. 1). The largest measures about 1 mile from east to west and about 11/2 miles from north to south. Porphyry Mountain is in the south-central part of this outcrop. Two smaller outcrops, separated by an elongate mass of Willow Spring granodiorite, are about l 1/2 miles southeast of Porphyry Mountain.

The main mass on Porphyry Mountain is a north-westward-trending horst bounded on the west, north, and east sides by normal faults. The south boundary is in part a fault contact with Pinal schist and in part an intrusive contact with the older granodiorite and, younger granite porphyry.

In both the Porphyry Mountain and Lost Gulch areas, there are two widespread textural varieties of the quartz monzonite that were separately mapped (pl. 7 and Peterson, Gilbert, and Quick, 1951, pl. 1). One variety is a porphyritic quartz monzonite composed of large phenocrysts of pale-red orthoclase, 25 to 80 mm long, in a coarse-grained groundmass of quartz, plagioclase, orthoclase, and biotite; the other is quartz monzonite porphyry, composed of large phenocrysts of orthoclase and smaller ones of plagioclase, quartz, and biotite in a fine-grained groundmass of quartz, orthoclase, and a little plagioclase. The contacts between the two varieties are sharp in some places and gradational in others. Quartz monzonite porphyry forms the central part of the Porphyry Mountain mass and is almost surrounded by porphyritic quartz monzonite.

The quartz monzonite porphyry shows considerable variation in texture. For example, in the central part of the Porphyry Mountain mass, phenocrysts compose no more than 25 percent of the rock, and the groundmass is very fine grained and distinct, whereas, near the margin of the mass, the phenocrysts predominate, and the groundmass is fine or medium grained and not readily apparent in every specimen. Thus, the quartz monzonite porphyry is crudely zoned, having relatively few phenocrysts and a very fine groundmass near the center and many more phenocrysts and slightly coarser groundmass near the margins.

In thin section under the microscope, the pale-red feldspar is seen to be microperthitic orthoclase clouded by indeterminate dust like inclusions. A little micro-dine is present in most thin sections. Many of the large orthoclase phenocrysts poikilitically enclose small crystals of oligoclase in a zonal arrangement. Some have round or oval cross-sections and have rims of oligoclase. Titaniferous magnetite, apatite, zircon, and sphene are accessory minerals. Most of the plagioclase is oligoclase, but a little of it is andesine.

The porphyritic quartz monzonite and quartz monzonite porphyry appear to have practically the same mineral composition. They are essentially 30 to 35 percent quartz, 20 to 25 percent orthoclase, 30 percent oligoclase, and about 8 percent biotite. The ground-mass of the porphyritic quartz monzonite ranges in grain size from 2 to 10 mm, whereas that of the quartz monzonite porphyry ranges from 0.1 to 0.8 mm; the most common range is from 0.2 to 0.4 mm. '

The original biotite of the quartz monzonite occurs as dark-brown subhedral books; but in the southern part of the Porphyry Mountain mass, much of it is recrystallized to aggregates of small biotite plates, a few being intergrown with muscovite. The aggregates are about the same size (2.5 to 8 mm in diameter) as the books. They have about the same distribution in the rock, and, like the books, invariably they are associated with small crystals of apatite, magnetite, and sphene. Thin sections show various stages in the change from books to aggregates; some aggregates have cores composed of remnants of the original books surrounded by numerous small biotite crystals having random orientations. From some biotite aggregates, small trains of tiny biotite crystals extend as much as 2.5 mm into the surrounding quartz and feldspar. In the quartz monzonite near some of its contacts with granite porphyry, aggregates of biotite can be seen, and in addition fine-grained biotite is scattered throughout the rock in veinlets that cut through all the other minerals.

The composition of the biotite in books may differ slightly from that in aggregates, but the optical properties of the two are essentially the same. Both show pleochroism in which X is pale olive, and T and Z are light olive brown. The optic angle (2V) ranges from 5° to 20°; and the index of refraction for the slow ray (gamma) ranges between 1.615 and 1.630; the low values tend to be those of the aggregates. Most of the books contain needlelike rutile inclusions oriented in 3 directions at 60° in the basal plane (001). Such inclusions have not been seen in the aggregates.

The cause of the recrystallization of the biotite is uncertain. Secondary biotite very similar to that in the Lost Gulch quartz monzonite has been described by various authors as a product of hydrothermal alteration associated with formation of mineral deposits. Hydrothermal alteration related to disseminated copper deposits is widespread in the quartz monzonite in both the Lost Gulch and Porphyry Mountain areas, and appears to be the most probable cause of the recrystallization. However, biotite is recrystallized in some specimens of the quartz monzonite that show no other evidence of hydrothermal alteration; and the distribution of aggregate biotite does not conform with the zoning pattern in the hypogene copper mineralization or associated hydrothermal alteration (Peterson, Gilbert, and Quick, 1951, p. 26-27), although it is limited entirely to mineralized areas. Furthermore, both types of biotite are similarly affected by hydrothermal alteration. The recrystallization of biotite may be a metamorphic effect produced by the intrusion of the granite porphyry bodies for it appears to be most complete in their vicinity. Near Gold Gulch, in the southern part of the Porphyry Mountain mass, all the biotite of the quartz monzonite occurs as aggregates, although the biotite in the granodiorite and granite porphyry in that area has not been recrystallized. The aggregate biotite decreases in abundance toward the north and is absent in the rock north of Porphyry Mountain. If the source of the quartz monzonite was south of Porphyry Mountain, as is likely, the recrystallization of biotite may be a deuteric change.

Dikes and small masses that range from aplite to alaskite porphyry have been intruded into both varieties of quartz monzonite and are most abundant near contacts between the two. The aplite is fine to medium grained and is nearly equigranular. It is composed of orthoclase, oligoclase, quartz, and, in some places, a little Muscovite or biotite. The alaskite porphyry has approximately the same texture and mineral composition, but it contains a few phenocrysts. Most of the phenocrysts are oligoclase and quartz, but there are some large phenocrysts of orthoclase and smaller ones of biotite. Except that it has fewer phenocrysts and biotite is less abundant, the alaskite porphyry is not clearly distinct from the quartz monzonite porphyry; and in some places the two are gradational.

Next to the fault that forms the northwest boundary of the mass of Lost Gulch quartz monzonite-southeast of Sleeping Beauty Peak, a relatively large outcrop of aplite appears to grade perfectly into the surrounding quartz monzonite porphyry. The central part of the outcrop is fine grained and contains no phenocrysts, but toward the margin, phenocrysts become progressively more abundant. Although the fine-grained aplite looks exactly like and contains the minerals of the groundmass of the quartz monzonite porphyry, thin sections show that it also contains muscovite.

No dikes or masses of pegmatite related to the quartz monzonite have been recognized. Although pegmatites are numerous in the two small outcrops of quartz monzonite south of Porphyry Mountain, they also intrude the younger Schultze granite, to which they probably are related.

Little is certain about the manner of intrusion and original shape of the quartz monzonite masses. The present rectilinear outcrop pattern of the Porphyry Mountain mass may not indicate the original shape of the mass, for the mass is now limited to a horst trending in a north-northwest direction. Diabase was later intruded along the east and west boundary faults of the horst and also along the north side of the outcrop, so that the quartz monzonite is now nearly surrounded by younger diabase. Part of the original roof of the complex remains north of Porphyry Mountain, where gently tilted beds of the Apache group cover the quartz monzonite (p. 58). Along the northern part of the west side of the complex, the original contact also remains, but there it is steep, although concordant. In Gold Gulch, west of Porphyry Mountain, quartz monzonite is in discordant intrusive contact with a small block of Pioneer formation; and south of Porphyry Mountain it is intruded into the granodiorite of Gold Gulch and Pinal schist along contacts dipping steeply southward. The steep contacts at the south and the concordant, gently-dipping roof to the north suggest that the quartz monzonite was intruded from a channel near and south of Porphyry Mountain and spread northward beneath the Scanlan conglomerate of the Apache group as a thick sill. The intrusion was a multiple process and consisted of intrusion of the porphyritic quartz monzonite phase, which was followed by that of the quartz monzonite-porphyry phase and later by injection of dikes of alaskite porphyry and aplite. The main mass of quartz monzonite porphyry is centered around Porphyry Mountain and, except where it has been intruded by younger diabase east of Porphyry Mountain, is surrounded by porphyritic quartz monzonite and older rocks. The original porphyry mass could not have been much larger than that now exposed, and it may be described as a chonolith, or irregular stock, within the quartz monzonite complex. Its southern contact has a steep southward dip outward from the center of the intrusion. The relation to the topography of many other parts of the contact suggests that the contact generally dips outward from the center, but because of its irregularity and the complications introduced by later faulting, the actual attitude of the contact is uncertain.

The locus of several intrusions was south of Porphyry Mountain and north of the Pinal schist exposed there. The first, a mass of granodiorite elongated in a general east direction, was intruded along what is now the north boundary of the schist in Gold Gulch. Later, both porphyritic quartz monzonite and quartz monzonite porphyry were intruded north and west of the granodiorite, and, although both of these rocks extend for more than a mile to the north, at least the intrusion of quartz monzonite porphyry seems to have been centered near the southern end of the area. Still later, the dikes and small bodies of granite porphyry, elongated and a lined in a general eastern direction, were intruded along the northern boundary of the granodiorite and into the adjacent quartz monzonite and diabase. Because this has been a zone of repeated intrusive activity, it seems likely that the connection of the quartz monzonite with its deep-seated magma reservoir is in this area. If so, the mass of porphyritic quartz monzonite north of Porphyry Mountain, which was intruded concordantly beneath the Scanlan conglomerate, is probably a sill at least 500 .feet thick that was fed by a discordant root near or south of Porphyry Mountain.

Less can be surmised concerning the manner of intrusion of the quartz monzonite complex in the Lost Gulch area. The main mass is not in contact with any of the younger sedimentary rocks except along the faults that form its northwest, northeast, and east boundaries. However, inclusions that are probably from the Scanlan conglomerate have been found at one place near the middle of the south boundary. The southern boundary is a steep intrusive contact with the Pinal schist and the rocks of the early Precambrian dioritic complex which intrude the schist. As in the Porphyry Mountain mass, a line of granite porphyry bodies trending generally eastward occur in the southern part of the outcrop in the Lost Gulch area roughly parallel to the south contact.

A block of quartz monzonite 1,600 feet northeast of the fault that forms the northeast boundary of the outcrop is overlain by small remnants of Pioneer formation. The block is completely surrounded by diabase, and it is uncertain whether the rock should be correlated with the Lost Gulch quartz monzonite or with the Ruin granite. The remnants of Pioneer formation are underlain by a thin layer of arkose, but no typical Scanlan conglomerate is present, and the arkose does not show the usual evidence of metamorphism resulting from the intrusion of quartz monzonitc
beneath it.

The steep intrusive contact with the lower Precambrian rocks along the south boundary is the only
suggestion that the quartz monzonite at Lost Gulch may have been intruded in much the same manner a;
the Porphyry Mountain mass. The two main out crops may even be continuous under the cover of younger formations that separate them. A line connecting the southern boundaries of the two outcrops strikes east northeast, the general trend of the zone that was the (locus of several igneous intrusions in the Globe-Miami
district).

The Lost Gulch quartz monzonite is clearly younger than the upper Precambrian rocks of the Apache group The rocks of the Apache group have been metamorphosed near their contacts with the quartz monzonite and a discordant intrusive contact between quartz monzonite and the Pioneer formation is exposed in Gold Gulch west of Porphyry Mountain. Blocks of the granitic arkose below the Scanlan conglomerate are included in the quartz monzonite, and inclusions that are probably from the Scanlan conglomerate have been found in the southern part of the mass in the Lost Gulch area. The only contact between quartz monzonite and Paleozoic rocks is along a fault near the north end of the mass at Lost Gulch, and it seems unlikely that such an intrusion occurred during the Paleozoic era.

The quartz monzonite has been intruded by diabase and by granite porphyry that is younger than the diabase (p. 36). The two small masses 11/2 miles south of Porphyry Mountain intrude Willow Spring granodiorite but are intruded by Schultze granite.
Therefore, the Lost Gulch quartz monzonite is younger than the rocks of the Apache group and the Willow Spring granodiorite but is older than the diabase, Schultze granite and granite porphyry. It could be of Paleozoic, Mesozoic, or early Tertiary age; however, since no intrusions of Paleozoic age have as yet been recognized anywhere in Arizona, it is tentatively regarded as one of the earlier intrusions that accompanied the Late Cretaceous or early Tertiary orogeny. Ransome (1919, p. 51-52) suggested early Mesozoic(?) age for the Lost Gulch quartz monzonite.

Xwsg Willow Spring granodiorite (Early Proterozoic?)

Ransome (1903, p. 78) gave the name Willow Spring granite to a small body of intrusive rock that crops out in Willow Spring Gulch, 1 1/2 miles west of Inspiration post office. A much larger body of similar rock crops at a mile to the northeast in the vicinity of Lost Gulch. This outcrop has an area of about a square mile, whereas the area of the outcrop in Willow Spring Gulch is less than a quarter of a square mile. Both areas are roughly oval in shape, but that in Willow Spring Gulch is partly bounded by faults. A third body crops out along the north side of Cottonwood Gulch 1 1/4 miles southeast of Porphyry Mountain.

Its outcrop has maximum dimensions of about 1,500 feet by 7,000 feet and is elongated northeastward. All three outcrops are on a line that trends east-northeast.

The rocks of the major part of each of the three intrusive bodies are lithologically and petrographically identical, and this is the sole basis for their correlation.

Except for a granite border facies described later, the rock is actually a biotite granodiorite porphyry rather than a granite. The fine-grained groundmass is composed of quartz, feldspar, and finely disseminated biotite that gives the rock a uniform medium-gray color. The most conspicuous phenocrysts are large crystals of orthoclase, most are 10 to 30 mm long. Some are rounded and have rims of plagioclase. Smaller phenocrysts of quartz, biotite, and plagioclase are 4 to 10 mm in diameter. The groundmass is uniform, but the number and relative proportions of the various phenocrystic minerals differ greatly from place to place. The proportion of orthoclase phenocrysts is the most variable; they generally form 5 to 15 percent of the rock. Where orthoclase phenocrysts are most abundant, the rock probably has the composition of quartz monzonite.

Thin sections show the groundmass to be of zoned oligoclase, quartz, microcline, orthoclase, and biotite in grains averaging about 0.4 mm in diameter. Almost two-thirds of the feldspar is oligoclase. The accessory minerals are apatite, magnetite, and sphene.

The granodiorite porphyry weathers rapidly. The deeply decomposed outcrops occupy basin like areas surrounded by ridges of the more resistant formations.

A rock believed to be a younger intrusion of the Willow Spring granodiorite intrusions occurs in the Willow Spring Gulch and Lost Gulch areas. It is clearly a separate intrusion that was injected along the borders of the two granodiorite masses and does not completely surround either. It is not present in the Cottonwood Gulch area.

The contacts between the older and younger intrusions are irregular but sharp and generally appear to dip outward from the centers of the outcrops. Along the northeast side of the Lost Gulch mass, the border intrusion overlies the granodiorite porphyry like a roof, and the contact dips very gently. In several places along the south and east sides of the Lost Gulch outcrop, the two intrusions are separated by tongues of schist. Many small inclusions of schist occur in the granodiorite porphyry, but they are most numerous near its contact with the border facies. In a few places, the border facies contains small inclusions of granodiorite.

The border facies is a biotite-muscovite granite. It is light gray to pinkish gray and fine grained and appears to be almost equigranular. The minerals distinguishable with the aid of a hand lens are quartz, feldspar, biotite, and Muscovite.

In thin sections, microcline, orthoclase, and quartz, in grains averaging about 0.5 mm in diameter, are the predominating minerals. Microcline and orthoclase compose 40 to 50 percent of the section, and oligoclase less than 15 percent. Muscovite occurs as large plates, the biotite as small ragged flakes. Apatite and magnetite are very sparse.

The Willow Spring granodiorite and granite border fades intrude only the Final schist and its intruded lower Precambrian dioritic complex. In the Cotton-wood Gulch area, the body of the Willow Spring granodiorite lies between two bodies of Lost Gulch quartz monzonite. Its contacts with the two are sharp, but the quartz monzonite includes numerous blocks of what seems to be granodiorite. Although the blocks cannot be definitely identified as granodiorite, the dikelike tongues of quartz monzonite that extend into the granodiorite at several places along its northern border strongly suggest that the quartz monzonite was intruded between the schist and the granodiorite body. Near the southwestern end of its outcrop, the granodiorite is intruded by Schultze granite, which also intrudes the quartz monzonite. This relationship is clear because many thin dikes of Schultze granite extend into the Willow Spring granodiorite.

South of the outcrop at Lost Gulch, a fault that displaces the Pioneer formation and diabase can be followed to within a hundred feet of the contact of the granite border facies of the Willow Spring granodiorite with the schist, but the contact does not appear to be displaced. If this criterion could be relied on, it would indicate that the granite border at least is younger than the diabase and the rocks of the Apache group. However, the actual intersection of the fault with the contact between the granite and schist has not been seen, and the throw of the fault need not have exceeded 100 feet.

On its northeastern side, the Willow Spring Gulch mass is in contact with diabase along a fault that displaces dacite, whereas the fault to the south of the outcrop is older than the dacite.

No fragments of the Willow Spring granodiorite or of its border facies have yet been found in the Scanlan conglomerate that crops out in several places near the south boundary of the Lost Gulch mass.

Thus the Willow Spring granodiorite and its border granite facies are probably older than the Lost Gulch quartz monzonite and Schultze granite. On the basis of the very meager and uncertain evidence presented by the relationships of the two faults and on the absence of fragments from the Willow Spring in the Scanlan conglomerate, it may be younger than the rocks of the Apache group and the diabase.

Xgs

Sunflower Granite (Early Proterozoic)

Granite

Xgc

Granitoid of Continental Mountain,Verde River Granite? (Early Proterozoic)

Leucocratic, pink-weathering, medium-grained, equigranular to slightly K-spar porphyritic quartz monzonite. This pluton is completely post-kinematic with respect to the host rocks in the area, but it is considered early Proterozoic because of its similarity to the Verde Valley granites of the easterly adjacent Humboldt Mt. quadrangle (Gilbert and others, 1998), and other granitoids of this map area (Grays Gulch) which are clearly concordant with respect to bedding

Xbg

Beeline 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.

Xpcg

Porphyritic quartz monzonite of Picadilla Creek (early Proterozoic)

Same composition as Beeline Granite 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 Beeline Granite.

Xmmg **Granitoid of Mine Mountain (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. This unit includes several equant to NE-elongate plutons within the Beeline quartz monzonite and along its SE margin.

Xgg **Granitoid of Grays Gulch (Early Proterozoic?)**

K-spar porphyritic, pink weathering quartz monzonite to quartz monzosyenite with abundant xenoliths. This tabular pluton occurs in the north-central part of the map area. It is petrographically more similar to the granitiod of Continental Mountain than to the other nearby, tabular, concordant plutons (Xqp). Because of its concordant, sill-like nature, it is considered to be only slightly younger than its early Proterozoic host rocks

Xccg **Quartz Monzonite of Cave Creek (Early Proterozoic)**

Nonfoliated, fine-grained quartz monzonite. Pluton occurs in the lower Cave Creek drainage basin

Xbbg **Granite of Bloody Basin (Paleoproterozoic)**

Medium- to coarse-grained, undeformed, equigranular to porphyritic leucocratic biotite granite. Included in Verde River red granite batholith of Anderson (1989b). Exposed along Skeleton Ridge, and along Verde Rim.
Alkali granite to granite is predominantly alkali-calcic, mildly peraluminous, very sodic to sodic, and very Fe rich. Age undetermined but presumed to be about 1,700 Ma, because of chemical similarity to both Payson Granite (Ed DeWitt, unpub. data, 1998) and Early Proterozoic metarhyolite beneath the Mazatzal Peak Formation.

Xgbc **Granitic rocks in Bronco Creek (Early Proterozoic)**

This coarse-grained K-feldspar porphyritic granite contains pink to gray subhedral phenocrysts of K-feldspar 1 cm long surrounded by a matrix of quartz, plagioclase, and about 10% biotite and homblende. Outcrops are crumbly and mostly covered with a regolith. Where visible the rock either contains variable amounts of hornblende or there is another, more felsic phase. Biotite is commonly slightly altered to hematite, and gives the rock a rusty spotted appearance. At first glance this rock looks very similar to the more felsic varieties of diorite (map unit Xd). The hematite and grussy regolith of Xgbc help to distinguish it from the former. This unit is locally foliated, though measuring foliation on crumbly exposures is difficult. The unit is in sharp contact with rhyolite (map unit Xr) and diorite (map unit Xd) where it cross-cuts the contact between those two units. Fine-grained, pale orange leucocratic dikes are abundant and may be map unit Ygm. Spencer and Richard (1999) identified this unit in the southwest comer of the Theodore Roosevelt quadrangle where it apparently is exposed in an area of only about 1 mi2

Xgb **Diorite-gabbro phase of Granitic rocks in the Mills Canyon area**

[name from Spencer and Richard, 1999] This medium- to locally coarse grained, equigranular mafic intrusive rock contains about 50-60% subhedral plagioclase phenocrysts and about 40-50% dark green, subhedral hornblende phenocrysts, both 2-7 mm wide. The only outcrop of this unit is exposed on the eastern edge of the map where if forms a small oval body within the slightly more felsic variety of map unit Xd. The contact is sharp, but the rock looks almost identical to the mafic variety of the diorite exposed at Buckhon Mountain. Spencer and Richard (1999) identified this unit to the east in the Theodore Roosevelt quadrangle.

Xgf **Fine-grained granitic dikes (Early Proterozoic)**

Dikes associated with the fine-grained quartz monzonite pluton (Xgd). The dikes cut both adjacent country rocks and the pluton

Xqp **Quartz porphyry (Early Proterozoic)**

Dark-colored, nonfoliated, concordant sills of quartz porphyry. Porphyry contains phenocrysts of plagioclase and biotite, ?????

Xug **Usery granite (Early Proterozoic)**

Dark steel grey mostly medium-grained granite/quartz monzonite containing 1-10 mm wide subhedral phenocrysts of white plagioclase, abundant dark green felty masses of biotite, grey to light pink K-feldspar, and about 5%-10% milky grey quartz. The rock is locally K-feldspar porphyritic, with K-feldspar phenocrysts up to 15-20 mm across. Large green-yellow sphene crystals are locally visible in hand samples. Locally, the rock is very strongly foliated and lineated, and is mylonitic. In most areas the rock contains rounded, 2-20 cm wide xenoliths of fine-grained, dark green amphibole(?)-feldspar-quartz-biotite. This granitoid forms steep, resistant, boulder-covered hills at Arizona Dam Butte and the west end of the Usery and Goldfield Mountains. Where foliated the rock is less resistant and forms low hills. Although this rock has been compared to the Ruin Granite to the east, the two are mineralogically different.

Xbcg **Granitoid of Bulldog Canyon (Early Proterozoic)**

fine to medium-grained sparsely K-feldspar porphyritic granitoid

Xbmg **Boulder Mountain Granophyre (Early Proterozoic)**

This rock contains anhedral to subhedral 1-5 mm phenocrysts (about 5% of rock) of light grey feldspar, dark green to black biotite, and minor clear-grey quartz, all in a light tan, micro-crystalline, granular matrix of feldspar and quartz. Biotite is mostly altered to chlorite. Plagioclase is partly altered to sericite. In one thin section containing K-feldspar and plagioclase phenocrysts, the opaque minerals are rimmed by a high relief mineral with birefringence similar to titanite/sphene. In another thin section microcline phenocrysts are more abundant than plagioclase and the opaques are not rimmed. Zircon is common in all rocks. The unit exhibits a pervasive, but weak, foliation defined by alignment of biotite crystals. Locally, foliation is defined by alignment of dark green lenticular colorations in the rock. The colorations are a few millimeters to a centimeter thick across the small axis, and from 1-20 cm long (good exposures are along the trail east of Edwards Park). There is no apparent difference in mineralogy between the colorations and the host rock, though superficially, they resemble fiamme. The contact between Xgr and Xf is sharp. Grain size in both units remains constant up to the contact. The contact between Xg and Xf is also sharp. Grain size is constant as well, except near Mud Spring where Xg is finer-grained and only marginally porphyritic. To the east in the Tonto Basin quadrangle this rock is intruded by quartz-feldspar porphyry dikes (not mapped). Locally, the rock contains dark oval inclusions 1-40 cm wide composed of fine-grained biotite, and others of unknown original composition altered to epidote. Muscovite is locally common on fracture surfaces. It occurs as masses of intergrown anhedral to subhedral crystals up to 3 mm long. Less common on fracture surfaces are rectangular hematite crystals up to 3-4 mm long

Xsme **Equigranular coarse-grained granite of Stewart Mountain (Early Proterozoic)**

Medium- to coarse-grained, equigranular to slightly K-feldspar porphyritic. Contains milky grey to clear quartz, light grey plagioclase, medium grey K-feldspar, and biotite (all subhedral). The rock also contains rounded xenoliths of fine-grained biotite, quartz and feldspar. Weathers into spheroidal boulders and sand-sized gruss. Mineralogically, this rock resembles the coarse grained granite (Xsmg). Foliation is very weak to non-existent. This unit may be a phase of Xsmg. Intrudes diorite (map unit Xsmd).

Xsmd **Diorite of Stewart Mountain (Early Proterozoic)**

Dark grey-green, medium- to slightly coarse-grained, equigranular plutonic rock, ranging from diorite to quartz diorite. Contains light grey plagioclase, minor K-feldspar and quartz, abundant dark green biotite partially altered to chlorite, and minor hornblende. This unit forms angular to rounded boulders that are very difficult to break. Forms resistant outcrops west of Stewart Mountain Dam. Intrudes map unit metarhyolite of Saguaro Lake (Xslr) and intruded by map unit Xsme.

Xsmg **Stewart Mountain Granite (Early Proterozoic)**

This porphyritic coarse-grained granite contains 1-3 cm long blue-grey K-feldspar phenocrysts in a matrix of anhedral to subhedral 2-15 mm wide phenocrysts of light grey plagioclase, clear-grey to milky blue-grey quartz, and felty masses of biotite. Plagioclase locally appears chalky-white compared to blue-grey K-feldspar. Sphene is visible locally. 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. In the south-central part of the study area, the rock south of the fault cutting through the granite is extensively altered to hematite. Locally, 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 between foliated and weakly to non-foliated zones. In the Stewart Mountain quadrangle foliation is pervasive, and very strong on the south side of the Salt River. The unit is locally cut by lighter-colored, fine-grained, foliated granitic dikes. Xgc correlates with the granite at Arizona Dam Butte, west of the study area, and, in general, grain-size increases from west to east.

Xpmg **Granitoid of Pass Mountain (Early Proterozoic)**

medium grained granitoid.

Xecg **Porphyritic granite of East Cedar Mountain (Early Proterozoic?)**

Brown, coarse-grained, weakly porphyritic, biotite-hornblende granite on east slope of East Cedar Mountain, west of Verde River. Contains euhedral, blocky alkali feldspar phenocrysts. Has higher color index than associated Payson granite (Xdpg). Age relation to Payson Granite unknown

Xi **Leucocratic granite dikes (Early Proterozoic)**

These dikes contain anhedral to subhedral 1-3 mm phenocrysts of light grey feldspar, clear quartz, and minor biotite mostly altered to hematite. Locally, K-feldspar crystals are up to 1.5 cm long. The rocks are foliated and forms resistant, light-colored ridges within the quartz monzonite they intrude. Most of the dikes strike northeast.

Xg **Equigranular granite**

Pink- to orange-weathering, coarse-grained, equigranular granite. Underlies extensive terrane in eastern part of the quadrangle and forms small stocks in southwest part of the quadrangle. Correlates with the Verde Valley Granite of Anderson (1989).

Xd **Dacite porphyry (Early Proterozoic)**

Pink- to lavender-weathering, lavender to medium gray dacite in northeast part of map area. Commonly porphyritic with coarse-grained phenocrysts of quartz and plagioclase (20-50%) set in a fine-grained to aphanitic groundmass, but locally fine-grained

Map Unit Explanation

Legend: Map Units for Tonto National Forest Geology

Xgd **Granodiorite porphyry (Early Proterozoic)**

Granodiorite porphyry (Early Proterozoic)

Xga **Aplitic granite**

This fine-grained felsic rock contains phenocrysts of anhedral to subhedral pink K-feldspar and gray quartz 1-2 mm wide. Contains very minor biotite. The rock is very difficult to break. Weathered surfaces are dark pink to orange and break into angular pieces. Fresh surfaces are dark pink and glassy, breaking with almost concoidal fractures. This rock is exposed in the southeast comer of the map area where it forms a long, dike-like band intruding diorite (map unit Xd). Where observed, contacts with the diorite are sharp

Xdd **Diorite (Early Proterozoic)**

Medium greenish-gray, medium-grained, equigranular to slightly porphyritic, unfoliated diorite intrusion in the Alder Group. Composed of greenschist-facies minerals, albite, chlorite, and epidote and minor hornblende, augite, quartz, and potassium feldspar

Xh **Hornblendite (Early Proterozoic)**

Hornblendite Medium- to coarse-grained hornblende-porphyritic diorite or gabbro. Hornblende phenocrysts comprising up to 75% of the rock are suspended in a fine- to medium-grained matrix of plagioclase. The rock is locally weakly foliated, but the foliation does not appear to be tectonic in origin

Cherry Creek Batholith (Paleoproterozoic)

Dioritic to granitic rocks

Xbt **Bland Tonalite (Paleoproterozoic)**

Screens and inclusions of fine-grained diorite or metabasite form <2% of the unit. The tonalite is massive to heterogeneously foliated, grading to quartz-feldspar-sericite-chlorite schist in high-strain zones. Many of the high-strain zones coincide with concentrations of screens. The tonalite is slightly more leucocratic to the southwest (5-15% mafics) and in some areas may grade into granodiorite.

Xbd **Diorite (Paleoproterozoic)**

Fine- to medium-grained weakly foliated to non-foliated diorite, small lenticular bodies spatially associated with Bland Tonalite.

Xlsl **Leucogranite of Little Squaw Creek (Paleoproterozoic)**

Fine- to medium-grained leucogranite containing less than 5% biotite. Appears to be phase of Bland Tonalite body in Little Squaw Creek.

Xbsg **Bishop Spring granodiorite (Paleoproterozoic)**

Medium-grained, equigranular biotite granodiorite. Undeformed to moderately foliated. Newly named herein for exposures along Bishop Creek, north of Rugged Mesa, in southeastern part of map area.
Granodiorite is calcic, metaluminous to mildly peraluminous, very sodic, and Mg rich to average in Fe/Mg ratio. Early Proterozoic age determined from Pb-Pb whole rock isotopic composition (Bryant and others, 1994). From DeWitt et al., Prescott NF (USGS map 2996, 2008).

Xbgd **Badger Spring Granodiorite (Early Proterozoic)**

Medium-grained, porphyritic leucocratic biotite granodiorite containing distinctive phenocrysts of quartz (Anderson and Blacet, 1972c). Exposed from north of Cordes Junction to canyon of Agua Fria River at far southern margin of map area. Undeformed in most exposures. Cuts Bland Tonalite (named unit Xbt).
Granodiorite is calcic, mildly peraluminous, very sodic, and average in Fe/Mg ratio. Early Proterozoic age determined from Pb-Pb whole rock isotopic composition (Wooden and DeWitt, 1991). Age about 1,740 Ma (S.A. Bowring, unpub. U-Pb zircon data, cited in Karlstrom and others, 1987)

Xcfg **Gabbro of Cornstalk Flat (Paleoproterozoic)**

Medium- to coarse-grained, equigranular, hornblende-rich gabbro-norite, gabbro, and gabbro-diorite. Undeformed and only mildly metamorphosed in Black Hills Unit mapped on USGS map 2996, no description provided; name proposed here for this particular body.

Xct **Cherry Tonalite (Early Proterozoic)**

Medium- to medium-coarse-grained hornblende-biotite diorite to granodiorite containing phenocrysts of hornblende (Anderson and Creasey, 1967). Includes tonalite of Cherry (DeWitt, 1989), and part of Cherry batholith (Anderson, 1989a). Newly named herein for exposures near Cherry. Type area is designated where main mass exposed from north of Cherry to far southeastern part of map area. Smaller bodies exposed along east side of Lonesome Valley. Prominent north-trending zone of high magnetic intensity along eastern Lonesome Valley probably marks western contact of Cherry Tonalite with metavolcanic rocks (Langenheim and others, 2002). Most mafic along western margin of main mass and in southern Lonesome Valley. Exposed in erosional highs beneath Tertiary basalt from Interstate 17 to southern margin of map area. Cuts Bishop Spring Granodiorite (unit Xbsg) northwest of Rugged Mesa. Cuts Bland Tonalite (newly named, unit Xbt) east of Perry Mesa and south of map area, along Squaw Creek. Undeformed in most outcrops, but mildly to strongly flow foliated in places. Strongly deformed along Shylock fault and Shylock high-strain zone in southwestern Black Hills. Hosts gold-bearing quartz veins in Cherry district that are genetically related to the tonalite (Clements, 1991).
Chemically is calc-alkalic, sodic to very sodic, and very Mg rich to Fe rich.

Age of sample from near Cherry, from U-Pb zircon analyses, is 1,740 Ma (Anderson and others, 1971). K-Ar hornblende dates of 1,694 and 1,690 Ma obtained from samples near Cherry (Lanphere, 1968; Dalrymple and Lanphere, 1971). 40Ar/39Ar total fusion date of 1,709 Ma obtained from one hornblende (Dalrymple and Lanphere, 1971). K-Ar biotite dates of 1,689–1,693 Ma also obtained from same samples. Conflicting age (cuts 1,720-Ma Bland Tonalite but has U-Pb zircon age of 1,740 Ma) may be due to more than one tonalite body within a composite pluton (Anderson, 1989a)

Xtp **Porphyritic leucogranite (Paleoproterozoic)**

Quartz and potassium feldspar porphyritic, fine-grained leucogranite matrix porphyry.

Proterozoic supracrustal rocks

Generally low to medium grade metavolcanic and metasedimentary rocks of Early Proterozoic age

Xbms **Schist of Southern Bradshaw Mountains (Paleoproterozoic)**

Quartz-sericite schist, chloritic schist, and amphibolite schist, locally including zones of ferruginous chert, rusty calcareous schist and marble. Only outcrops along west side of Black Canyon in extreme NW part of compilation area

Xmgs **Schist of Moore Gulch (Paleoproterozoic)**

Lithologically similar to schist of southern Bradshaw Mountains. Relationship to that unit uncertain.

Xpbc **Brooklyn Peak conglomerate**

Conglomerate , contains boulders of horblende-biotite tonalite

Xbps **metavolcanic and metasedimentary rocks of Brooklyn Peak**

felsic tuff, conglomerate, and volcaniclastic rocks

Xnrf **Felsic metavolcanic rocks of New River Mountains (Paleoproterozoic)**

Porphyritic rhyolite and rhyodacite.

Xnrh **Hypabyssal rhyolitic rocks of New River Mountains complex**

Massive intrusive rhyolitic rocks

Xl **Limestone**

Northwest of Humbolt Mountain the Xsc unit is interbedded with beds of lavender to white limestone (Xl).

Xcm **Mudstone**

Interbeds of olive-green mudstone within Xcg.

Xqmc **Quartzite of Malpais Canyon (Early Proterozoic)**

Dark bluish-gray massive quartzite. Isoclinally folded bands probably represent relict bedding. Individual pendants and swarms of pendants in Early or Middle Proterozoic granitoids in the Edwards Peak, Boulder Mountain, Granite Mountain strip

Xhmr **Rhyolite of Herder Mountain (Early Proterozoic)**

Fine-grained metamorphosed rhyolite. This rock contains about 5-10% phenocrysts of quartz and feldspar in a pink to tan aphanitic to sericitic matrix. The unit commonly shows contorted to relatively laminar flow-banding. Stretched pumice clasts and blocks are visible locally. In places near the contact with the quartzite the rhyolite is deformed into a gneiss (mapped separately as Xgu). Contacts with Yg are sharp

Proterozoic supracrustal rocks of southern Mazatzal Mountains

Proterozoic supracrustal rocks of southern Mazatzal Mountains, Red Rock group and associated units

Xmu **Mazatzal Group, undivided (Early Proterozoic)**

Light- to dark-purplish red-brown, medium- to coarse-grained, locally pebbly quartzite in upper part of Pine Creek, at the northeastern corner of the area-Medium- bedded and cross-bedded. Grades through a few meters into underlying conglomerate (Xrc). Contains a layer of rhyolite ash-flow tuff (Xrr) in upper Pine Creek. A small exposure of quartzite in the extreme southeastern part of the area adjacent to Highway 89 may be equivalent. Likely corresponds Co Mazatzal Peak Quartzite (Xmpw, Xmpr) and (or) Deadman Quartzite (Xmd) of Mazatzal Mountains. Thickness about 1,100 m

Xmpr **Red quartzite member (Early Proterozoic)**

Greenish-gray to reddish-brown, silty and sandy shale and minor sandstone exposed on the western and eastern flanks of the Mazatzal Mountains. Shale consists of 25-40 percent quartz grains, 0.03-0.1 mm across, in a matrix of very fine grained white mica and black to red-brown iron oxides in laminated, thin, hard, weakly fissile beds. Some beds ripple marked. Locally has weak cleavage. Sandstone in planar to cross-laminated beds 1-60 cm thick forms less than 5 percent of the unit. Thickness 120-230 m

Xmm **Maverick Shale (Early Proterozoic)**

Greenish-gray to reddish-brown, silty and sandy shale and minor sandstone exposed on the western and eastern flanks of the Mazatzal Mountains. Shale consists of 25-40 percent quartz grains, 0.03-0.1 mm across, in a matrix of very fine grained white mica and black to red-brown iron oxides in laminated, thin, hard, weakly fissile beds. Some beds ripple marked. Locally has weak cleavage. Sandstone in planar to cross-laminated beds 1-60 cm thick forms less than 5 percent of the unit. Thickness 120-230 m

Xmpw **White quartzite member**

Light-gray or pinkish to white, commonly medium- to coarse-grained, locally gritty, crossbedded quartzite in beds generally 0.2-1 m thick. Crops out in cliffs and steep slopes in high parts of the Mazatzal Mountains. Thickness 320 m, top not exposed

Xmd **Deadman Quartzite (Early Proterozoic)**

Grayish red-purple to reddish-brown, fine- Co medium-grained, crossbedded quartzite Chat crops out on Cactus Ridge and lower slopes of the Mazatzal Mountains. Contains minor amounts of hematitic shale and argillaceous sandstone. Local basal conglomerate 0-7m thick in was consists of angular and subangular pebbles, chiefly of red brown rhyolite. Thickness 24-450m

Xmsq **Silty quartzite (Early Proterozoic)**

Reddish-brown to tan and grayish-green, thin-bedded, fine-grained sandstone, siltstone, and minor shale in upper part of quartzite (Xmu). Thickness about 60 m

Xsdb **Basaltic rocks of South Fork of Deadman Creek (Early Proterozoic)**

Basaltic rocks apparently intruding Mazatzal Quartzite between the south fork of Deadman Creek and upper Davenport Wash.

Xr **Rhyolite pendants (Early Proterozoic)**

Fine-grained metamorphosed rhyolite. This rock contains about 5-10% phenocrysts of quartz and feldspar in a pink to tan aphanitic to sericitic matrix. The unit commonly shows contorted to relatively laminar flow-banding. Stretched pumice clasts and blocks are visible locally. In places near the contact with the quartzite the rhyolite is deformed into a gneiss (mapped separately as Xgu). Contacts with Yg are sharp. Forms swarm of pendants in SE part of Carefree granite pluton

Xdpm **Pine Mountain Porphyry (Early Proterozoic)**

Gray to tan, porphyritic to aphyric, foliated rhyodacite to rhyolite in sill complex emplaced in strata of the upper part of the Alder Group. Phenocrysts are quartz, sodic oligoclase, and minor potassium feldspar and altered biotite in a quartz-feldspar to quartz-sericite groundmass. Foliation pronounced at margins. Main sill is 650 m thick; satellitic sills are 0-40 m thick

Xt **Rhyolitic ash-flow tuff (Early Proterozoic)**

Meta-rhyolite containing fragments of slate and mafic rocks up to 10 cm that is stratigraphically below the Houdon Formation. Considered by Wessels (1990) to be older and unrelated to the Red Rock rhyolite and correlated by him with the Flying W formation of Gastil (1958)

Xme **Melange (Early Proterozoic)**

Blocks of carbonate and siltstone in a disrupted slate matrix that "is spatially associated with, and contains components of, the Bread Pan Formation" (Wessels, 1990). Cross-bedded quartz-arenite lenses and beds (his map unit BPq = Bread Pan formation quartzite) are shown by Wessels within this unit. Wessels (1990, p. 18) proposes an origin by "intense tectonic transposition" but notes that Roller (1986) "suggested that the unit may also have resulted from soft sediment deformation." Wessels applied the name "mélange" to this unit but considered the term to be "non-genetic"

Xpb **Pillow basalt and chert complex (Early Proterozoic)**

Pillow basalts, amygdaloidal basalt lava flows, chert, and volcanic-lithic breccias and metasedimentary rocks (Wessels, 1990). Inferred top direction in the pillow basalts, based on the "downward protruding lobes" of the pillows, is to the northwest toward the sheeted dike complex. This relationship, and the presence of a sheared band of granite between the pillow basalt unit and the sheeted dikes, led Wessels (1990) to infer that the pillow basalt unit is faulted against the sheeted dikes, with a strip of "1.76 Ga granite" sheared between the two as well as intruded by the dikes. Considered by Wessels to be part of the East Verde River Formation

Xsd **Sheeted dike complex (Early Proterozoic)**

Aphanatic mafic dikes with parallel chilled margins and sparse granitoid screens between dikes. Dikes typically strike northwest and dip steeply to the west (Wessels, 1990)

Xrr **Red Rock rhyolite (Early Proterozoic)**

Described by Ludwig (1974) as welded vitric (now devitrified) and lithic tuffs, volcanic breccias, flows, and possibly intrusions, of rhyolitic and rhyodacitic composition. Rocks of this map unit are exposed in the core of the Red Rock syncline where they overlie the top of the Alder Group, and in the northwestern corner of the map area where they are in contact with the East Fork member. Ludwig identified a feeder dike to the Red Rock rhyolite in the lower Gold Creek area. Ludwig (1974, p. 72) stated that "the contact [with the East Fork member] itself is not exposed, but appears to be depositional, as no evidence of unusual shearing was detected in the regions giving best exposure near the contact (within 10 to 100 feet)." However, Wrucke and Conway (1987) interpreted this contact as a fault. In the core of the Red Rock syncline,

Ludwig (1974) described the contact between the Red Rock rhyolite and the Telephone Canyon member as conformable but intruded by "mafic sheets" everywhere except at one location where faulting was suspected. In contrast, Wrucke and Conway (1987) considered the "mafic sheets" to be lava flows, and the contacts to be depositional. Roller (1987) described this unit as ash-flow tuffs with minor volcanic breccias and lava flows.
Near the northeast corner of the map area rocks of this unit consist of pink, tan, and light-gray, massive and locally autobrecciated, crystal-poor felsic lava containing up to 10% rectangular, euhedral to subhedral feldspar and biotite phenocrysts. Quartz phenocrysts are rare to absent. Weak and discontinuous compositional layering that could be relict flow banding or flattened fragmental texture. Lensoidal blebs 1-3 mm long could be relict feldspar, small quartz crystals could be secondary (C. Ferguson and J. Spencer, this report). Map units from Reno Pass OFR 04-03

Xfi1 **Intrusive felsic porphyry (Early Proterozoic)**

Non-foliated rhyodacite porphyry sheets and dikes of Ludwig (1974). This unit also includes, at the mouth of Oak Spring Canyon at the east foot of the Mazatzal Mountains, an area of massive, reddish gray to reddish brown to dark reddish brown felsite (it is possible that this unit is extrusive). This felsite has an aphanitic groundmass that contains 1-2%, 1-2 mm quartz phenocrysts and 1-2%, 1-2 mm pink feldspar phenocrysts (S. Richard, this report). Described as unfoliated to slightly foliated, plagioclase porphyritic (1-4 mm), felsite and crystal poor felsite with sparse fine quartz (Wrucke, mazatzal wilderness OFR). Includes feeders to the Red Rock rhyolite and named the Gold Creek intrusives by Ludwig (1974). Considered to be part of the Diamond Rim Intrusive Suite (Wrucke and Conway, 1987; Conway and Silver, 1989).
Tan, pink, and white unfoliated rhyolite and rhyodacite porphyry sills in central units of the Alder Group. Has phenocrysts 1-2 mm. across and an aphanitic groundmass. A few sills have alkali feldspar phenocrysts 0.5-1 cm long and a granular groundmass. Thickness 0-30 m

Xoa **Mt Ord Andesite (Early Proterozoic)**

Massive fine grained andesitic rock

Alder Group (Proterozoic)

Proterozoic sedimentary and volcanic rocks

Xasv **Sedimentary and volcanic rocks of the Alder group (Early Proterozoic)**

Undivided Alder Group. Deformed and metamorphosed sedimentary and volcanic rocks

Xam **Mixed volcanic rocks**

Dark brownish-green, mostly aphyric basalt pillow flows and breccia and porphyritic andesite containing plagioclase phenocrysts in lower one-third of the unit. The breccia has a matrix of coarse-grained gray .calcite. Massive white to lavender phenocryst-poor rhyolite" brown volcanic breccia, white to red chert, and minor mafic volcanic rocks in the upper-two-thirds of the unit. Copper occurrences present in eastern exposures of the unit near Copper Camp Creek. The breccia is chaotic rhyodacite(?) and minor chert in clasts as much as 4 m across. Lenses of the breccia intertongue with overlying shale (Xas). Thickness 400-500 m

Xas **Shale-Purple,**

Laminated to, thin-bedded shale and sparse, thin siltstone or sandstone interbeds. Locally interbedded with volcanic breccia near base of the unit. Thickness 50-300 m

Xs **Psammite and minor phyllite, Alder Group (Early Proterozoic)**

Psammite and minor phyllite (Early Proterozoic)

Xats **Cross-bedded quartzose sandstone, conglomerate, slate, and tuff (Early Proterozoic)**

Cross-bedded quartzose sandstone, conglomerate, slate, and tuff correlated with Telephone Canyon member of Ludwig (1974)

Xav **volcanic sandstone and conglomerate**

Green to purplish-green, massive unsorted, poorly bedded volcanic sandstone and conglomerate. Unit consists largely of immature rhyodacite debris that is credely graded from conglomerate upward intoc sandstone. Has minor interbedded purple shale. Basal one-third of the unit is mostly cong^paerate composed of cobbles, pebbles, and granules of rhyodacite and minor jasper and purple shale. Upper two-thirds of the unit is green sandstone or graywacke. The upper 50-150 m is mottled in green and has a distinctive wavy foliation. Phenoelasts and phenocrysts in clasts are quartz and plagioclase as well as epidote, chlorite, opaque minerals, and quartz pseudomorphic after biotite and possibly hornblende. Thickness 500-1,000 m

Xatq **Quartzite, Telephone Canyon Member (Early Proterozoic)**

Quartzite of Telephone Canyon Member. one marker bed in Gold Creek area

Xatr **Rhyolite lava, tuff, breccia and minor conglomerate, Telephone Canyon Member (Early Proterozoic)**

Rhyolite, tuff, Rhyolite breccia, locally grades into cobble conglomerate

Map Unit Explanation

Legend: Map Units for Tonto National Forest Geology

Xamr **Massive Rhyolite**

Red to brown, massive rhyolite porphyry 1.6 km northwest of Lion Mountain. Contains small sparse quartz and feldspar phenocrysts in fine, sugary groundmass. May be part of the Alder Group or .may be intrusive sericite, magnetite, hematite, epidote, chlorine, blue green amphibole, and rare zircon. Sericite, epidote, chlorite, andamphibole are metamorphic minerals. Mafic clasts are difficult to identify because of metomorphic modification. Thickness about 2,500m
Thickness about 2,500

Xaon **Oneida Member, Tuff, tuff-breccia, and conglomerate (Early Proterozoic)**

Tuff, tuff-breccia, and conglomerate (Early Proterozoic)

Xpef **Phyllitic sedimentary rock, East Fork member, Alder Group (Early Proterozoic)**

Phyllitic sedimentary rock

Xqef **Quartzite, East Fork Member, Alder Group (Early Proterozoic)**

Quartzite

Xpwf **West Fork Member, Alder Group (Early Proterozoic)**

Phyllitic sedimentary rocks

Xass **Fine-grained metasedimentary rocks, West Fork Member (Early Proterozoic)**

Purple to maroon, laminated and thin-bedded shale, siltstone, and minor sandstone. Has sparse, thin interbeds of green volcanic sandstone and dacite pebble conglomerate near the base and minor green and yellow shale elsewhere. Coarser beds locally are graded. Thickness 300-600 m

Xami **Mafic to intermediate volcanic rocks (Early Proterozoic)**

Mafic to intermediate lava flows and hypabyssal intrusions (Early Proterozoic)-Basaltic andesite and less common dacite lava flows and dikes. Includes porphyritic and aphyric lava flows, tuffs, and volcaniclastic sandstones and conglomerates. Rocks included in this unit form a thin layer at the base of the Red Rock rhyolite that was interpreted by Ludwig (1974) as a sheet-like intrusion, and by Wrucke and Conway (1987) as lava flows. About 1 mile southwest of Cottonwood Spring, rocks of this unit consist of variably foliated, dark green, plagioclase porphyritic andesite lava and/or sills. Plagioclase phenocrysts are up to 2 cm, euhedral to subhedral, and make up between 5% and 30% of the flows. Some of the units may be hypabyssal intrusions, but most display amygdaloidal or auto-brecciated textures typical of lava flows (C. Ferguson, 2004, AZGS OFR 2004-03). Along the east edge of bedrock in the Reno Pass area, adjacent to Tonto Basin, rocks of this unit consist of medium to dark gray metavolcanic rocks, in some areas with a clear fragmental texture (fragments 1-5 cm long) that appears to represent a flattened breccia. Possible relict vesicles are present locally (J. Spencer, this report).
East of Tonto Creek consists of mafic dikes(?) in the Bread Pan Formation. These are dark green chlorite rich rock that may be relict lava flows, but at least in part are intrusive because they cross cut compositional layering in adjacent slate (Wessels, 1990, p. 20)
Rocks of this map unit are of probable mixed affinity, including (1) related to the Mount Ord andesite but faulted into the lower Alder Group, (2) part of the Alder Group, and (3) younger intrusions associated with the Red Rock Group

Xhq **Quartzite, Houdon Formation (Early Proterozoic)**

Gray purple quartz-arenite, with trough and planar cross bedding; pebble conglomerate near top

Xhcg **Conglomerate of Houdon Formation (Early Proterozoic)**

Conglomerate with up to 10 cm clasts of jasper, quartz, and slate. Dark red to black hematite staining is common, cleavage is typically well developed

Xhsl **Slate of Houdon formation (Early Proterozoic)**

Brown and gray slate, with distinct centimeter scale bedding with graded beds (Wessels, CM91-I)

Xpbp **Phyllite and slate, Breadpan formation (Early Proterozoic)**

Maroon and gray slate, interbedded with white to gray siltstone; minor carbonate layers present

Xdip **Intermediate composition metavolcanic rocks (Early Proterozoic)**

Brown to green, porphyritic and aphyric, foliated dacite to andesite sills emplaced in the Alder Group and Red Rock Group (Xrr) in the southeastern part of the area. Contains plagioclase, epidote, chlorite, opaque minerals, and quartz. Considered by Ludwig (1974) to be intrusive, but some occurrences may be flows. Thickness 0-150 m

Xacv **Dacitic volcanic breccia, subaqueous lithic tuff, mafic flows and pillow lava, and bedded chert (Early Proterozoic)**

Dacitic volcanic breccia, subaqueous lithic tuff, mafic flows and pillow lava, and bedded chert (Early Proterozoic)

Map Unit Explanation

Legend: Map Units for Tonto National Forest Geology

Xacc **Bedded chert (Early Proterozoic)**

Bedded chert (Early Proterozoic)

Xahs **Volcaniclastic sandstone, sedimentary breccia, with minor conglomerate, slate, limestone, and quartzite (Early Proterozoic)**

Described by Ludwig (1974) as "medium to coarse-grained, poorly sorted, faintly bedded volcanic sandstone" with less abundant "phyllites, gravelly volcanic wackes, sedimentary breccias, and cobble conglomerate" with local exposures of "limestone, dolomite, and bedded chert." Described by Wrucke and Conway (1987) as volcanic sandstone and lithic greywacke with minor shale, pebbly greywacke, conglomerate, and breccia, with a total thickness of 650 to 1100 m. Map units from Reno Pass OFR 04-03; includes unit Xag of Wrucke and Conway (1987)

Xvs **Argillaceous schist**

Tectonically interleaved with the meatfelsite unit (Xv). Occursas small, elongate bodies , some of which contain lithic clasts.

Proterozoic supracrustal rocks of the Cave Creek area

Metavolcanic and metasedimentary rocks between the New River Mountains and Humboldt Mountain

Xcg **Granitoid boulder to cobble conglomerate, argillaceous sandstone, and mudstone (Early Proterozoic)**

Conglomerate with distinctive, medium-grained, equigranular granodiorite clasts along with abundant mafic volcanic clasts. Conglomerates are interbedded with pebbly, granule sandstones and dark green mudstones similar to strata of the argillite (Xs) unit

Xccm **Mafic metavolcanic rocks of Cave Creek Terrane (Early Proterozoic)**

Mafic (basalt-ultramafic) subaqueous lava complex, consisting of dark brown- to light green-weathering, dark green to black basalt and basaltic andesite. Commonly massive or composed of volcanic breccia. Locally displays pillow structures and hyaloclastites. The unit is rarely amygdaloidal, and locally porphyritic, with coarse-grained plagioclase or pyroxene phenocrysts. Generally displays green schist-grade metamorphic recrystallization, and is locally interbedded with volcaniclastic sandstone and mudstone. Locally include andesitic rocks. Several major outcrop areas, include Cramm Mountain block, Humboldt Mountain-Rover Peak block, and Cottonwood Creek block. Corresponds to Cramm Mountain volcanics of Anderson

Xcma **Mafic to intermediate metavolcanic rocks of Cave Creek Terrane (Early Proterozoic)**

Andesitic to basaltic subaqueous lava complex, consisting of brown- to light green-weathering, medium to dark gray basaltic andesite or andesite that characteristically display coarse-grained plagioclase phenocrysts. Locally displays pillow structures and hyalocalstites. Differs from Xm in that Xma is generally lighter-colored and lacks pyroxene phenocrysts. Interbedded locally with tuffaceous, conglomeratic, and argillaceous turbidite sedimentary rocks

Xcst **Andesite tuff and tuff breccia of Skunk Tank Canyon (Early Proterozoic)**

Massive, light gray- to brown-weathering porphyritic andesite with abundant plagioclase phenocrysts. The unit also contains abundant lithic fragments and possible pumice fragments and is interpreted as a subaqueous ash-flow tuff

Xfv **Felsic lava and lava breccia (Early Proterozoic)**

Light gray- to light pink-weathering, crystal-poor (quartz and feldspar) felsite. Flow-banding and autoclastic primary textures are commonly preserved, indicating origin as lava flows

Xfx **Crystal-rich felsic to felsic intermediate volcanic rocks (Early Proterozoic)**

Light pink to tan, feldspar- and quartz-phyric, porphyritic volcanic rock with approximately 30% phenocrysts. Occurs west of Black Mesa where its relationship to the other supracrustal rocks of the area could not be determined, however its position suggests that it lies near the bottom of the volcanic sequence

Xfs **Felsic volcaniclastic and pyroclastic rocks**

Felsic to intermediate composition clastic rocks displaying a wide variety of textures, ranging from pyroclastic to volcaniclastic conglomerate. The more pyroclastic and volcaniclastic varieties contain mostly angular to subangular volcanic clasts, and abundant crystal clasts that could be phenocrysts. The unit also includes minor mudstone and rounded plutonic boulder-cobble clast conglomerate with variable amounts of volcanic detritus.

Xcqs **Felsic lava, volcaniclastic and pyroclastic rocks of Quien Sabe Spring (Early Proterozoic)**

Felsic to intermediate composition clastic rocks displaying a wide variety of textures, ranging from pyroclastic to volcaniclastic conglomerate. The more pyroclastic and volcaniclastic varieties contain mostly angular to subangular volcanic clasts, and abundant crystal clasts that could be phenocrysts. The unit also includes minor mudstone and rounded plutonic boulder-cobble clast conglomerate with variable amounts of volcanic detritus

Xcac **Greenish argillite and chert of Cave Creek Terrane (Early Proterozoic)**

Dark green argillite, probably derived from fine-grained mafic tuffaceous or volcaniclastic rocks. Greenish gray argillite interbedded with thin- to medium-bedded chert (typically jasperoid), and tabular-clast, chert pebble to cobble argillite matrix conglomerates. Some of the argillites contain rusty brown weathering intervals suggestive of carbonate. Unit is strongly associated with the contact zones between the argillite and mafic volcanic complex units

Xsc **Siliceous shale and chert (Early Proterozoic)**

Greenish gray argillite interbedded with thin- to medium-bedded chert (typically jasperoid), and tabular-clast, chert pebble to cobble argillite matrix conglomerates. Some of the argillites contain rusty brown weathering intervals suggestive of carbonate. Unit is strongly associated with the contact zones between the argillite (Xs) and mafic volcanic complex (Xm or Xma) units

Xc **Chert (Early Proterozoic)**

Individual chert beds

Xcgg **Fine-grained metasedimentary of Grays Gulch (Early Proterozoic)**

Dark-colored (gray to greenish gray and purple) mudstone and siltstone interbedded with between 5% and 25% gray, fine- to medium-grained and rare granule sandstones. The sandstones are thin- to medium-bedded with argillaceous matrix and they commonly display classic Bouma sequence sedimentary structures. Massive, graded beds are commonly capped by parallel to ripple cross-laminated, fine-grained sandstone or siltstone. Flame structures, ball and pillow structures, and sharp erosive bases are common. Locally, mud-chip intraformational cobble-pebble conglomerate is present. The sand is generally quartzose with a few percent feldspar. Some of the granule sandstones are arkosic. The argillaceous strata commonly contain a few percent thin-bedded laminated or ripple cross-laminated siltstones. The unit is interbedded with both siliceous (cherty) and calcareous intervals some of which were too thin or discontinuous to be mapped separately

Xlcc **Limestone of Cave Creek terrane (Early Proterozoic)**

Several thin bands of massive gray limestone (probably a turbiditic packstone) within metavolcanic sequences SW of Rover Peak and in Gray's Gulch area

Xfi **Crystal-poor rhyolite sills (Early Proterozoic)**

Light-colored, crystal-poor, locally flow-banded rhyolite sills. The sills occur as thin (less than 20 meters and typically less than 5 meters) concordant bodies within the mafic lava complex. The unit forms a prominent sill, currently oriented as if it were a vertical dike in the southeast corner of the map area along the contact between the turbidite (Xs) unit and the mafic lava complex (Xm). The dike-like feature in this area is locally referred to as the Chinese wall

Xf **Felsite**

White- to light gray-weathering, medium to dark gray, fine- to coarse-grained felsite. Locally granophryic, with phenocrysts of plagioclase, K-feldspar, and quartz. In some areas this unit is hypabyssal. A single, thin sill of crystal-poor rhyolite occurs in the southeast corner, near Bronco Butte.

Xcms **Argillite, siltite, and argillaceous sandstone of Continental Mountain (Early Proterozoic)**

Dark-colored (gray to greenish gray and purple) mudstone and siltstone interbedded with between 5% and 25% gray, fine- to medium-grained and rare granule sandstones. The sandstones are thin- to medium-bedded with argillaceous matrix and they commonly display classic Bouma sequence sedimentary structures. Massive, graded beds are commonly capped by parallel to ripple cross-laminated, fine-grained sandstone or siltstone. Flame structures, ball and pillow structures, and sharp erosive bases are common. Locally, mud-chip intraformational cobble-pebble conglomerate is present. The sand is generally quartzose with a few percent feldspar. Some of the granule sandstones are arkosic. The argillaceous strata commonly contain a few percent thin-bedded laminated or ripple cross-laminated siltstones. The unit is interbedded with both silceous (cherty) and calcareous intervals some of which were too thin or discontinuous to be mapped separately

Supracrustal rocks of Indian Springs Peak (Proterozoic)

New grouping for group of metasedimentary and metavolcanic rocks around Indian Spring Peak (which is formed by Tertiary volcanic rocks overlying the Proterozoic units). Probably related to the Alder Group and Mt. Ord Andesite of the Slate Creek zone to the NE in the Mazatzal Mountains

Xisq **Quartzite of Indian Springs Peak(Early Proterozoic)**

Blue-grey to tan, fine- to coarse-grained quartzite. Typically fine-grained (grains less than 1 mm) and laminated with thin limonite/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

Map Unit Explanation

Legend: Map Units for Tonto National Forest Geology

Xiss **Metasedimentary rocks of Indian Spring Peak (Early Proterozoic)**

A sequence of fine-grained metasedimentary rocks that are interbedded with more mature quartzite (map unit Xqis) 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

Xisu **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

Xisv **Intermediate composition metavolcanic rocks of Indian Spring Peak (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

Supracrustal rocks of the McDowell Mountains (Proterozoic)

McDowell Mountains area

Xmmw **Metagraywacke of McDowell Mountains (Early Proterozoic)**

Fine-grained, light to medium silvery gray biotite-muscovite-quartz schist. Strongly foliated. Preferentially breaks into plates which crumble easily and have a gritty texture. Some surfaces have a pale rusty stain. The rock locally contains more massive zones containing 1-4 mm light grey feldspar and biotite crystals in a medium grey, siliceous aphanitic matrix. The zones may heve been interbedded felsic-to-intermediate volcanic flows or tuffs. The biotite-muscovite schist also contains very locallized lenses of dark amphibolite which may have been sills or later intrusions.

Xmms **Sillimanite schist of McDowell Mountains (Early Proterozoic)**

Coarse-grained schist containing long, needle-like clear-gray crystals of sillimanite and up to 2 cm long in a dark gray-green matrix of dark red-gray garnet and muscovite. All crystals are anhedral. Rock is dark green, dense, and layered. Layering may represent relict primary sedimentary layering. The long axes of the sillimanite crystals are parallel to the plane of layering. In thin section sillimanite is embayed and surrounded by muscovite but it is not clear if the sillimanite is altering to or from muscovite. Occurs as sparse pendants in Carefree Granite.

YXmq **Quartzite of McDowell Mountains (Middle or Early Proterozoic)**

Light pink and blue-gray clean quartzite. Bedding is visible locally, and trough and planar cross-bedding, defined by thin magnetite bands, show that up-section is to the north-northeast. The bedding locally forms a small northeast-plunging anticline in the quartzite north of McDowell Peak. Between McDowell Peak and East End the quartzite has been intruded by diorite and granite and has formed small isolated roof pendants between the two plutons. Most exposures are highly fractured and yet are very resistant, forming steep rugged ridges and cliffs in the McDowell Mountains.

Xmmr **Metarhyolite of McDowell Mountains (Early Proterozoic)**

Fine-grained, light gray to pink, quartz-sericite schist. Generally contains very small (<1mm) anhedral phenocrysts of gray feldspar and quartz. Locally, the rock contains crystals of feldspar and milky quartz up to 4 mm wide and contains elongate lenses of fine-grained biotite with their long axes parallel to foliation. 1-3 mm wide magnetite porphyroblasts have been altered to hematite. Locally small (<2 mm) pyrope garnet porphyroblasts are visible. Locally contains 2-12 mm-long lenses altered to epidote (pumice?). Strongly foliated. Forms resistant, light-colored ridges in the southwest corner of the study area in the McDowell Mountains

Xmmv **Mafic volcanic rocks of McDowell Mountains (Early Proterozoic)**

Dark gray-green, fine-grained biotite-amphibole schist containing 1-3 mm anhedral black amphibole porphyroblasts. Generally, the unit is strongly to moderately foliated. In areas that are only weakly foliated or nonfoliated (particularly in T. 3 N., R. 6 E., section 6 to the south of the study area) subhedral, light gray plagioclase laths are abundant. Locally, white quartz veins and dark quartz-tourmaline veins several centimeters thick cross-cut the foliation.

Proterozoic Supracrustal rocks of Stewart Mountain

Small outcrops of Proterozoic metavolcanic and metasedimentary rocks as pendants in Usury and Stuart Mountain Granite

Xv **Metafelsite (Early Proterozoic)**

Metafelsite. Tectonically sheared quartz and feldspar porphyroblastic schist. Crystals are generally less than 5mm and range in abundance from 5 to 40%. The unit is interpreted as a felsic volcanic rock because it locally contains inclusions that appear to be lithic and pumice clasts. In the easterly adjacent Horse Mesa Dam quad, the map unit includes thin, tectonically interleaved argillaceous schist, some of which appears to be metaconglomerate

Xslc **Metaconglomerate of Saguaro Lake (Early Proterozoic)**

Contains clasts of fine- to medium-grained, leucocratic, equigranular to slightly K-feldspar porphyritic granite, and clasts of felsic lava containing clear quartz and white feldspar (1-4 mm) in an aphanitic tan to dark grey siliceous matrix. Some clasts show flow banding. Also locally contains dense, heavy clasts which contain 2-6 mm subhedral phenocrysts of plagioclase and K-feldspar in a dark green fine-grained matrix. All clasts are well-rounded and range in size from small pebbles to about 30 cm across. Clasts resemble river cobbles and are poorly sorted. Matrix is fine-grained quartz-feldspar-sericite. Locally may be a sandstone. Foliation is weak to absent and the strongly indurated rock generally breaks into angular blocks. The contact between map units Xc and Xp is very locally exposed in a few gullies. Rounded pebbles are entrained and completely surrounded by phyllite, but it is not clear which unit is older

Xslr **Metarhyolite of Saguaro Lake (Early Proterozoic)**

This rock contains porphyroblasts of subhedral, partially rounded light grey feldspar 3-4 mm wide, slightly larger milky blue, partially rounded quartz up to about 8 mm wide, and smaller anhedral to subhedral biotite and minor muscovite, all in a medium grey aphanitic matrix. Crystals are more easily seen on weathered surfaces. Exhibits shades of pink, green, and grey. Locally fiamme-like features are visible, suggesting part of this unit may be a welded tuff. Generally resistant and forms steep hills with blocky, angular clasts on the northeast side of Saguaro Lake and southwest of Stewart Mountain Dam. Foliation is weak to strong. Local folding is visible at Blue Point Bridge, where the rock is also intruded by a fine- to medium-grained feldspar-amphibole-rich dike. Intruded by Xge

Xslp **Phyllite of Saguaro Lake (Early Proterozoic)**

Fine-grained, light grey to dark grey-green rock containing quartz and feldspar fragments up to 2 mm wide in a sericitic matrix. Biotite and muscovite form thin banding, possibly reflecting alteration of primary bedding features. Locally, light grey to pink stretched pumice fragments are visible. Rock is very fissile compared to rhyolite (map unit Xr). This unit may contain protoliths of tuff, volcaniclastic sediments, and some lava

Xbs **Biotite schist (Early Proterozoic)**

Contains fine-grained, dark green biotite and less abundant grey feldspar. Biotite is almost everywhere altered to chlorite. Locally contains rare cubic hematite porphyroblasts up to 2 mm wide. Feldspars appear broken. Resembles a chloritic breccia associated with Tertiary extensional detachment faults in Arizona. Foliation is locally weak but is mostly very strong. This rock is confined to narrow northwest-trending zones of intense shearing within the porphyritic and equigranular granites (map unit Xgc) at Stewart Mountain, and this unit includes a second similar north-trending screen in the Usury Mountains

Xsli **Mafic to intermediate hypabyssal intrusive rock of Saguaro Lake (Early Proterozoic?)**

Dark green lenticular intrusion containing phenocrysts of plagioclase and hornblende(?), in a dark green aphanitic matrix. Occurs in one small outcrop between phyllite (Xslp) and metaconglomerate (Xslc)

Supracrustal rocks of Four Peaks (Proterozoic)

Metavolcanic and metasedimentary rocks at the southern end of the Mazatzal Mountains

Xfsu **Upper sedimentary unit of Four Peaks (Early Proterozoic)**

This unit contains dark slate, phyllite, and minor thin-bedded quartzite. The protoliths were thinly bedded to laminated fine-grained sandstone and siltstone. Bedding and graded beds are visible locally, the lower part of the member is interbedded with light blue-gray quartzite beds of the upper quartzite unit (map unit Xqu). At this gradational contact the beds are complexly folded. Powicki (1996) observed quartz, muscovite, chlorite, and feldspar in the fine-grained sandstones, and graphite, chlorite, quartz, and iron-oxides in the slate. Dark spots in the phyllite are probably pseudo morphs of cordierite replaced by aggregates of quartz, chlorite, muscovite, and biotite (Powicki, 1996). This unit is only exposed in a small structural basin immediately to the east of Four Peaks

Xfqu **Upper quartzite of Four Peaks (Early Proterozoic)**

Blue-gray to tan and light purple, fine- to coarse-grained quartzite. Locally fine-grained (though mostly recrystallized) and contains thin iron-oxide laminations. Thin to medium bedding is distinct and ranges in thickness from a few centimeters to about 2 meters thick. Cross-bedding is abundant. The rock is mostly recrystallized, consisting of coarse-grained intergrown quartz crystals. Contains minor metamorphic muscovite. Locally the unit contains light gray, radiating mica crystals (pyrophyllite?), black tourmaline, rectangular hematite crystals up to about 3 mm wide, and rare red garnet. The unit is very competent and resistant and forms the precipitous peaks of Four Peaks itself. The unit is folded into an asymmetric, north-vergent, doubly plunging syncline. The upper and lower parts of the unit are interbedded with fine grained siltstone and it is at these locations that small-scale folding is most pronounced

Xflg **Gneissic lower sedimentary unit of Four Peaks (Early Proterozoic)**

This unit contains both biotite-schist and compositionally layered gneiss. The gneiss displays abundant dark spots a few millimeters wide composed of micaceous aggregates of biotite, muscovite, and chlorite, which Powicki (1996) interpreted as pseudo morphs of cordierite. Light tan, anhedral andalusite porphyroblasts occur locally (Powicki, 1996). Dark-colored melanosomes contain more biotite and chlorite where as light-colored leucotomies contain more quartz and muscovite. Together they form thin bands 2-5 mm thick. Banding is wavy and has no preferred orientation on scales larger than a few meters. The banding superficially resembles bedding, and may be bedding, but contains abundant porphyroblasts. Locally the rock exhibits a fragmental fabric, where angular blocks of gneiss are slightly rotated with respect to their neighbors, and the areas in between blocks are filled slightly lighter-colored leucocratic material. Panicky (1996) interpreted this to be a fabric formed by partial melting of this unit (an anatexis fabric). Gneissic layering diminishes southward over a span of 50 meters or less where it grades into sedimentary fabrics in the lower sedimentary unit (map unit Xsl) immediately northwest of Browns Peak. The protolith for his unit was the lower sedimentary unit and was mapped separately because gneissic layering masks original sedimentary fabrics in this unit

Xfsl

Lower sedimentary unit of Four Peaks (Early Proterozoic)

This unit contains gray to gray-green phyllite, psammite, and less abundant quartzite. The protolith for this unit was probably interbedded siltstone, fine-grained silty sandstone, and clean quartz sandstone. Rare, gravel beds a few centimeters thick are visible in the steep ravine west of the Amethyst mine. Powicki (1996) observed conglomeratic beds up to 1 meter thick to the west of Four Peaks. Dark spots in phyllite are porphyroblasts of cordierite, replaced to varying degrees by fine-grained chlorite and muscovite (Powicki, 1996). Visible along the trail immediately west of Browns Peak bedding, foliation, and compositional banding are all parallel and gradational with one another. Locally, the unit is cut by thin quartz veins and rare muscovite-granite veins. Quartzite beds are more abundant up-section, where the unit grades into the upper quartzite unit (map unit Xqu). The unit weathers into gray-green platy outcrops and erodes into relatively smooth slopes

Xfql

Lower quartzite of Four Peaks (Early Proterozoic)

This light blue gray to light purple quartzite is very similar to the upper quartzite unit (map unit Xqu). It is thin- to medium-bedded with beds a few centimeters to ~1 meter thick. Beds are both planar-laminated and cross-bedded, with cross-bedding defined by thin, dark iron-oxide laminations. Locally, it contains minor muscovite and chlorite. The rock is locally interbedded with thin beds of gray phyllite. Locally, fractures are stained with hematite. The rock is mostly recrystallized. West of Four Peaks most of the unit has been intruded by granite, though the intrusive contact appears to parallel the lower margin of the unit. South of Four Peaks the unit pinches out southwestward. On the east side of Four Peaks the rock is intensely fractured and locally smeared out and intimately associated with rhyolite (map unit Xr) along foliations planes

Xfpt

Tuff of Four Peaks (Early Proterozoic)

This rock is mineralogically similar to the rhyolite (map unit Xr). It contains roughly equant, 1-3 mm quartz and feldspar phenocrysts in a serricitic matrix. The rock also contains stretched pebbles of a crystal-poor, felsic volcanic rock, indicating this was a fragmental rock. The clasts are best seen on weathered outcrops. The felsic clasts are very similar to crystal-poor, felsic volcanic clasts within early Proterozoic Conglomerate to the southwest at Saguaro Lake (map unit Xc of Skotnicki and Leighty, 1997b). This unit was recognized only in one small area about 1 mile south of Four Peaks, where it is stratigraphically at the top of the rhyolite an below the lower quartzite (map unit Xql)

Xbca

Amphibolite (Early Proterozoic)

Dark green amphibolite in thin screens in felsic metafolcanic rocks of Browns Cave.

Xvbc

Felsic metavolcanic rocks of Brown's Cave (Early Proterozoic)

This rock contains about 5-10% 1-3 mm quartz and locally feldspar phenocrysts in a tan to pink aphanitic to serricitic matrix. The rock is generally tan to pinkish tan and light gray. Foliation is prominent in this rock and outcrops are commonly platy. On weathered outcrops roughly equant quartz phenocrysts are conspicuous. Southwest of Four Peaks, near the contact with the lower quartzite unit (map unit Xql) the rhyolite is light gray and locally displays prominent kink-bands (83) cutting the primary foliation (Si). On the ridge, about VA mile southwest of the exposure of map unit Xm, the rhyolite contains former vugs or cavities that have been replace by white, coarse-grained quartz. Looking north, these quartz-filled vugs are sigmoidal or S-shaped. In the east-central part of the map area the unit contains light gray flattened clasts centimeters to tens of centimeters wide. Looking down on the foliation plane these inclusions are well-rounded, but appear to be composed of the same material as the surrounding rock. Some magnetite laminations strongly suggest that this part of the unit is a volcaniclastic conglomerate. Immediately southeast of the map area, exposed along Bronco Creek less than 1 mile from Apache Lake, the rhyolite is interbedded with dark green metaconglomerate. The metaconglomerate contains deformed clasts of rhyolite, fine-grained sandstone, and shale, all in a fine-grained, dark green matrix. Proposed name for Brown's Cave in Alder Canyon at the southern edge of the outcrop area of the unit

Xrpb

Rhyolite porphyry, metavolcanic rocks of Brown's Cave (Early Proterozoic)

This crystal-rich rock contains abundant anhedral to subhedral light gray phenocrysts of K-feldspar 1-2 mm wide, minor biotite, and conspicuous, milky gray, locally embayed quartz 1-7 mm wide. Both feldspar and quartz locally occur as large phenocrysts up to 12 mm wide. The rock weathers into blocky and rounded outcrops rather than the platy outcrops of the lighter colored rhyolite (map unit Xr). Difficult to break. Biotite is smeared out along the foliation plane. Exposures of this rock are generally darker-colored than exposures of map unit Xfbc. This unit is exposed in irregularly shaped bodies within map unit Xfbc

Xbmd

Diorite of Buckhorn Mountain (Early Proterozoic)

This rock is composed of a felsic phase in the east which grades into a more maphic phase in the west. The felsic phase is medium- to coarse-grained and contains subhedral phenocrysts of light grey feldspar (appears to be mostly plagioclase), clear-grey quartz, biotite, and hornblende. Biotite forms dark felty clumps partially altered to chlorite. Hornblende occurs as subhedral rectangular crystals up to 1 cm long that are locally poikalitic. Dark brown subhedral titanite (spene) phenocrysts up to 5 mm long are abundant. The mafic phase contains the same phenocrysts, but contains a greater percentage of mafic minerals and less quartz and feldspar. This unit is very resistant and commonly forms large rounded boulders around Buckhorn Mountain. Some slopes are smooth and grus-covered. The rock is pervasively foliated, but the strongest foliation is commonly confined to narrow zones several centimeters to meters wide. Exposures in the northeast contain a wide zone 50-100 meters wide where the rock is deformed into a mylonite. Other mylonitic zones are common but are generally confined to very narrow zones, surrounded by less deformed rock. Locally, biotite forms a prominent lineation. At least three different ages of dikes cut the diorite: leucocratic aplite dikes cross-cut foliation and are themselves weakly foliated; the aplite dikes are cut by fine-grained granite dikes (Ygm?) which do not appear foliated; both of these dikes are cut by aphanitic leucocratic dikes which are commonly pegmatitic and have pegmatitic margins. To the west in the Maverick Mountain quadrangle, these last two dikes appear to be related

Map Unit Explanation

Legend: Map Units for Tonto National Forest Geology

Xmbc **Marble of Brown's Cave (Early Proterozoic)**

A thin interval of light gray weathering, dark-gray, very fine-grained marble, that occurs within the metaconglomatic unit of Browns Cave (Xcbc) along upper Alder Creek

Xcbc **Conglomeratic metasedimentary rocks of Brown's Cave (Early Proterozoic)**

Metaconglomerate, arkose, and pebbly feldspathic arenite; these rocks display abundant primary sedimentary structures and consistent south-facing stratigraphic facing directions. They are typically non-foliated, in contrast with the strongly foliated metavolcanic rocks they overlie. However, in some areas a weak foliation, sub-parallel to that which is pervasively displayed in the country rocks, is present along the edges of this rock unit. Along Ash Creek the unit includes Xr, a metamorphosed and tectonized, welded, rhyolite ash-flow tuff and related volcaniclastic conglomerate and/or breccia. Flattened pumice or fiamme clasts are cut by a tectonic foliation. A thin interval (less that 5 meters wide) of thin-bedded, white, crystal-poor unwelded tuff, Xt, is present locally along the contact between Xr and Xc. Along upper Alder Creek unit Xc contains an interval of light-gray weathering, dark-gray, very fine-grained marble, Xm

Xp **Pinal Schist, undivided (Early Proterozoic)**

undivided low-grade metasedimentary rocks of Pinal Schist

Xps **Pelitic schist (Early Proterozoic)**

Pelitic schist--bluish gray to dark gray, fine-grained, muscovite-biotite schist with numerous, variably folded hydrothermal quartz stringers. Foliation is defined by compositional layering, phyllosilicate orientation, and quartz segregations. Compositional banding in schist tends to be thin to very thin (2-15 mm). Quartz stringers are irregular but are commonly approximately parallel to fabric defined by phyllosilicate orientation. Quartz veins in thickened fold hinges locally form rods visible on foliation surfaces and may be parallel to crenulation fold axes. Weak lineation in some areas is an intersection between dominant foliation and axial surface cleavage of over-printing crenulation, and in other areas is a mineral lineation parallel to hinges of isoclinal folds that appear to be associated with S1 fabric generation

Xpm **Psammite facies (Early Proterozoic)**

Fine grained, psammitic schist in which bedding is locally visible. Tan weathering. Sand grains consist primarily of quartz with minor feldspar and sparse to very sparse lithic fragments. Protolith is inferred to have ranged from massive medium- to coarse-grained sand-stone to interbedded thin- to medium-bedded, shale, siltstone, and sandstone

Xpc **Calc-silicate facies (Early Proterozoic)**

no description

Xpcs **Calc-silicate and schist facies (Early Proterozoic)**

Similar to Xpc, but with more >50% interlayered schist and psammite

Xpq **Quartzite-Dark gray massive ferruginous quartzite (Early Proterozoic)**

Forms resistant ledges

Xpp **Phyllite facies-Massive (Early Proterozoic)**

Platy, gray to silvery gray, slightly schistose phyllite.

Xpw **White-mica rich marker unit, Pinal Schist (Early Proterozoic)**

No description given

Xpwa **Amphibolite and white-mica rich spotted schist (Early Proterozoic)**

No description given

Xpsa **Amphilbolite, psammitic schist (Early Proterozoic)**

Thin layers of fine grained, dark green to black amphibolite, locally compositionally banded. Banding is defined by either thin (1 to 3 mm thick), quartz and feldspar rich, epidotized leucosomes, or up to 2 meter thick layers of dark gray colored, thin-banded quartzites. Banding in quartzites is defined by very thin, red, green, or light colored layers.

Xpsq **Quartz-rich marker unit (Early Proterozoic)**

No description given

Xu **Supracrustal rocks (Early Proterozoic)**

Metamorphosed volcanic and sedimentary rocks occurring as pendants in Payson granite and along the border of the Carefree granite. These rocks are not well studied, but are a potential link between supracrustal rocks associated with the Alder group in the Mazatzal Mountains and those of the Cave Creek area

Map Unit Explanation

Legend: Map Units for Tonto National Forest Geology

XYgp **Oracle Granite and schist (Middle Proterozoic and Early Proterozoic)**

Zones of biotite granite (Oracle granite) with abundant, partially resorbed inclusions of Pinal schist. Mixed zones are common in contacts between these units. Gradational contacts into homogeneous granite.

Xbmm **Diorite-metabasite complex of southern Bradshaw Mountains (Early Proterozoic)**

Mafic igneous complex consisting mostly of fine- to medium-grained diorite with lesser metabasite and tonalite.

Xmgd **Diorite-metabasite complex of Moore Gulch (Paleoproterozoic)**

Mafic igneous complex consisting mostly of fine- to medium-grained diorite with lesser metabasite and tonalite.

Xgn **Felsic gneiss (early Proterozoic)**

This leucocratic gneiss is highly deformed locally and contains leucosomes of quartz and feldspar, and quartz and muscovite. Locally it is very fine-grained and resembles deformed rhyolite. In other places it resembles deformed, interbedded rhyolite and quartzite. Exposures of this rock are very few and are found about 1 mile southwest of Herder Mountain near the dirt road. (Text for map displays Xgu but the map the unit appears to be Xgn)