State of Arizona
Bureau of Geology and Mineral Technology

Geologic Investigation Series Map GI-2-A

GEOLOGY
TEMPE QUADRANGLE, MARICOPA COUNTY, ARIZONA

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Tempe, Scottsdale, and Phoenix, and the
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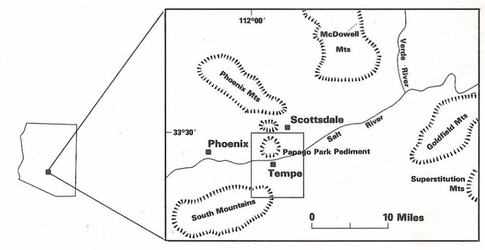


INTRODUCTORY STATEMENT

The Tempe Quadrangle lies in the broad valley of the Phoenix Basin, and includes parts of the Cities of Tempe, Scottsdale, and Phoenix. The quadrangle has been intensely urbanized except for the Indian Reservation to the east, the Salt River channel east-west across the center, and Papago Park Pediment north of the river. Total relief is 645 feet (197 m), ranging from 1100 feet (335 m) in the Salt River bed to 1745 feet (532 m) at the summit of Barnes Butte. With the exception of a few isolated rock masses, the area occupies a relatively flat desert plain formed primarily by older and modern alluvial deposits.

CLIMATE

The arid subtropical climate of the study area is characterized by rapid heating by day and rapid cooling by night, producing diurnal temperature changes often exceeding 30°F (17°C). Summers are hot with daytime temperatures normally warmer than 100°F (38°C). Winter temperatures are usually in the sixties, and may rise into the lower eighties, with an average of only 30 days when lows dip below freezing. The average daily temperature is 89°F (32°) in July, and 50°F (10°C) in January.

Precipitation amounts are slight, averaging 7.2 inches (19cm) annually. Drought conditions are most severe in May and June, followed by the "monsoon season" from mid-July to mid-September, when late afternoon thunderstorms are preceded by gusty winds and blowing dust. December to February is the rainy season, with gentle, often continuous winter rains and cloudy days.

VEGETATION

The Tempe Quadrangle is in the Lower Sonoran life-zone with characteristic desert shrub vegetation. The creosote bush-white bursage community inhabits less rocky areas of low relief. The paloverde-saguaro community of small-leaved trees, shrubs, and cacti is well developed on the rocky, well drained slopes of Papago Park Pediment, South Mountains, and Tempe Butte. The diverse cactus flora include cholla, prickly pear, hedgehog, pincushion, and fishhook. Riparian trees of the arroyos include blue paloverde, mesquite, catclaw, desert willow, and hackberry. Saltbush and tamarix form extensive stands across Salt River bottomland. Annual wildflowers and several species of natural grasses may be remarkably abundant following extremely wet winters.

REGIONAL GEOLOGY

Southern Arizona lies in the Basin and Range Province, characterized by alternating broad, elongate basins and long, narrow mountain ranges. This unique physiography resulted from a period of regional block-faulting along steep, normal faults, that began in Arizona approximately 17 million years ago. Basin and Range faulting is the result of extension due to thinning of the earth's crust. Vertical movement of crustal blocks created mountains on the upthrown side and basins on the downthrown side. As erosion and downwasting lowered the mountains, great thicknesses of clastic sediments accumulated in the adjoining basins.

GEOLOGIC HISTORY

The earliest event recorded in the Tempe Quadrangle is the extrusion of silicic ash and lava flows, which were subsequently metamorphosed in Precambrian time producing metarhyolite. The metarhyolite is intruded by two granites. The relationship between those two granites, Tovrea and Camelback Granites, is not evident within the quadrangle. The metarhyolite and Camelback Granite show evidence of cataclastisis.

During a period of faulting in mid-Tertiary time, the old rocks were uplifted to form mountains. Alluvial fans formed at the base of these mountains, and thick deposits of coarse, angular rock debris accumulated (the Camels Head Formation). These deposits were interbedded with ash and lava flows extruded from local fissures. The andesite of Tempe Butte has a radiometric date of 17.6±0.4 million years (Scarborough and Wilt, 1979). (See the reverse side of this map for the geologic time scale).

The bedrock exposed at Papago Park Pediment, Tempe Butte, Twin Buttes, and Bell Butte are small, tilted and uplifted fault-blocks almost completely buried by aggrading valley alluvium. In response to the continued uplift of the ranges and relative subsidence of the basin, the Salt River has cut several terrace levels, and the pediment colluvium and alluvial fans have been entrenched.

ENVIRONMENTAL GEOLOGY

The geology map serves as a basis for the development of additional maps depicting various environmental concerns. See reverse side of this map for an introductory statement regarding environmental geology and a brief description of each map in this environmental geology folio.

SELECTED REFERENCES

Atkinson, D. E., and Hay, S. M., 1983, Preliminary report of Motorola Chemical Leak Project, Section 2: Geology: *in* Gutierrez-Palmenberg, Inc., 1983, Preliminary report of Motorola Chemical Leak Project: Phoenix, Arizona, p. II-1-II-35, with Appendix A, 42 p.

Champine, A. L., 1982, The microstructures and petrofabrics of the mylonite-chloritic breccia transition, South Mountains, Maricopa County, Arizona: unpublished Master of Science thesis, Arizona State University, 102 p.

Christensen, G. E., Welsch, D. G., and Péwé, T. L., 1978, Environmental geology of the McDowell Mountains area, Maricopa County, Arizona: Arizona Bureau of Geology and Mineral Technology, Geologic Investigation Series, GI-1-A, 1:24,000.

Cordy, G. E., Holway, J. V., and Péwé, T. L., 1977, Environmental geology of the Paradise Valley Quadrangle, Maricopa County, Arizona: Tempe, Arizona, unpublished folio of maps prepared for the City of Scottsdale, 14 sheets, 1:24,000

Green, C. R., and Sellers, W. D., 1964, Arizona climate: Tucson, Arizona, University of Arizona Press, 503 p.

Kokalis, P. G., 1971, Terraces of the Lower Salt River Valley, Arizona: unpublished Master of Science thesis, Arizona State University, 103 p.

Lowe, C. H., 1964, Arizona landscapes and habitats, *in* Vertebrates of Arizona: University of Arizona Press, p. 1-82.

Nations, J. D., and Lindsay, E., 1976, Pleistocene *Equus* from Salt River terrace gravels, Phoenix, Arizona: Journal of the Arizona Academy of Science, Volume 11, p. 27-28.

Péwé, T. L., 1978, Terraces of the middle Salt River Valley in relation to the late Cenozoic history of the Phoenix Basin, Arizona, *in* Burt, D. M., and Péwé, T. L., (Eds.) Guidebook to the geology of central Arizona: Arizona Bureau of Geology and Mineral Technology, Special Paper number 2, p. 1-45.

Reynolds, S. J., 1985, Geology of the South Mountains, Central Arizona: Arizona Bureau of Geology and Mineral Technology, Bulletin 195, 61 p.

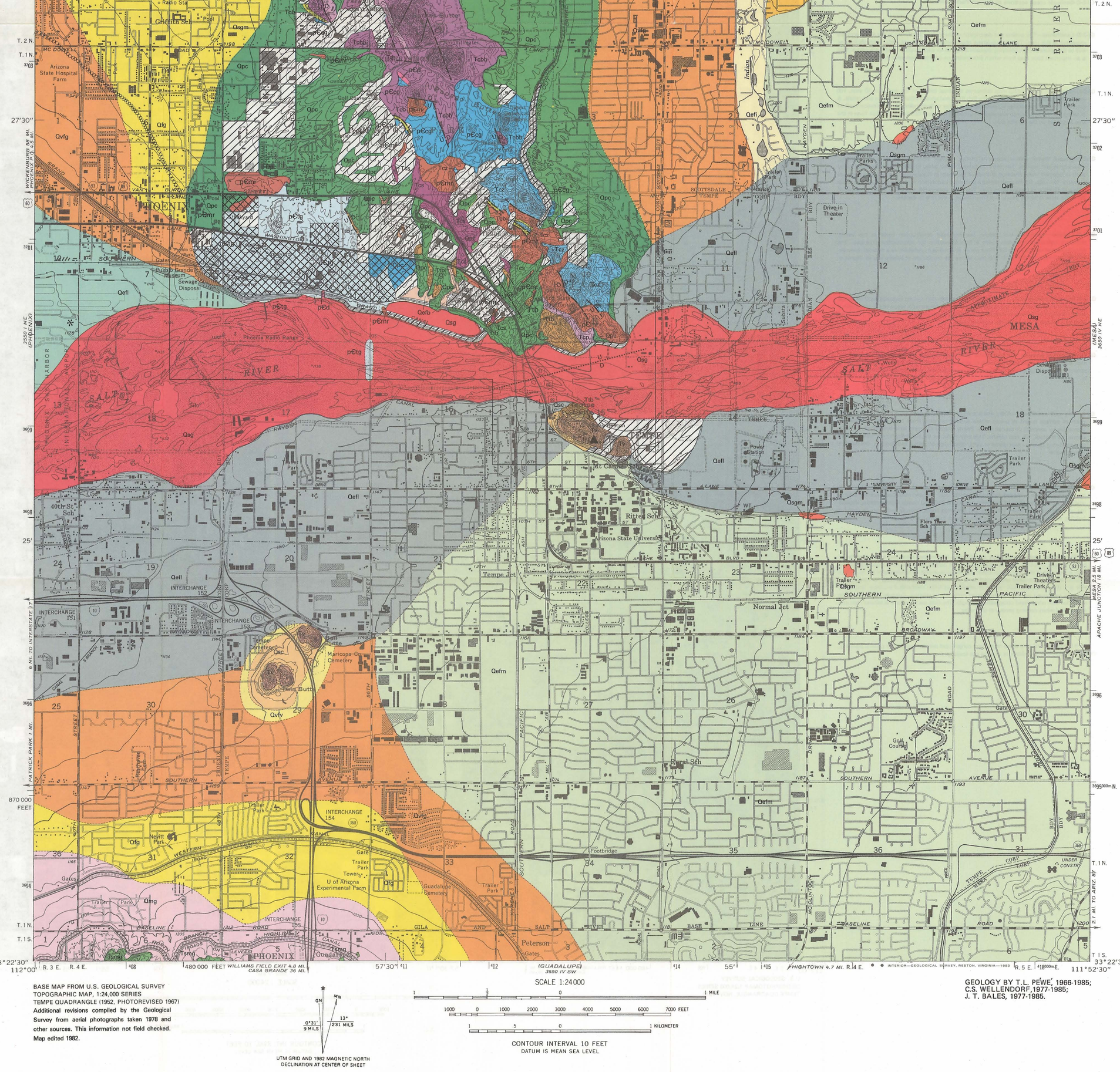
Scarborough, R. B., 1981, Reconnaissance geology: Goldfield and Northern Superstition Mountains: Arizona Bureau of Geology and Mineral Technology, Fieldnotes, Volume 11, Number 4, p. 6-10.

Scarborough, R. B., and Wilt, J. C., 1979, A study of uranium favorability of Cenozoic sedimentary rocks, Basin and Range Province, Arizona, Part I: United States Geological Survey Open-file Report 79-1429, 100 p.

Wilson, E. D., Moore, R. T., and Cooper, J. R., 1969, Geologic map of Arizona: Arizona Bureau of Mines and U. S. Geological Survey, 1:500,000.

MAP SYMBOLS

- Contact, dashed where gradational or inferred.
- Fault, dashed where inferred, dotted where buried. U, upthrown side; D, downthrown side.
- 45 — Dip and strike of beds, in degrees.
- Vertebrate fossil locality.
- 17.6 — Radiometric date — 17.6 ± 0.4 million years.
- Deeply buried edge of Papago Park Pediment as determined by geophysical methods.
- Area covered by Map GI-2-B
- Artificial cover, outcrops and contacts buried.
- Surface cover quarried.



BASE MAP FROM U.S. GEOLOGICAL SURVEY
TOPOGRAPHIC MAP, 1:24,000 SERIES
TEMPE QUADRANGLE (1952, PHOTOREVISED 1967)
Additional revisions compiled by the Geological Survey from aerial photographs taken 1978 and other sources. This information not field checked. Map edited 1982.

UTM GRID AND 1982 MAGNETIC NORTH
DECLINATION AT CENTER OF SHEET

SCALE 1:24000

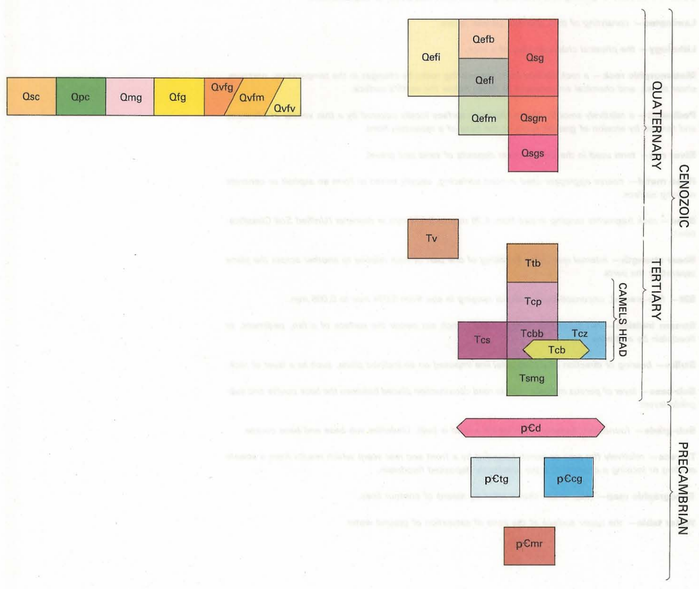
1 MILE
1000 0 1000 2000 3000 4000 5000 6000 7000 FEET
1 KILOMETER

CONTOUR INTERVAL 10 FEET
DATUM IS MEAN SEA LEVEL

INTERIOR—GEOLOGICAL SURVEY, RESTON, VIRGINIA—1983

GEOLOGY BY T.L. PÉWÉ, 1966-1985;
C.S. WELLENDORF, 1977-1985;
J. T. BALES, 1977-1985.

TIME RELATION OF MAP UNITS



EXPLANATION

UNCONSOLIDATED ROCKS

Qsgs / Qsgm / Qsg — SALT RIVER SAND AND GRAVEL — Moderately to well sorted, well stratified sand and gravel; locally interbedded with silt. Well rounded clasts, 2 to 12 in. (5 to 30 cm) of Tertiary volcanic rocks (36.3%), Precambrian metamorphic rocks (48.4%), and Precambrian granitic rocks (15.3%). Qsgs - strongly calichified sand and gravel of Sawik Terrace. Qsgm - strongly calichified sand and gravel of Mesa Terrace. Qsg - noncalichified sand and gravel of the modern channel.

Qefm / Qefl / Qefb / Qefi — EXTREMELY FINE ALLUVIUM — Gray to tan, moderately-well sorted, well stratified, sandy silt and clay; few to no clasts, averaging 25% sand, 75% silt and clay. Qefm - moderately to strongly calichified silt over Mesa Terrace gravel. Qefl - weakly to noncalichified silt over Lehi Terrace Gravel. Qefb — noncalichified silt over bedrock. Qefi - locally strongly calichified silt of Indian Bend Wash.

Qvfg / Qvfm / Qvfv — VERY FINE ALLUVIUM — Tan to brown, moderately sorted, moderately well stratified, weakly to moderately calichified, gravelly sandy silt and clay, averaging 10% gravel, with subangular to subrounded clasts generally not exceeding 1/2 in. (1.3 cm), 35% sand, and 55% silt and clay. Qvfg - composed largely of granitic clasts. Qvfm - composed largely of metamorphic clasts. Qvfv - composed largely of volcanic clasts.

Qfg — FINE ALLUVIUM — Gray to tan, moderately sorted, moderately stratified, weakly to moderately calichified, gravelly sandy silt and clay, averaging 20% gravel with subangular to subrounded granitic clasts generally not exceeding 1 ½ in. (3.8 cm), 40% sand, and 40% silt and clay.

Qmg — MEDIUM ALLUVIUM — Gray, poorly sorted and stratified, moderately to strongly calichified, silty sandy gravel, averaging 40% subangular granitic clasts generally not exceeding 1 ft (30 cm), 30% sand, and 30% silt and clay.

Qsc — SLOPE COLLUVIUM — Gray, poorly sorted, strongly calichified, angular talus on lower bedrock slopes; 1/2 to 8 in. (1.3 to 18.4 cm) clasts in matrix of silt and rock fragments.

Qpc — PEDIMENT COLLUVIUM-ALLUVIUM — Gray to white, very poorly sorted and stratified, strongly calichified, angular to subangular rock fragments, 1/4 to 8 in. (0.7 to 18.4 cm) in diameter, size generally decreasing away from the highland source.

CONSOLIDATED ROCKS

Tv — VOLCANIC ROCKS — Dark gray to grayish-pink, undifferentiated lava flows including alkali olivine basalt, amygdaloidal basalt, intermediate latite, and rhyodacite; local xenoliths of granite and sandstone.

Ttb — TEMPE BEDS — Interbedded strata consisting of abundant pink to red, poorly to moderately sorted, pebbly arkosic sandstone; less abundant tan, brownish-green, yellow, and purple, moderately-well sorted siltstone; pink to green, poorly sorted volcanic arenite and green to white tuff; boundaries between beds are generally sharp, locally gradational; bedding thicknesses and median grain-size decrease upsection; abundant sedimentary structures.

CAMELS HEAD FORMATION

Tcp — Papago Park Member — Bright red to tan, moderately sorted, well stratified, arkosic fanglomerate composed of coarse-grained pebbly sandstones with subangular to subrounded clasts of granite and metarhyolite, 1/2 to 12 in. (1.3 to 30 cm) in diameter, alternating with finer-grained micaceous arkosic gritstones, sandstones, and siltstones in graded sequences.

Tcs — Stadium Breccia Member — Reddish brown, coarse-grained, poorly sorted and stratified, massive arkosic breccia; subangular to angular clasts, 1/2 to 18 in. (1.3 to 45 cm) in diameter, slightly imbricated; consists of granite (40 to 70%) and metarhyolite (25 to 55%), locally almost entirely metarhyolite; matrix of silt and fine sand with rock fragments, ferrugenous cement.

Tcbb — Barnes Butte Breccia Member — Reddish brown, coarse-grained, poorly sorted and stratified, massive arkosic breccia; subangular to angular clasts, 1/4 in. to 15 ft (0.7 cm to 4.5 m) in diameter, slightly imbricated; composed of granite (70 to 85%) and metarhyolite (10 to 20%) in a matrix of rock fragments and ferrugenous cement.

Tcz — Zoo Breccia Member — Purple to reddish-brown, coarse-grained, unsorted, poorly stratified, massive breccia; clasts are angular and fresh, 1/4 in. to 2 ft (0.7 to 60 cm) in diameter; consists of metarhyolite (30 to 100%), granite (0 to 35%), and a small amount of a distinct dacite porphyry; matrix of silt and clay in ferrugenous cement.

Tcb — Basal Member — Red to purple to brown sandstone and diamictite, locally interbedded with green to white tuffaceous sandstone and breccia; poorly to moderately sorted and stratified; angular clasts from 1/4 to 8 in. (0.7 to 20 cm) in diameter; of local derivation.

Tsmg — SOUTH MOUNTAINS GRANODIORITE — Gray, medium-grained, mylonitic granodiorite with gneissic foliation.

pCd — GREENSTONE DIKE — Green to greenish-black, highly altered and fractured, fine-grained intrusive rock.

pCcg — CAMELBACK GRANITE — Pink, coarse-grained to porphyritic granite; contains large pink feldspar crystals, 1/4 to 3/4 in. (0.7 to 2.1 cm). Locally highly sheared; cut by veins of quartz, and dikes of aplite and greenstone; xenoliths of metarhyolite and a dark fine-grained rock.

pCtg — TOVREA GRANITE — Gray, coarse-grained, large rounded crystals of gray quartz, 1/4 to 1¼ in. (0.7 to 3.2 cm); segregations of ferromagnesian minerals altered to epidote and chlorite. Weathers deeply with red oxidation rind, 1/4 to 1/2 in. (0.7 to 1.3 cm) thick; cut by greenstone and aplite dikes.

pCmr — METARHYOLITE — Gray to pink, orange-weathering, blocky, foliated; locally porphyritic, commonly layered with flattened pumice inclusions; epidotized; locally cut by greenstone and aplite dikes. Commonly highly fractured and brecciated.