State of Arizona
Bureau of Geology and Mineral Technology

Geologic Investigation Series Map GI-1-A

GEOLOGY
MC DOWELL MOUNTAINS AREA
MARICOPA COUNTY, ARIZONA

by
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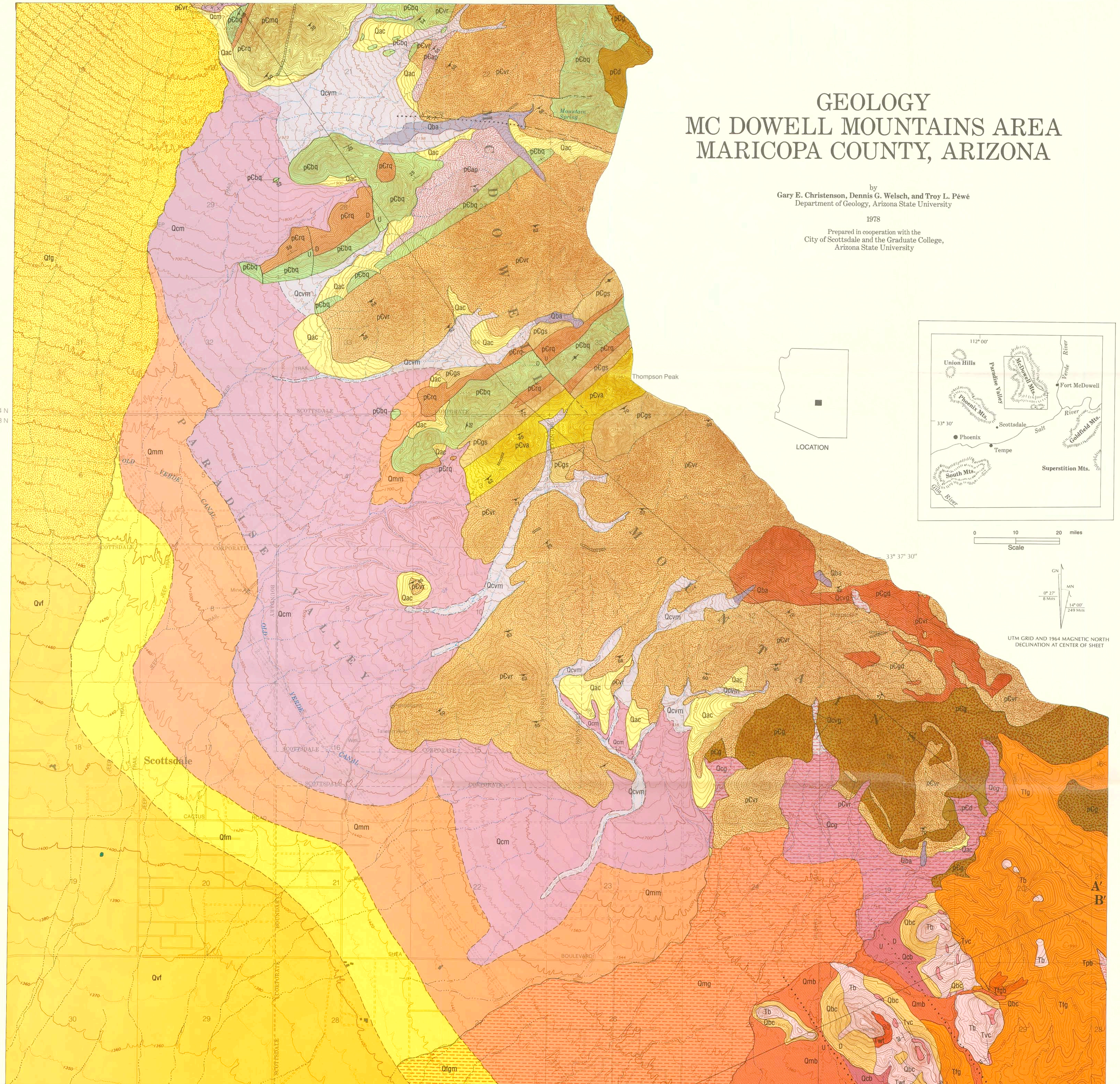
1978

Prepared in cooperation with the
City of Scottsdale and the Graduate College,
Arizona State University



Base maps from U.S. Geological Survey Topographic maps, 1:24000 series: Currys Corner (1964), McDowell Peak (1965), Paradise Valley (1965), and Sawik Mountain (1964)

SCALE 1:24 000

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10 FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

Geology by G. E. Christenson, D. G. Welsch, and T. L. Péwé, 1974–76.

LOCATION

Union Hills
Paradise Valley
McDowell Mts.
Fort McDowell
Verde River
Phoenix Mts.
Scottsdale
Phoenix
Tempe
Salt River
Goldfield Mts.
South Mts.
Superstition Mts.
Gila River

UTM GRID AND 1964 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET

INTRODUCTORY STATEMENT

The McDowell Mountains form the northeastern edge of the broad northwest-trending Paradise Valley basin in which the cities of Scottsdale and Paradise Valley are located. The high peaks of the McDowell Mountains reach elevations of 4,000 feet (1330 m) forming a picturesque northeastern border of the Phoenix-Scottsdale metropolitan area.

The first evidence of man's presence in the McDowell Mountains consists of Indian petroglyphs etched into coatings of desert varnish on boulders and rock outcroppings. The quest for mineral wealth brought the first white men into the area as suggested by numerous test pits and prospect trenches, and exploration continued with several small mines operating into the early twentieth century. At present, no mines remain in operation and the area has been essentially undeveloped until recent times.

In the past few years urbanization has encroached into the area with the rapid expansion of the Phoenix metropolitan area. Several residential and commercial developments are being constructed and complete development of the alluvial slopes of the McDowell Mountains area can be forseen in the not-too-distant future. To aid in proper land-use planning prior to such development, maps depicting environmental geologic conditions important to construction have been produced. These maps show conditions for excavation, waste disposal, and material resource development; delineate hazardous areas due to unstable slopes and flooding; and depict groundwater depth and quality where data are available.

GEOGRAPHIC SETTING

The McDowell Mountains are in southcentral Arizona 10 miles (16 km) northeast of Scottsdale. The area mapped includes parts of the Curry's Corner, Paradise Valley, McDowell Peak, and Sawik Mountain quadrangles (U.S. Geological Survey Topographic map series, 1:24,000). The actual boundaries of the map area are Pima Road to the west, the northern edge of the Salt River Indian Reservation to the south, the ridge crest and eastern edge of the Sawik Mountain Quadrange to the east, and the 1964 Scottsdale Corporate Boundary to the north. This includes parts of T3N R5E, T3N R6E, and T4N R5E, Gila and Salt River Baseline and Meridian.

CLIMATE

The study area is characterized by an arid subtropical climate with essentially two seasons: winter and summer. The average annual precipitation is 7.83 inches (19.8 cm). Winter lasts from November to May, and is characterized by mild temperatures, moderate-strong winds, and partly cloudy skies. The normal daily maximum temperatures are in the middle to upper 60's and 70's (18–28°C) with winter nighttime temperatures dropping into the 30's or 40's (1–7°C). Winter precipitation is associated with the middle latitude storms that move eastward from the Pacific Ocean, though the storms usually pass to the north, producing only cloudy skies. The area has several days of gentle, continuous light precipitation when the storms move south of their normal route.

The summer lasts from June to October and is characterized by hot daytime temperatures, heavy short-period thunderstorms, and light winds. The daytime temperatures are commonly warmer than 100°F (38°C) and regularly reach 110°F (43°C) or more during the end of June and the beginning weeks of July, with nighttime temperatures often above 80°F (26°C). Summer precipitation during July and August is associated with convective moist tropical air masses from the Gulf of Mexico which spread out westward from the mountains, producing early-evening, heavy, short-period thunderstorms. These storms are commonly accompanied by lightning and are often preceded by gusty winds blowing from the east. Heavy precipitation can occur when September-October tropical systems move through the State.

FLORA AND FAUNA

The principal vegetation types in the McDowell Mountains area represent a typical lower Sonoran Desert upland community. The vegetation is characterized by a palo verde-saguaro association with a complex assemblage of smaller vegetation types. These include foothill palo verde, mesquite, ironwood, creosote bush, canotia, ocotillo, and bursage as well as many varieties of cacti such as cholla, prickly pear, barrel, and saguaro. This assemblage of flora flourishes in the coarse soils of mountain slopes and alluvial fan surfaces and is perhaps the most scenic of all communities in the Sonoran Desert region, making it a very desirable area for development. In the extreme southwest corner of the area near the floor of Paradise Valley, a creosote community characterized by creosote bush, white bursage, and bunchgrass occurs on the fine-grained soils of the more arid basin floor.

The most abundant fauna is reptilian. Varied species of lizards, snakes, and desert tortoise live on the alluvial fans and the foothill slopes. Mammalian fauna are less numerous but include rabbit, coyote, javelina, and deer. Many species of birds, including cactus wren and roadrunner, also inhabit the area.

REGIONAL GEOLOGY

Southern Arizona, south of the Mogollon Rim, generally is referred to as the Basin and Range Physiographic Province. As implied by the name, this province is characterized by alternating broad, elongate basins and long, narrow mountain ranges which generally trend in a northwesterly direction. This unique physiographic expression formed as a result of a period of extensive faulting which began about 15 million years ago when large blocks of the earth's crust were uplifted along faults which locally trend to the northwest (Damon and others in press). The present mountain ranges, including the McDowell and Phoenix Mountains, were formed about this time. They occur on the relatively upthrown sides of these large faults, whereas the basins (Paradise Valley, Phoenix Basin) occur on the relatively downdropped sides of the faults. Erosion and downwasting occurred continuously as these large masses of rock were relatively elevated, and up to thousands of meters of alluvium and other sediments accumulated in the adjoining basins.

GEOLOGIC HISTORY

The McDowell Mountains are composed principally of rocks of Precambrian age. Two distinct ages of Precambrian rocks are present. The earlier Precambrian rocks are quartzites, phyllites, greenschists, and metavolcanic rocks of various types. These rocks form the high peaks of the McDowell Mountains with the predominant metamorphic rock type being a northeast trending, southerly dipping foliated metarhyolite and metatuff unit. This unit is underlain by quartz-mica schist (probably metavolcanic rocks of dacite and andesite composition) and greenschists (metabasalts), which are in turn underlain by units of quartzite of various colors. These quartzites range from being massive and structureless to being intricately cross-bedded and ripple-marked. A phyllite-argillite of extreme variability occurs interbedded with these quartzites and all are interpreted to represent metasedimentary rocks. This entire sequence of sediments and volcanics has undergone at least one episode of metamorphism and folding which has resulted in the formation of a series of folds with axes trending northeast, parallel to the foliation in the rocks. These folds include a gentle, broad syncline in the northern section and a very steep isoclinal anticline in the central section (see geologic cross section, plate 1-B).

Intrusion of the igneous rocks occurred in later Precambrian time, their compositions ranging from diorite to granite. Altered metamorphic rocks occurring within and around these intrusives retain the consistent northeast strike and southerly dip common to other metamorphic rocks in the area. Contact relationships indicate a post-metamorphic age for the granitic intrusions.

A large gap in the geologic record exists between the Precambrian rocks and the Tertiary fanglomerates. No known record of Paleozoic and Mesozoic history is preserved in this region. The Tertiary fanglomerates crop out on the southeast side of the mountains and contain rock types found presently in the northern part of the range. Modern alluvial fans in the area do not contain such rock types, indicating that a significant change in topography and drainage has occurred since deposition of the fanglomerates. The fanglomerates include a coarse red unit overlain by a coarse gray unit, which is in turn overlain by Tertiary basalt flows, welded ash-flow tuffs, and various (volcaniclastic) rocks. These Tertiary units subsequently were cut by northwest trending normal faults resulting in three basalt-capped fault blocks in the southeastern part. The southwest sides of these faults were relatively uplifted and tilted, and thus the originally horizontal basalt flows and underlying fanglomerate dip to the southwest 18–29°. Considerable erosion of the fault blocks has occurred, and surfaces of erosion cut on the fanglomerate, apparently related to ancient levels of the Verde River, occur on the extreme eastern portion of the map. Erosion of these fanglomerates and volcanics, and erosion of the higher portions of the McDowell Mountains, has continued to the present so that modern alluvial fans composed of sediment derived from these uplands extend into Paradise Valley to the west and south.

ENVIRONMENTAL GEOLOGY

From the basic geologic data, derivative environmental geology maps have been constructed. Data used to supplement the geologic map in constructing these derivative maps include: (1) engineering tests of consolidated rocks for crushing strength and resistance to abrasion, (2) tests on unconsolidated material to determine grain-size distribution and Atterberg Limits, (3) numerous field observations of caliche development, rock-jointing fracture patterns, and stream incision, and other data pertinent to environmental considerations.

Maps depicting (1) landforms, (2) land slopes, (3) distribution and development of caliche, and (4) ground-water depth, distribution, quality, and recharge, were constructed as base maps. From these base maps the geologic map and supplemental data interpretive maps depicting: (5) geologic hazards, (6) material resources, (7) excavation conditions were compiled. This folio can be utilized by planners, engineers, public officials, or anyone interested or involved in land use, to assist in the evaluation of the suitability of the area for development.

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EXPLANATION

UNCONSOLIDATED ROCKS[1]

Qvf
Very Fine Alluvium
Tan to brown, moderately sorted, moderately stratified, weakly calichified, alluvium averaging 5% subrounded gravel with clasts generally not exceeding ½ inch (1.3cm), 30% sand, and 65% silt and clay. Lithology of unit undifferentiated.

Qfm Qfg Qfgm
Fine Alluvium
Tan to buff, moderately sorted, moderately stratified, weakly to moderately calichified alluvium averaging 15% subrounded gravel with clasts not exceeding 1½ inches (3.8 cm), 50% sand, and 35% silt and clay. Qfm, clasts composed of platy metamorphic rocks. Qfg, composed of grus and clasts of granite with 25% gravel, 50% sand, and 27% silt and clay. Qfgm, composed of grus and clasts of granite and metamorphic rocks.

Qmm Qmb Qmg
Medium Alluvium
Gray to buff, poorly sorted, moderately stratified, moderately to strongly calichified alluvium averaging 30% subangular gravel with clasts generally not exceeding 1 foot (30 cm), 50% sand, and 20% silt and clay. Qmm, clasts composed of platy metamorphic rocks. Qmb, composed of grus and clasts of granite, basalt, and metamorphic rocks. Qmg, composed of grus and clasts of granite and metamorphic rocks.

Qcm Qcb Qcg
Coarse Alluvium
Gray to buff, poorly sorted, poorly stratified, moderately to very strong calichified alluvium averaging 50% subangular gravel with clasts generally less than 2 feet (61 cm), 30% sand and 20% silt and clay. Qcm, clasts composed of grus and clasts of granite, basalt, and metamorphic rocks. Qcb, composed of grus and clasts of granite and metamorphic rocks. Qcg, clasts composed mostly of basalt.

Qcvm Qcvg
Very Coarse Alluvium
Gray to buff, poorly sorted, poorly stratified, strongly calichified (noncalichified in dry washes) alluvium averaging 55% angular gravel with clasts generally less than 3 feet (91 cm), 30% sand, and 15% silt and clay. Qcvm, clasts composed of platy metamorphic rocks. Qcvg, composed of grus and clasts of granite and metamorphic rocks.

Qba
Boulder Alluvium
Color varies with parent rock type, poorly sorted, poorly stratified, noncalichified alluvium composed of boulders commonly exceeding 3 feet (91 cm) with minor amounts of silt and clay. Occurs at heads of fans in steep mountain stream channels. Composed of local rock types.

Ttg Ttgb
Fanglomerate
Gray to tan, poorly sorted, moderately stratified, moderately consolidated, locally very strongly calichified medium- to coarse-grained alluvium averaging 40% angular gravel, 30% sand, and 30% silt and clay, locally containing boulders up to 5 feet (152 cm). Ttg, composed of grus and clasts of granite and metamorphic rocks. Ttgb, cut and fill channels composed of grus and clasts of granite, basalt, and metamorphic rocks.

Tpb
Papago Buttes Deposits[2]
Red, poorly sorted, moderately stratified, moderately consolidated, medium- to coarse-grained alluvium composed of grus and clasts of granite and metamorphic rocks.

Qbc
Basalt Colluvium
Black, poorly sorted, poorly stratified, strongly calichified angular talus debris on the side and at the foot of basalt hills. Contains boulders up to 5 feet (152 cm), locally with only boulders at the surface.

Qac
Alluvium-Colluvium
Color varies with rock type, poorly sorted, poorly stratified, strongly calichified angular talus debris on fan surfaces and bedrock slopes averaging 55% angular gravel less than 3 feet (91 cm), 25% sand, and 20% silt and clay. Composed of local bedrock types.

CONSOLIDATED ROCKS

Volcanic rocks

Tb
Basalt
Blue to black, fine-grained, blocky to massive, locally finely fractured quartz-bearing basalt flows.

Tvc
Volcaniclastics
Red to pink, fine- to very coarse-grained clastic volcanics including air-fall ash, lahar(?), basalt pumice breccias, and basalt agglomerates within and between flows.

Twt
Welded Tuff
Brown to purple, coarse-grained, massive quartz latite(?) welded ash-flow tuff, locally with basalt inclusions and cut by basalt dikes.

Intrusive rocks

pCgr
Granite
Yellow to reddish brown, coarse-grained, massive granite, locally fine- to medium-grained, characteristically weathers spheroidally.

pCgd
Granodiorite
Dark green to dark gray, coarse-grained, massive granodiorite, characteristically weathers spheroidally.

pCd
Diorite
Dark grey to black, fine- to coarse-grained, blocky diorite, locally highly fractured and highly sheared.

Metamorphic rocks

pCvr
Taliesin Quartzite[2]
Light green to black, very fine-grained, platy to blocky, foliated quartzite, probably metamorphosed rhyolite and dacite flows and tuffs, locally cut by greenstone dikes. Weathers orange to grayish red. Highly fractured and weathers to a sugary texture near intrusive rocks.

pCva
Quartz-mica Schist
Gray to dark green, fine-grained, platy and locally fissile, moderately to highly foliated quartz-mica schist, probably metamorphosed dacite and andesite flows and tuffs.

pCgs
Greenschist
Gray to dark green, fine-grained, platy to fissile to massive, moderately to highly foliated, chlorite-rich greenstones and greenschists, probably metamorphosed basalt flows and mafic pyroclastics.

pCmq
Micaceous Quartzite
Silver to gray, fine- to medium-grained, platy, micaceous metamorphosed argillaceous sandstone, locally jointed to form thick rectangular blocks.

pCrq
Red Quartzite
Red to white, medium- to coarse-grained, massive metamorphosed orthoquartzite, with minor interbedded silver mica schists, green quartzites, and greenstone.

pCbq
Blue Quartzite
Blue to black, medium- to coarse-grained, locally cross-bedded and conglomeratic, massive metamorphosed orthoquartzite with minor interbedded silver mica schist, green quartzites, and greenstone.

pCap
Argillite-Phyllite
Red-brown to black, fine-grained, slaty to massive (locally fissile) argillite and phyllite, probably metamorphosed shales and siltstones.

1) Classification of unconsolidated units is based on the Unified Soil Classification system: gravel–greater than 4.76mm, sand–4.76 to .074mm, silt and clay–less than .074mm
2) Papago Buttes deposits and Taliesin quartzite are informal rock names, named for localities where similar rocks are found (Papago Buttes) or for localities where excellent examples of the particular rock type crops out (Taliesin West).

MAP SYMBOLS

Contact, dashed where gradational.
Fault, dashed where inferred, dotted where buried.
Dip and strike of beds.
Dip and strike of foliation.
Veins of milky quartz, generally less than 5 feet (1.5 m) wide.
Basalt dikes, generally less than 2 feet (0.6 m) wide.
Metamorphic rocks hydrothermally altered, generally along faults, to a soft, talcy, well-foliated, fissile, light green mica schist.
A——A' Geologic cross section (see Landforms Map, GI-1B)

Time Relation of Map Units