RECONNAISSANCE ENVIRONMENTAL GEOLOGY OF THE TONTO FOOTHILLS, SCOTTSDALE

MARICOPA COUNTY, ARIZONA

by Troy L. Péwé, Ray Kenny and Jim Bales,

1985

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GEOLOGY

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INTRODUCTION*

The Tonto Foothills part of the City of Scottsdale lies along the extreme northeast edge of the broad northwest-trending Paradise Valley Basin in which parts of the Cities of Paradise Valley and Phoenix are also located. The area also includes most of the broad Pinnacle Peak Pediment and some of the mountains north of Carefree.

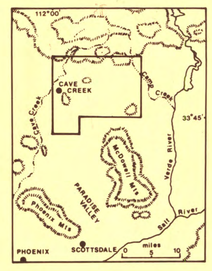
In the past few years, urbanization has encroached upon this area with the rapid expansion of the metropolitan area. Residential and commercial developments are being constructed. Complete development of the northern part of Scottsdale, including north-east Paradise Valley and the Pinnacle Peak Pediment, except for the northern mountains, can be foreseen in the not-too-distant future. To aid in proper land-use planning prior to such development, maps are needed depicting environmental and geological information, as well as the delineation of hazardous areas due to unstable slopes, flooding, and information on conditions for waste disposal based on an analysis of permeability of the sediments, development of caliche, flooding, and depth-to-groundwater and bedrock.

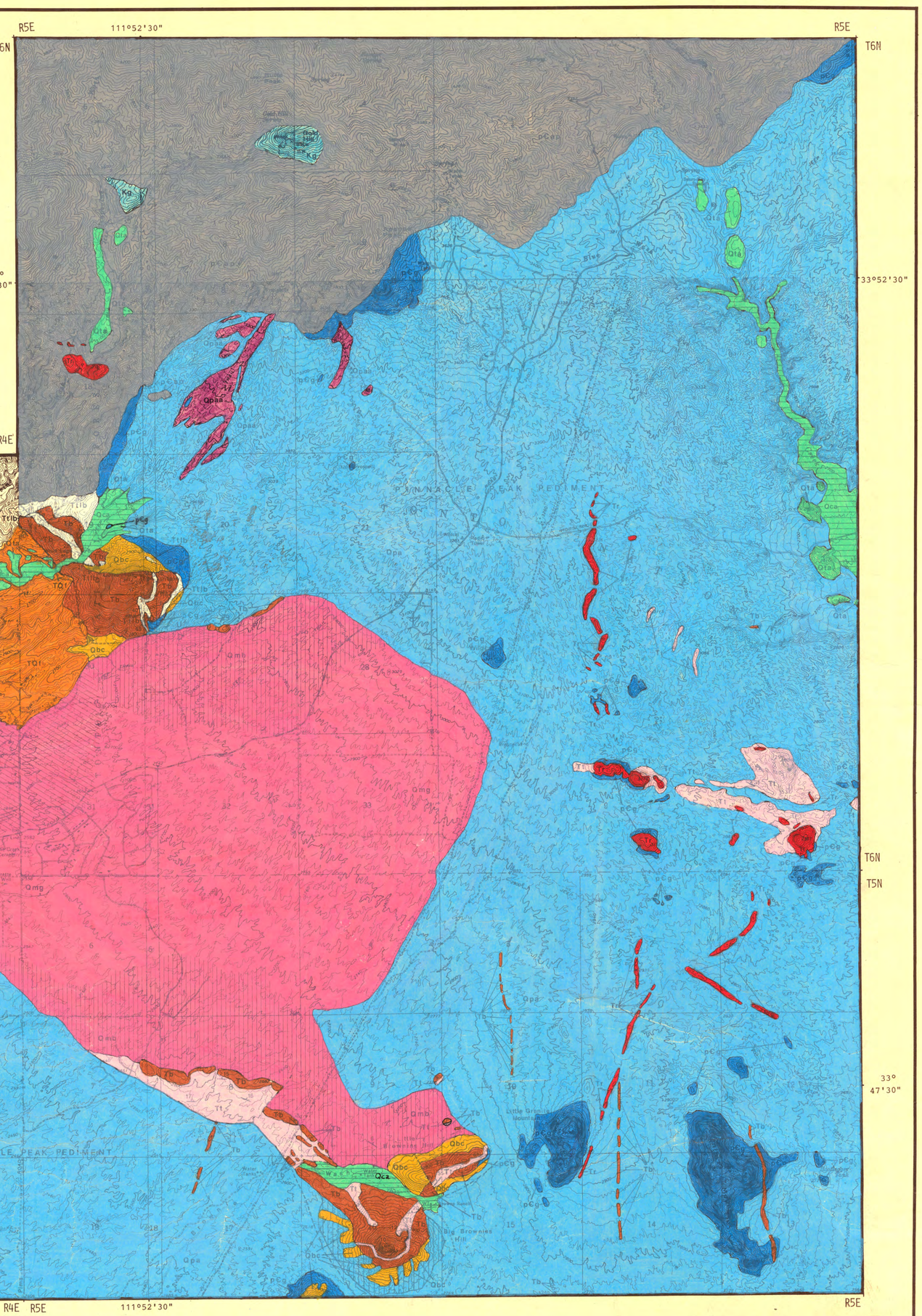
Geographic setting

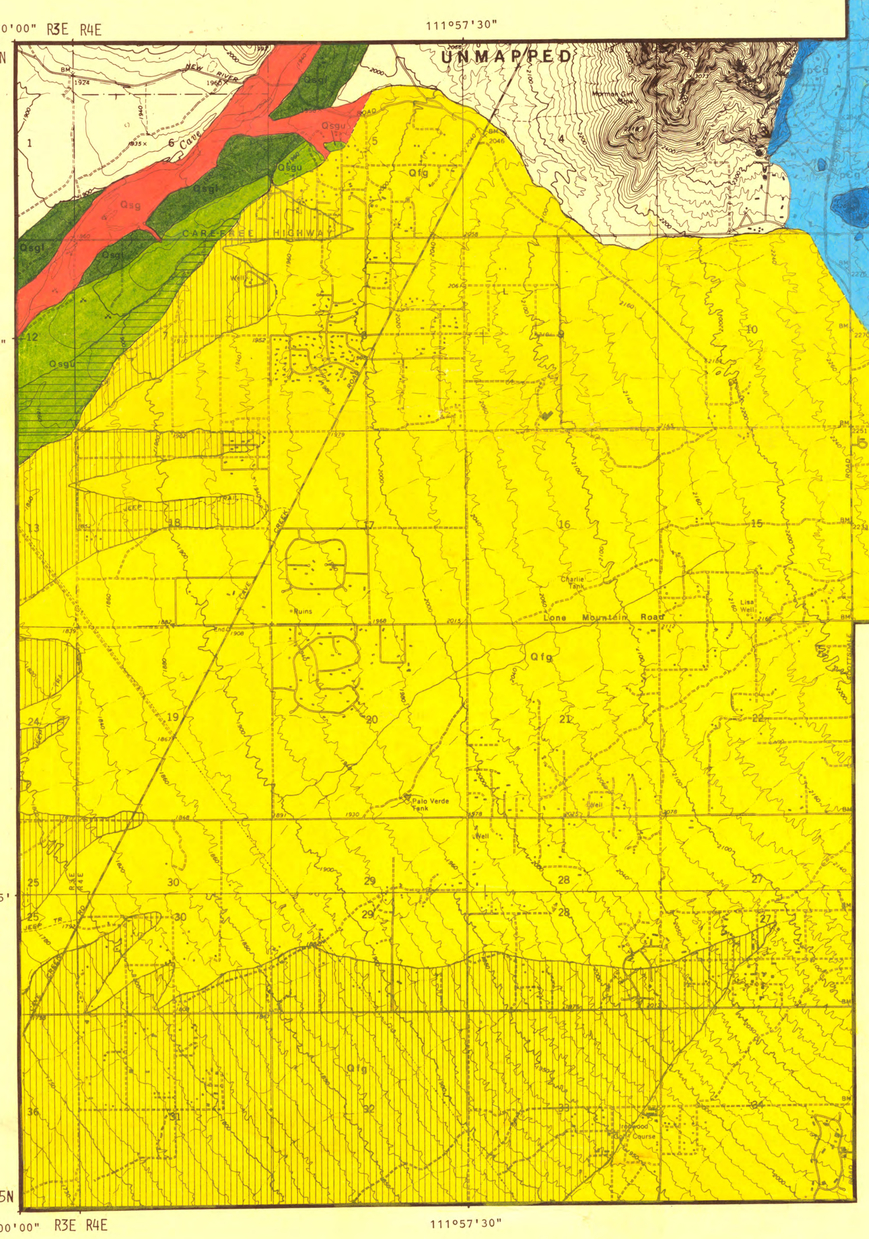
The Tonto Foothills area is in south-central Arizona, about 25 miles (40km) north of the Salt River. The area mapped includes parts of the Curry's Corner, Humboldt Mountain, Wildcat Hill, New River Mesa and Cave Creek Quadrangles (U.S. Geological Survey Topographic Map Series, 1:24,000). It extends north from Jomax Road to Jenny Hill Road, and east from 38th Street to 136th Street on the west. It comprises 144 square miles (375km), including parts of the Pinnacle Peak Pediment, Paradise Valley, and the mountains north of Carefree. The villages of Cave Creek and Carefee lie in the northwest part of the area.

Regional geology

Southern Arizona, south of the Mogollon Rim, is generally referred to as the Basin and Range Physiographic Province. As the name implies, this province is characterized by alternating broad, elongate basins, and long, narrow mountain ranges which trend generally northwest. This unique physiography resulted from a period of extensive faulting which began about 18 million years ago, when large blocks of the earth's crust were uplifted along faults which locally trend northwest (Damon and others, 1984). The present mountain ranges, and isolated mountains and hills, were formed at about this time. They occur on the upthrown (relative motion) sides of these faults, whereas the basins (Paradise Valley and Carefree structural basins) occur on the downdrop sides of these faults. The erosion and downwasting occurred continuously as these large rock masses elevated; and up to 5,000 ft (1,525km) or more of alluvium and other sediments accumulated in the adjoining basins.







Base map from U.S.G.S. topographical maps, 1:24,000 Series; Cave Creek (1965); Currys Corner (1964); Humboldt Mountain (1964); New River Mesa (1964); Wildcat Hill (1965).

SCALE 1:24 000

CONTOUR INTERVAL 10, 20, 40 FEET

ROAD CLASSIFICATION

Heavy-duty — Light-duty
Medium-duty — Unimproved dirt

Geology by T.L. Péwé, Ray Kenny, and Jim Bales; 1984-85.

Geologic history

The mountains north of Carefree and the Pinnacle Peak Pediment are composed principally of rock of Precambrian age. Two distinct ages of Precambrian rocks are present. The earlier Precambrian rocks are greenish-gray to gray to black, fine-grained, well fractured and jointed, slaty to phyllitic to massive slates, argillites, phyllites, and schists that were probably metamorphosed from shales and siltstones. These rocks form the mountains north of Carefree and the entire sequence of sediments has undergone at least one episode of metamorphism.

Intrusion of a coarse-grained, yellow to reddish brown, potassium-rich granite occurred in later Precambrian time. Geologic study of the contact relations of the area adjoining the Tonto Foothills on the south indicates a post-metamorphic age for the granitic intrusion. In that part of the Pinnacle Peak Pediment just south of the southern border of the area, it is known that most of the hills have a core of quartzite that was slightly to almost completely altered as it was surrounded by the granite.

A large gap in the geologic record exists between Precambrian rocks and the Tertiary volcanics which occur on the north and south sides of the Carefree structural basin, except for two masses of equigranular, locally permineralized, massive granite intruded in Cretaceous times in the metamorphic rocks in the northern part of the area. No record of Paleozoic history has been found in the region. The granitic instrusions of Cretaceous age are of a reddish pink to pale brown, coarse- to medium-grained granite and mineralized with veins and dikes of quartz-bearing metalliferous deposits including gold and minor sulfides. The late Tertiary volcanic rocks include reddish pink to pale brown, welded rhyolite dikes, flows, plugs, and pumice-bearing tuffs, as well as cream to buff to red brown tuff and tuff breccia locally partially to substantially welded. In addition, there occurs basalt flows, locally with calicite-filled amygdules. After the deposition of the lava flows and pyroclastic deposits, Basin and Range faulting continued in late Tertiary, during which time volcanic deposits on the north and south sides of the Carefree region were tilted into what is now a deep structural basin extending east-west across the study area in the vicinity of Cave Creek, Carefree, and as far east as Big Brownie's Hill. The basin is about 3 miles (4.8km) wide and about 6 miles (9.6km) long. Considerable erosion of the fault block mountains and lava flows occurred in late Tertiary and Quaternary time, forming extensive pediments and depositing sediments in the structural basins. As the granitic mountain block eroded, a pediment surface sloping both to Paradise Valley on the west and to the Verde Valley on the east was produced. The pediment is a gently sloping bedrock erosional landform, with a veneer of granitic alluvium 1 to 5 ft (0.9 to 1.6m) thick, locally up to 15 ft (4.6m). The edges of the pediment extending into Paradise Valley are buried by an ever-thickening wedge of alluvium worn from the pediment and the mountains.

Environmental geology

From the basic geologic data, derivative geology maps have been constructed. Data used to supplement the geologic map in constructing these derivative maps include: 1) tests on unconsolidated materials to determine grain size distribution and Atterberg limits; 2) numerous field observations of caliche development, rock jointing, fracture patterns and; 3) other data pertinent to environmental considerations, such as sub-surface information, water-well logs, dry-well borings, and sewer and other utility trenches.

Maps have been prepared depicting hazards to development such as slope instability, earthquake problems, and presenting waste disposal evaluation involving the geologic parameters limiting the location of septic tanks, waste stabilization ponds, sanitary landfills and sources for cover for sanitary landfills. These maps may be utilized by planners, engineers, public officials, or anyone interested or involved in land use to assist in evaluating the suitability of the area for development.

*This map involves general investigation on a broad scale and does not preclude the necessity of individual site analysis.

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EXPLANATION

MAP SYMBOLS

Contact, dashed where gradational.

Fault, dashed where inferred

40 Dip and strike of beds.

33 Dip and strike of foliation.

TIME RELATION OF MAP UNITS

Unconsolidated rocks

Qfg, Qms, Qmb, Qmb, Qsg, Qsgl, Qsgu, Qta, Qca, Qbc, Qpaa, Qpa — QUATERNARY

TQf — TERTIARY-QUATERNARY

Consolidated rocks

Igneous Extrusive and Sedimentary

Ttlb, Tb, Tr, Tt, Twt — TERTIARY

Intrusive Igneous

Kg — CRETACEOUS

pCg — PRECAMBRIAN

Metamorphic

pCap — PRECAMBRIAN

UNCONSOLIDATED ROCKS

Fine Alluvium (Qfg)
Tan to buff, moderately sorted, moderately stratified, moderately to strongly calichified alluvium averaging 28% subrounded gravel with clasts generally not exceeding 1 ½ in (3.8 cm), 55% sand and 17% silt and clay. Vertical patterned area indicates greater than average clay content near and at the surface.

Medium Alluvium (Qmg, Qmb, Qmb)
Gray to buff, poorly sorted, moderately stratified, weakly to very strongly calichified alluvium averaging 52% subangular gravel with clasts generally not exceeding 1 ft (30 cm), 40% sand, and 8% silt and clay. Near bedrock outcrops clasts may be 1 or 2 ft (30 to 60 cm) or larger and reflect the local rock type. Qmb, composed of grus with abundant clasts of subangular basalt and other volcanic rocks. Qma, composed mostly of grus with abundant thin lenses and layers of fine sand and silt.

Cave Creek Sand and Gravel (Qsg, Qsgl, Qsgu)
Gray to brownish gray, moderately to well sorted, well stratified, coarse-grained sand and gravel, locally interbedded with silt. Well rounded clasts, 2 to 48 in (5 to 120 cm). Matrix of sediments less than 4 in (10 cm), 73% gravel, 22% sand, and 4% silt. Matrix composed of 24% metabasalt, 24% other dark metamorphic rocks, 17% basalt, 7% granite, 6% quartzite, 5% silicic volcanic breccia, and 17% miscellaneous rock types. Qsgu, moderately to strongly calichified sand and gravel with lenses of overbank silt of upper Cave Creek Terrace. Horizontal patterned area indicates eroded upper terrace. Qsgl, weakly to moderately calichified sand and gravel with lenses of overbank silt of lower Cave Creek Terrace. Qsg, noncalichified sand and gravel of the modern channel.

Sand, Gravel, and Terrace Alluvium (Qta, Qca)
Light gray to buff, moderately to well sorted, moderately to well stratified, medium-grained sand and gravel locally interbedded with lenses of overbank silt. Well rounded (basalts) to subangular (metamorphic) clasts 1 to 12 in (2.5 to 30 cm), near bedrock outcrops clasts may exceed 1 ft (30 cm) and reflect the local rock type. Size distribution of sediment: 51-70% gravel, 18-55% sand, and 3-5% silt and clay. Composition of sediment matrix less than 4 in (10 cm) is 25% metabasalt, 30% other metamorphic rocks, 20% granite, 8% rhyolite breccia. Qta, weakly calichified sand and gravel terrace deposits. Qca, noncalichified sand and gravel of the modern floodplain.

Basalt Colluvium (Qbc)
Black to dark gray, poorly sorted, poorly stratified, moderately to strongly calichified, angular mass wasting debris on the slopes and at the foot of basalt hills. Contains boulders up to 5 ft (152 cm), locally with only boulders at the surface.

Argillite Pediment Alluvium (Qpaa)
Greenish gray to dark gray to black, poorly sorted, angular, planar, poorly stratified, coarse sandy alluvium forming remnant cover on dissected granite pediment; clasts of metamorphic and volcanic rock less than 1 ft (30 cm) in diameter; near bedrock outcrops clasts may be greater than 1 ft (30 cm).

Sombrero Formation (TQf)
Gray to brownish gray, poorly to locally moderately stratified, well-indurated, poorly to moderately sorted, angular to subrounded fanglomerate with clasts generally less than 1 ft (30 cm), but locally to 3 ft (1 m). Matrix of sediments smaller than 4 in (12 cm) is 24% gravel, 75% sand, and 2% silt. Matrix composed of 25% metabasalt, 42% other dark metamorphic rocks, 14% basalt, 6% breccia-conglomerate 6% quartzite, 3% quartz, 2% granite, and 3% others.

Granitic Pediment Alluvium (Qpa)
Gray to buff, poorly sorted, moderately stratified, moderately to very strongly calichified, fine to medium alluvium composed of grus averaging 20% to 35% subangular gravel with clasts generally 1 to 2 in (2.5 to 5.1 cm), locally 6 to 13 in (15.2 to 30.5 cm) near bedrock outcrops, 50% to 70% sand and 10% to 15% silt and clay. Alluvium in washes is well stratified, moderately sorted grus with few large clasts. Alluvium forms a thin blanket 1 to 5 ft (0.3 to 1.6 m) thick over the irregular surface of the granite pediment; local thicknesses to 15 ft (4.6 m). Rounded, widespread clusters and isolated protuberances of yellow to reddish brown, coarse-grained, massive Precambrian granite project 1 to 20 ft (0.3 to 6.1 m) high above the alluvium or crop out along bedrock washes. Vertically patterned area indicates known grus thickness of 5 to more than 30 ft (1.6 to more than 9.1 m).

CONSOLIDATED ROCKS

SEDIMENTARY

Tuffaceous Lake Beds (Ttlb)
Light gray to reddish tan to white, fine-grained, well stratified, moderately to well-sorted, crenulated, tuffaceous locally calcareous lacustrine deposits, with alternating layers and lenses of mudstones, siltstones, tuffaceous sandstones, and locally silty laminae.

IGNEOUS

EXTRUSIVE

Basalt (Tb)
Dark gray to black, fine-grained, blocky to scoriaceous to massive, locally finely fractured to strongly jointed basalt flows; locally with calcite-filled amygdules. Local dikes generally 2 to 20 ft (60 cm to 6.1 m) wide. Cross-hatched pattern area indicates a highly weathered, calichified basalt colluvium; clasts up to 3 ft (90 cm).

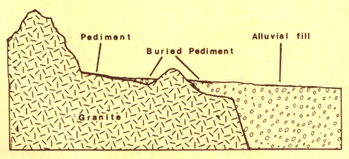
Rhyolite (Tr)
Light gray, cream to pink, resistant, mostly cliff-forming, partially to completely welded rhyolitic dikes, flows, plugs, and pumice-bearing tuffs; locally sheared, fractured, and cut by quartz dikes and jasperoid veins.

Tuff (Tt, Twt)
Light cream, buff to red brown, friable, porous, fine-grained, locally micaceous tuff and tuff breccia, with clasts generally 1/16 in (1.15 mm) to 1/8 in (3.1 mm), locally up to 4 in (10 cm). Twt, reddish brown to dark gray, well indurated, crystalline, partially to substantially welded, massive, resistant, cliff-forming micaceous rhyolite tuff.

INTRUSIVE

Medium-grained Granite (Kg)
Reddish pink to pale brown, coarse- to medium-grained, equigranular, locally permineralized, massive granite, principally composed of quartz and potassium feldspar crystals; locally fine- to medium-grained aplite dikes; locally faulted and mineralized with veins and dikes of quartz-bearing minor sulfide and metaliferous deposits.

Coarse-grained Granite (pCg)
Yellow to reddish brown, coarse-grained massive granite, potassium feldspar crystals up to 4 in (10 cm), characteristically weathers spheroidally; fine-grained aplite dikes up to 10 ft (3 m) thick, weathers into vertical cliffs and pinnacles.

METAMORPHIC

Argillite-Phyllite (pCap)
Greenish gray to gray to black, fine-grained, well fractured and jointed, slaty (locally fissile) to phyllitic to massive, slate, argillite, phyllite and schist; probably metamorphosed shales and siltstones.