GEOLOGIC MAP OF THE HORSESHOE DAM 7.5' QUADRANGLE, MARICOPA COUNTY, ARIZONA

by

Charles A. Ferguson[1], Wyatt G. Gilbert[1], Steven J. Skotnicki[1],
Chester T. Wrucke[2], and Clay M. Conway[3]

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[1] Arizona Geological Survey

[2] USGS, 345 Middlefield Road, MS 901, Menlo Park, CA 94025

[3] 366 S. 300 E. (97-12), Blanding, Utah 84511

Introduction

The Horseshoe Dam quadrangle straddles part of the lower Verde River valley of central Arizona, a north-trending, west-tilted half-graben along the southern edge of the Transition Zone tectonic province (Spencer and Reynolds, 1989). The graben is filled with Miocene sedimentary and volcanic rocks. Elevations in the quadrangle range from 2000' to 4500', and the area is thickly vegetated with upper Sonoran desert flora. The north-facing slopes are generally choked with dense patches of brush, but the south-facing slopes are relatively open. The area can be reached via the Horseshoe Dam road, a graded gravel road accessible to all vehicles, and a number of primitive jeep trails on the west side of Verde River. Most of the country east of Verde River is either roadless or part of the Mazatzal Wilderness area.

Acknowledgements

The Horseshoe Dam quadrangle represents a compilation of three separate efforts. Areas to the east of Verde River were mapped as part of a United States Geological Survey wilderness study by Wrucke and Conway (1987). Skotnicki (1996) mapped the southern third of the quadrangle west of Verde River along with the southerly adjoining Bartlett Dam quadrangle. The rest of the quadrangle was mapped by Ferguson and Gilbert in 1998 and 1999 in conjunction with mapping of the westerly adjacent Humboldt Mountain quadrangle (Gilbert and others, 1998). The map was compiled by Ferguson in August, 1999 and reviewed by the other authors before preparation of the final version.

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Proterozoic Rocks

The Proterozoic crystalline basement of the Horseshoe Dam quadrangle is dominated by two major plutons, an Early Proterozoic equigranular granite (Xg) to the north named Payson Granite (Conway and others, 1987; Wrucke and Conway, 1987) and a Middle Proterozoic porphyritic granite (Yg) to the south. Numerous screens of metavolcanic and metasedimentary rocks of probable Early Proterozoic Alder Group affinity occur along the intrusive contact between the two granites. The Payson Granite is cut by numerous shear zones and hosts NE to E-striking, steeply dipping mylonitic fabrics. The Payson Granite was later called the Verde River Granite by Anderson (1989). Because of precedence, we recommend that the name Payson Granite be used for this pluton. The Payson Granite, dated at 1,703-1,697 Ma (Silver and others, 1986), is part of the Diamond Rim Intrusive Suite and is considered to be the subjacent equivalent of extensive ash-flow tuffs of the Tonto Basin Supergroup exposed in the region around Payson northeast of the quadrangle (Conway and others, 1987).

The Middle Proterozoic porphyritic granite was dated at 1422.5 $\pm$ 2.2 Ma (using a sample from an area just to the south of the map area) and given the informal name Pinnacle Peak granite by Isachsen and others (1999). Isachsen and others (1999) correlated the Pinnacle Peak granite with the Camelback Granite of Doorn and Péwé (1991), but Skotnicki (in preparation) insists that these two bodies are distinct and separate and refers to the porphyritic

granite in Horseshoe Dam Quadrangle as the Carefree Granite. The porphyritic granite is a monotonous unit characterized by the lack of tectonic fabrics, shear zones, mylonitic overprint, or quartz veins in the map area. To the east of Verde River, Wrucke and Conway (1987) report abundant inclusions of granodiorite in the porphyritic granite.

Tertiary

The Tertiary stratigraphic sequence consists of basaltic lava, conglomerate, sandstone, and lesser amounts of mudstone, limestone and felsic tuff. In Horseshoe Dam quadrangle, the base of the Tertiary sequence consists principally of basalt and interbedded tuff in three stratigraphic units (Tbt, Tt, and Tb) having a combined thickness of 100-300 m. Elsewhere in the lower Verde Valley, volcanic rocks equivalent in age to the basal sequence in Horseshoe Dam quadrangle overlie an older sequence of nonvolcaniclastic conglomerate and sandstone referred to by Wrucke and Conway (1987) as older conglomerate (Toc). The unit designated as lower conglomerate in the Horseshoe Dam map area (Tcl) is volcaniclastic and overlies the basal sequence of basalt and tuff. The lower conglomerate of Horseshoe Dam quadrangle is separated from a sequence of younger units (Tc, Ts, Tl, and Tby) by an angular unconformity. The younger sequence consists of volcaniclastic conglomerate (Tc) interbedded with sandstone (Ts), fine-grained lacustrine siliciclastic and carbonate rocks (Tl), and several discontinuous and relatively thin basalt flows (Tby). In general the sedimentary rocks of Horseshoe Dam quadrangle become finer grained up-section and toward the center of the basin. The lacustrine map unit of Horseshoe Dam quadrangle (Tl), was originally mapped as a calcareous tuff (Wrucke and Conway, 1987). Finding little evidence of pyroclastic textures in these rocks, we have reinterpreted this as a lacustrine unit dominated by limestone, and correlate it with the limestone of Chalk Mountain a few kilometers to the north (Wrucke and Conway (1987).

The Tertiary sequence ranges from middle Miocene to late Miocene and possibly Pliocene in age. A felsic tuff within the lower third of the basal basalt sequence at the west edge of the outcrop belt in Horseshoe Dam quadrangle has yielded a single-crystal, sanidine $^{40}Ar/^{39}Ar$ age of 15.41 $\pm$ 0.21 Ma (Peters, 1999, Figure 1, Table 1). Wrucke and Conway (1987) report whole-rock K/Ar ages ranging from about 16 to 8 Ma in basalt lavas of the same basin-fill sequence to the east and north of this map area. The older basalt lavas of Horseshoe Dam quadrangle correlate with the 14-16 Ma Hickey Formation, a widespread suite of alkali basalts present throughout the Transisition Zone of central Arizona (eg. Leighty, 1997). The older (approximately 21 Ma) Chalk Canyon Formation basalts which are present in the westerly adjacent Humboldt Mountain and New River Mesa quadrangles (Gilbert and others, 1998; Ferguson and others, 1998) are apparently not present in the lower Verde Valley.

Quaternary

The Quaternary map units and unit descriptions for this report were taken largely from Pearthree and others (1997) 1:100,000 scale compilation of the area, and Skotnicki's (1996) map of the southerly adjacent Bartlett Dam quadrangle. Quaternary units are defined on the basis of relative age and compositional variation within the units are discussed in the unit descriptions.

Structure

The lower Verde Valley is a half-graben bounded to the west by a major, east-side-down normal fault juxtaposing Proterozoic crystalline rocks with the Miocene supracrustal succession. The fault accounts for at least 1.5 km of offset in the northwest corner of the map area, but to the south, offset along the main strand diminishes, and offset probably is taken up along other faults which apparently step to the southeast. The east-side-down faults also appear to be

overlapped by the youngest sedimentary rocks of the basin-fill sequence.

Dips of the basin-fill sequence define a west-northwest-trending synform. The synform is interpreted in cross-section A-A', sheet 1 as the product of multiple angular unconformities and fanning dips of the basin-fill units toward a buried tilt-domain boundary horst. The west-tilted blocks east of Verde River are poorly defined, and mostly inferred from the steep westerly tilts of the older basalt unit (Tb), but also based on the major northeast-side-down fault which runs just northeast of Horseshoe Dam. Mapping east of the river is extracted from reconnaisance scale work of Wrucke and Conway (1987). Detailed mapping east of the river in this area should help clarify the structure of this area, which is shown in a schematic fashion on cross-section A-A'. To the west of Verde River, the structure depicted on cross-section A-A' is based on detailed mapping which shows a series of east-tilted fault blocks bounded by low-angle, west-dipping normal faults. These west-dipping faults are interpreted to be cut by the higher angle, east-side-down range-bounding fault system. There is no evidence of west-dipping faults cutting the younger sedimentary and volcanic units (Tc, Ts, Tl, and Tby), but these younger rocks are clearly cut by the higher angle, east-side-down basin-bounding faults. Only the youngest portion of the basin-fill sequence, which apparently overlies the younger basalt (Tby) appears to overlap the major basin-bounding fault (about 2 km due north of St. Clair Mountain).

The nature of the synformal tilt-domain boundary is poorly understood because it is buried by young sedimentary rocks in the central and northwestern parts of the quadrangle or it occurs in areas along the southern stretch of Verde River in Horseshoe Dam quadrangle that have not been mapped in detail. The buried central horst block bounded by oppositely dipping normal faults as shown on cross-section A-A' is purely hypothetical. The cross-section is shown this way in order to account for the synformal structure in a regional extensional tectonic setting. If the cross-section were shown as a simple syncline it would suggest that the basin had undergone a phase of Miocene or younger compression. More detailed mapping of areas east of Verde River will hopefully clarify the the nature of the tilt-domain boundary.

Regional significance

The overall gentle westerly dip of the Tertiary sequence in the lower Verde River valley probably reflects regional westerly tilting related to the major basin-bounding fault along the western edge of the basin. In contrast to this major fault, a series of gently west-dipping, west-side-down normal faults cut the Tertiary sequence along the western edge of the basin (Sheet 1). These east-tilted blocks are apparently overlapped by the gently west-dipping younger sedimentary rocks, suggesting that the west-side-down normal faults predate the basin-bounding, high-angle, east-side-down fault. This relationship is very similar to the structure of Tonto Basin on the east side of the Mazatzal Mountains, where a major, high-angle, east-side-down normal fault bounds a half-graben basin dominated by gentle westerly dips of the basin-fill sequence. In Tonto Basin, Ferguson and others (1998) recognized an older sequence of steeply east-dipping conglomerate unconformably overlain by the gently west-dipping sedimentary sequence. In Tonto Basin, an essentially flat-lying lacustrine unit is present near the top of the basin-fill sequence, and it includes minor nonwelded tuffs dated at 18.55 $\pm$ 0.56 Ma (K/Ar biotite; Nations, 1987; Mayes, 1990). The basalts in the lower part of the Tonto Basin succession are Oligocene to early Miocene (whole rock K-Ar dates of 22.6 $\pm$ 1.2 Ma (Muehlberger, 1988; Mayes, 1990) and 27.16 Ma $\pm$ 1.2 Ma (Damon and others, 1996). The Tonto Basin sequence is therefore considerably older than the sequence in lower Verde Valley.

Directly to the west of the lower Verde Valley, volcanic rocks near the base of the Tertiary sequence are approximately 21 Ma (Gilbert and others, 1998; Ferguson and others, 1998). In some areas these volcanics rest directly on basement, but in most areas a sequence of

nonvolcaniclastic conglomerate with northeasterly paleoflow indicators underlies the oldest volcanic rocks. At Humboldt Mountain and on New River Mesa, basaltic lavas correlative in age (ie. the 14-16 Ma Hickey Formation) to those that form the base of the section in lower Verde Valley are present at the top of the Tertiary section, several hundred meters above the unconformity with Proterozoic crystalline basement (Gilbert and others, 1998; Ferguson and others, 1998).

There is good evidence of an older phase of east-tilting associated with west-side-down faulting in both Tonto Basin (Ferguson and others, 1998) and in the lower Verde River valley basin (this report), even though the timing of extension in these basins was diachronous (extension in Tonto Basin is considerably older). This is significant because it implies that the overall extension in the Transistion Zone might be much greater than the 1% or 2% that has been proposed for the Transition Zone (eg. Leighty, 1997).

The absence of Oligocene or early Miocene sedimentary and volcanic rocks in the lower Verde Valley is significant because it indicates that the lower Verde Valley was an area of nondeposition or highly selective erosion of these rocks during the late Oligocene and early Miocene (prior to about 16 Ma). In the western Mazatzal Mountains (to the east and northeast of the map area) an older conglomerate unit (overlain by the 16 Ma basalt that represents the base of the Tertiary section in Horseshoe Dam quadrangle) is preserved in paleocanyons with paleoflow indicators towards an ancestral Verde River to the west (Wrucke and Conway, 1987). It appears that extension and subsidence in the lower Verde Valley did not commence until the early to middle Miocene.

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Table 1 Analytical results of single-crystal laser fusion $^{40}Ar/^{39}Ar$ analysis of sample F8-166.

ID	$^{40}Ar/^{39}Ar$	$^{37}Ar/^{39}Ar$	$^{36}Ar/^{39}Ar$ (x 10^{-3})	$^{39}Ar_K$ (x 10^{-15} mol)	K/Ca	$\%^{40}Ar^*$	Age (Ma)	±1σ (Ma)
F-8-166, F5:92, single crystal sanidine, J=0.000789402, D=1.00253, NM-92, Lab#=9440								
06	10.97	0.0066	0.6723	0.969	77.4	98.2	15.27	0.14
12	11.12	0.0068	0.9057	0.500	75.3	97.6	15.39	0.26
11	11.10	0.0048	0.3910	0.346	106.0	99.0	15.57	0.37
08	11.28	0.0064	0.9525	0.762	79.3	97.5	15.60	0.17
weighted mean		MSWD = 0.81	n=4		84.5 ±14.4		15.41	0.20*

Notes:
n= number of analyses used for weighted mean calculation
Isotopic ratios corrected for blank, radioactive decay, and mass discrimination, not corrected for interferring reactions.
Individual analyses show analytical error only; weigthed mean age error includes error in J and irradiation parameters.
Analyses in italics are excluded from mean age calculations.
K/Ca = molar ratio calculated from reactor produced $^{39}Ar_K$ and $^{37}Ar_{Ca}$.
* 2σ error

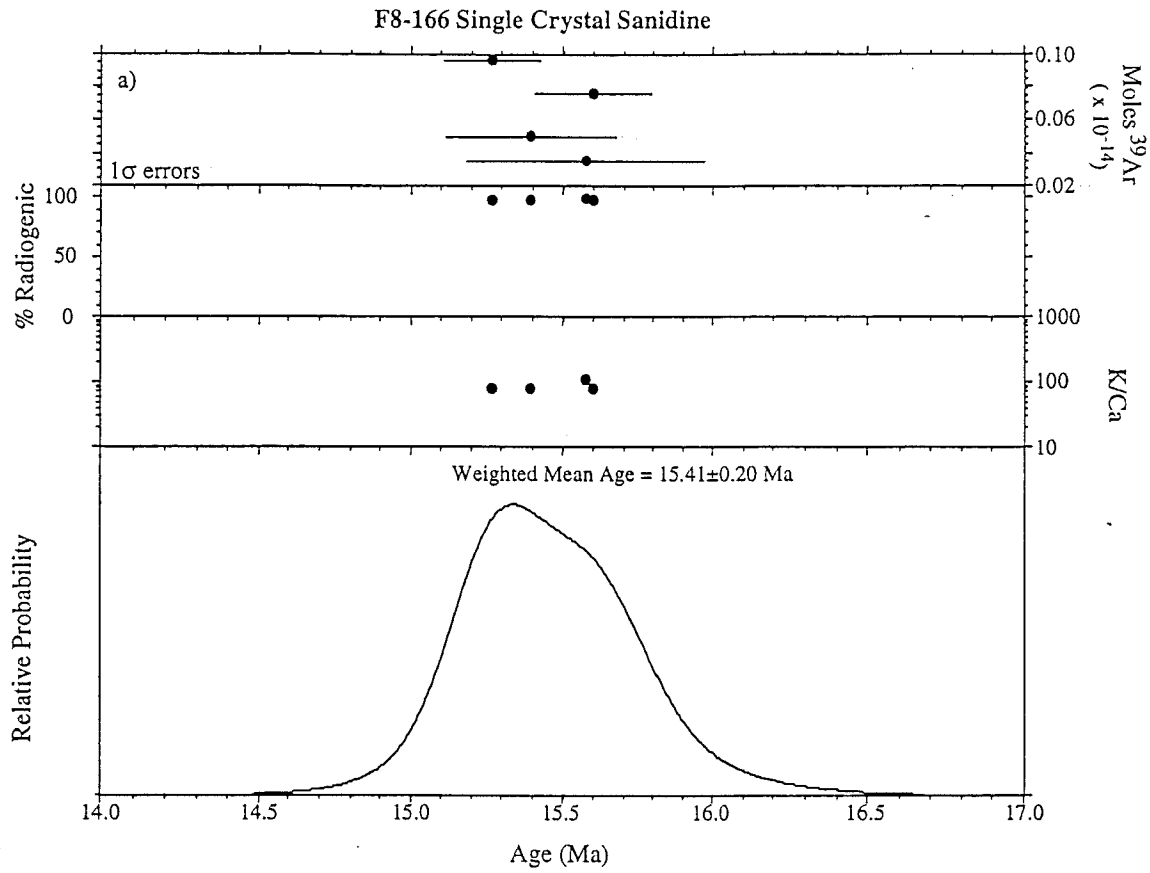

Figure 1 Diagram showing cumulative age probability distribution (Deino and Potts, 1992) and other analytical parameters for single-crystal laser fusion $^{40}Ar/^{39}Ar$ analysis of sample F8-166.

UNIT DESCRIPTIONS
HORSESHOE DAM QUADRANGLE, MARICOPA COUNTY, ARIZONA

QUATERNARY RIVER DEPOSITS

Qycr **Active river channel deposits (Holocene)**: Channel deposits of the Verde River. Channel banks are commonly well-defined, ranging from 1 to 3 m in height. Along some stream reaches, however, channel depth decreases and the channel diverges into several smaller, anastomosing channels. Moderately sorted deposits consist primarily of sand and well-rounded cobbles and boulders, with local accumulations of silt. Deposits within Qycr channels are modern to historical in age.

Qyr **Holocene river terrace deposits**: Low river terrace deposits with weak soil development. Several different levels of terraces are included in this map unit. The lowest and youngest of these terraces are discontinuous and contain both channel (crudely bedded coarse sands, gravels, and cobbles) and overbank (finely laminated clays, silts, and fine sands) sediments. Somewhat older Holocene terraces comprise the majority of unit Qyr. These terraces range from 1 to 5 m above active channels. They are fairly continuous and broad; they contain both channel and overbank deposits, with the latter dominating the upper part of the terrace. Alluvial bedforms near the surface are absent or weakly expressed due to bioturbation. There is organic accumulation in uppermost soil horizons, and slightly oxidized horizons exist at deeper levels. In places, fine nodules of calcium carbonate have begun to accumulate. These deposits are correlative with the Lehi terrace of the Salt and Verde rivers (Péwé, 1978).

Qlr **Late Pleistocene river terrace deposits**: Late Pleistocene river terrace deposits with moderate soil development are mapped as unit Qlr. Qlr terrace surfaces range from about 2 to 15 m above modern channels, and terrace surfaces have undergone some dissection by small streams that flow across them. Qlr alluvium includes channel deposits consisting of sand, cobbles, and small boulders and overbank deposits consisting of sand, silt, and clay. Soil development on Qlr terraces is moderate, with some reddening, moderate clay accumulation, and stage II calcium carbonate accumulation. These deposits are probably correlative with the Blue Point terrace of the Salt River (Péwé, 1978).

Qmr **Middle Pleistocene river terrace deposits**: High river terrace deposits with strong soil development. Qmr terraces range in height above the modern channel to as much as 30 to 70 m. Qmr alluvium is composed of sand, gravel, and cobble channel deposits and silty and clayey overbank sediments. Desert pavement development is weak and rock varnish is variable. Some Qmr terraces have broad, well-preserved alluvial surfaces. In many areas, however, Qmr surfaces have been eroded into a series of low, rounded ridges and moderately incised stream channels. Soils associated with Qmr terraces are strongly developed where they have not been seriously eroded. Clay accumulation in Qmr soils is variable; well-preserved soils have fairly strong, reddish brown horizons with loam to clay loam textures. Qmr soils typically have strongly developed calcic or petrocalcic horizons (Stage III-V). These deposits are correlative with the Mesa terrace of the Verde and Salt rivers (Péwé, 1978).

Qor **Older Pleistocene river terrace deposits**: Very old, very high, degraded river terrace remnants with variable soil development. Qor terraces exist as isolated remnants standing high above adjacent Qmr terraces. Because Qor terrace deposits have been exposed to erosion for most of the Quaternary, they seldom retain their original terrace form and instead form a series of isolated ridges and hills. Qor deposits are coarse, with clasts ranging in size from pebbles to boulders. Coarse-grained rocks at the surface are highly pitted, and fine-grained rocks are commonly fractured. There is no desert pavement development in areas that have undergone significant erosion, but in a few places where depositional surfaces are preserved desert pavement and rock varnish are moderately to strongly developed. Qor soils are dominated by thick petrocalcic horizons with Stage IV-V morphology. These deposits are correlative with the Sawik terrace of the Salt River (Péwé, 1978).

QUATERNARY PIEDMONT DEPOSITS

Qy **Younger alluvium (Holocene)**: Unconsolidated young deposits covering active channels, low terraces and alluvial fans associated with ephemeral streams draining piedmonts and mountain areas. Qy deposits consist of unweathered sand, silt, pebbles, cobbles, and boulders. Channel deposits are typically coarse and very poorly sorted, with particles ranging from silt to cobbles or boulders. On terraces and alluvial fans, deposits consist primarily of sand and silt, with some gravel. Channel deposits are generally well-stratified and lack any appreciable soil formation. Soils on terraces and alluvial fans are weakly developed and primary depositional topography (gravel bars and finer-grained swales) is commonly preserved. Surface colors typically are light brown to yellowish brown; slight reddening deeper in the soil profile is common. Surface clasts have no rock varnish. Soil development is generally limited to surface enrichment of silt from eolian sources, slight reddening due to oxidation, and weak calcium carbonate accumulation. Generally, late Holocene soils are minimally developed, whereas middle and early Holocene soils typically contain cambic horizons, weak calcic horizons (Stage I or less; morphologic stages of calcium carbonate accumulation are after Gile and others, 1981, and Machette, 1985), and are noticeably reddened.

Qc **Colluvium and talus (Holocene)**: Slope deposits, ranging from bare talus cones to soil-covered, mud-rich colluvium. The unit is shown in two areas near the western, basin-bounding fault.

Ql **Late Pleistocene alluvium**: Late Pleistocene relict alluvial fan and terrace deposits with moderate soil development. Deposits are poorly sorted, ranging from sand to cobbles and boulders, coarser in upper piedmont and mountain areas. Desert pavement and rock varnish development is quite variable, ranging from nonexistent to moderate. Subdued depositional bar-and-swale surface topography is common. Ql surface colors typically are similar to or slightly redder than Qy surfaces (light brown to reddish yellow). Ql soils commonly contain zones of clay accumulation that are weakly to moderately strongly developed. These upper horizons of Ql soils are reddened relative to their parent material. Calcic horizon morphologies are typically Stage II.

Qm(Yg) Pedimented granite (middle Pliestocene): Areas of deeply weathered porphyritic granite (Yg) that form deeply incised peidmont slopes. Age is probably middle to late Pleistocene.

Qm **Middle Pleistocene alluvium**: Dissected middle Pleistocene alluvial fan and terrace deposits with moderate to strong soil development are mapped as Qm. Deposits are very poorly sorted, ranging from sand to boulders, fining downstream. Qm surfaces typically are 2 to 10 m above modern channels, with dissection decreasing downslope as Qm surfaces converge with younger surfaces. Desert pavement and rock varnish development are moderate to strong on stable Qm surfaces, but may be variable or weak on surfaces that have experienced significant erosion. Qm soils typically are strongly developed. Surface color range from strong brown to reddish brown. Qm soils typically contain reddened horizons that are moderately to strongly enriched in pedogenic clay. Clasts within argillic horizons may be highly weathered. Calcic horizon development typically is fairly strong (Stage II-IV), but Qm units generally do not have cemented petrocalcic horizons (caliche).

Qo **Older Pleistocene alluvium**: Deeply dissected remnants of very old Quaternary alluvial fans with strong soil development are mapped as Qo. Qo surfaces are high above modern channels. Qo deposits typically are very poorly sorted, with particles ranging from sand to boulders. Desert pavement on Qo surfaces varies from none to moderate; rock varnish varies from none to strong. Qo soils are characterized by strong carbonate and silica cementation and variable clay accumulation, depending on their preservation. In areas where fairly extensive planar Qo surfaces are preserved, Qo soils typically include reddish brown to red, clay-rich horizons and cemented petrocalcic horizons with laminar caps (caliche; Stage V). In areas where Qo remnants are of limited extent, or on slopes below planar fan surfaces, argillic horizons may have been removed by erosion leaving a duric or petrocalcic horizon and caliche fragments at the surface. The common presence of caliche fragments on Qo surfaces indicates erosion or bioturbation of the original surface.

TERTIARY

Tc **Conglomerate and sandstone, undivided (Miocene)**: A complex unit dominated by conglomerate to the west and sandstone and pebbly sandstone toward the center of the basin and to the east. Conglomerates contain sub-angular to rounded clasts chiefly of granitic and/or basaltic lithologies. Clast size decreases, and the degree of rounding increases toward the basin interior. Basaltic clasts dominate in areas directly overlying basalt, and granitic lithologies dominate along the range-bounding fault escarpment to the west. Conglomerates toward the center of the basin contain subordinate clasts of quartzite, rhyolite, and other Early Proterozoic lithologies of the Mazatzal Mountains. The conglomerates and sandstones are generally medium-bedded, but to the west they are medium- to thick-bedded. To the east the unit includes sparse interbeds of laminated to thin-bedded silty mudstone.

Tby **Younger basalt (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. Wrucke and Conway (1987) report compositional variation ranging from olivine basalt to andesite and an age of 8.3 $\pm$ 2.6 Ma for the highest preserved flow of this unit about 5 km north of the north

edge of the map area.

Tl **Lacustrine deposits (Miocene)**: Thin- and medium-bedded, laminated, light-colored, muddy siltstone and mudstone interbedded with rare pebbly sandstone and sandstone. The unit also includes very light-colored, thin- to medium-bedded limestone, typically recrystallized. Some limestones preserve ooid-pisoid grainstone/packstone texture, algal laminations, and stromatolites.

Ts **Sandstone (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.

Tcl **Lower conglomerate (Miocene)**: A sequence of conglomerate recognized on the east side of Verde River that directly overlies a thick succession of basalt lava (Tb) and is overlain by younger conglomerates and sandstone (Ts and Tc) along an angular unconformity. The clasts are principally of granophyre and aplite but locally include small amounts of Proterozoic quartzite and rhyolite. Interlayered fine- and coarse-grained, thin- to medium-bedded sandstone containing lenses and beds of arkosic granules and fine pebbles forms as much as three-fourths of the unit. Locally the unit contains abundant basalt flows.

Tb **Basalt lava (Miocene)**: Massive, amalgamated basalt lava flows containing between 5 and 15% phenocrysts of olivine and pyroxene, sparse bytownite, and rare, partially resorbed quartz. Individual flows are separated by thin soil intervals or reddish scoriaceous pyroclastic units, and felsic tuff beds. Wrucke and Conway (1987) report compositions as silicic as trachyandesite on Tangle Mountain approximately 15 km north of the map area and suggest that parts of the unit elsewhere may include andesite. Whole rock K/Ar ages from this unit range between 12.3 $\pm$ 0.8 Ma and 16.1 $\pm$ 0.15 Ma from the top and bottom of the unit, respectively (Wrucke and Conway, 1987).

Tt **Tuff (Miocene)**: Nonwelded and locally welded felsic tuff containing up to 30% phenocrysts of plagioclase and biotite and rare sanidine. The unit typically occurs as a single nonwelded unit less than 10 meters thick within the lower third of the basalt lava unit (Tb), but in some areas it underlies basalt lava and directly overlies crystalline basement. In the central part of the map area, the unit consists of two distinct welded to partially welded tuffs, both less than 10 meters thick, that are seperated by a thin basalt lava flow in some areas. A sanidine, single-crystal, laser fusion, $^{40}Ar/^{39}Ar$ date of 15.41 $\pm$ 0.21 Ma was obtained from this unit at the west edge of its outcrop area.

Tbt **Basalt and tuff (Miocene)**: Complex interbeds of nonwelded felsic tuff and basalt lava from one locality in the southeast corner of the map area along the west bank of Verde River. The exposure was mapped from a distance.

MIDDLE PROTEROZOIC

Yg **Porphyritic granite (Middle Proterozoic)**: Light brown- to orange-weathering, porphyritic granite with megacrysts of K-feldspar up to 5.0 cm but more typically 2-3 cm set in a medium- to coarse-grained granitic groundmass with up to 10% biotite.

Inclusions of granodioritic composition are common, and the granite it characterized by a lack of quartz veins or tectonic fabric in the map area. The granite correlates with the Pinnacle Peak granite of Isachsen and others (1999) which is dated at 1422.5 $\pm$ 2.2 Ma, but is also referred to as the Carefree Granite (Skotnicki, in preparation).

Yp **Pegmatite (Middle Proterozoic)**: K-feldspar, quartz, tourmaline pegmatite and minor aplite dikes and stocks found on the east side of Verde River in the southeast corner of the map area.

EARLY PROTEROZOIC

Xg **Payson Granite (Early Proterozoic)**: Pink- to orange-weathering, medium- to coarse-grained, hypidiomorphic granular, leucocratic, biotite granite, locally tourmaline bearing. The granite has been dated at approximately 1700 Ma (Silver and others, 1986), and it also contains unmapped bodies of granophyre.

Xvs **Metavolcanic and metasedimentary rocks, undivided (Early Proterozoic)**: Dark green to gray, fine- to medium-grained biotite schist, psammite, and amphibolite. Interpreted as a suite of metavolcanic and metasedimentary rocks.

Xu **Undifferentiated supracrustal and plutonic rocks (Early Proterozoic)**: Shown only in cross-section.