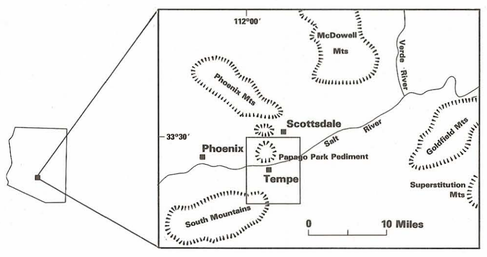
GEOLOGIC CROSS SECTIONS OF PAPAGO PARK PEDIMENT TEMPE QUADRANGLE, MARICOPA COUNTY, ARIZONA

Troy L. Péwé Cathy S. Wellendorf James T. Bales

Department of Geology Arizona State University

1986

Prepared in cooperation with the cities of Tempe, Scottsdale, and Phoenix, and the Arizona State Land Department



INTRODUCTORY STATEMENT

Papago Park Pediment is the erosional remnant of an upthrown fault block which has been cut by several smaller faults. Since the time of uplift. erosion has reduced the original upland mass to a number of small inselbergs protruding above a relatively gently sloping surface. The bedrock surface is locally covered by up to 20 feet (6 m) of calichified colluvium-alluvium. This deposit has accumulated in response to the aggrading valley-fill alluvium. In response to a change in the regimen of the Salt River, tributary streams draining the pediment have incised deep channels into the calichified colluvium-alluvium, locally exposing bedrock. This colluvium-alluvium is thought to be as much as 5 million years old due to the thickness and induration of the caliche. Therefore the pediment itself must be even older for it to be reduced to a nearly level surface before the younger deposit formed above it.

GEOLOGIC HISTORY

The oldest rock exposed at Papago Park Pediment is Precambrian metarhyolite, produced from low-grade metamorphism of rlyolitic ashes and lava flows. Similar rocks occur in the Phoenix Mountains and McDowell Mountains (Taliesin Quartzite) to the north and northeast, where they are interbedded with metasedimentary rocks probably deposited in shallow, shifting seas. The metarhyolite is intruded by two distinctly different granites; the relationship between the two granites is not evident within the Tempe Quadrangle. Tovrea Granite, a gray granite rich in quartz and biotite, is similar in composition to plutons found elsewhere in Arizona which yield ages of 1,650 to 1,760 million years old. Camelback Granite, a pink granite rich in microcline and perthite with less than 10% mafic minerals, was probably emplaced at the same time as similar granites found at Camelback Mountain, McDowell Mountains, and Usery Mountains, which yield ages of 1,350 to 1,450 million years old. Both granites and the metarhyolite are intruded by basalt and aplite dikes and quartz veins.

An unconformity exists between the eroded Precambrian rocks and the mid-Tertiary red beds. No rocks of Paleozoic nor Mesozoic Eras are found in the Tempe Quadrangle or the surrounding area. Some time before the deposition of the red beds, the metarhyolite and Camelback Granite were subjected to intense shearing and cataclastisis.

During the mid-Tertiary time, rapid uplift and erosion of the Precambrian rocks resulted in the deposition of red beds, including fanglomerates, sandstones, and siltstones. Early mid-Tertiary volcanic eruptions produced ash that was retransported and deposited along with channel sands and weathered rock debris, and was preserved in scattered localities (the Basal Member of the Camels Head Formation). As the highlands rose, alluvial fans formed at the base of the mountain front, and coarse, angular, unsorted deposits accumulated in the proximal fan environment. A variation in sediment source is indicated by a local variation in the composition of the clasts and reflects separate lobes of fans that coalesce with and overlie one another. The proximal facies are very coarse and poorly stratified, having originated as talus, landslides, and mudflows (Zoo Breccia, Barnes Butte Breccia, and Stadium Breccia members of the Camels Head Formation). On the mid-fan, waterlaid deposits were interbedded with debris flow deposits originating from the reworking of the proximal facies. The deposits are finer-grained, with better sorting, and stratification (Papago Park Member). Ephermeral streams reworked the deposits of the proximal and mid-fan, and carried these sediments to the distal ends. Distal facies are finer-grained, well stratified and well sorted (Tempe beds). Local volcanism, probably in the form of fissure eruptions, produced ashes and lavas ranging in composition from basalt to rhyodacite, which overlie and are interbedded with the red beds. Andesite of Tempe Butte has a radiometric date of 17.6 ± 0.4 million years (Scarborough and Wilt, 1979). Basalt sills (Drosendahl, 1986) (termed andesite by Scarborough [1981]) in the Camels Head Formation at Mt. McDowell, 16 miles (28 km) east of Tempe have dates of 18.7 to 17.7 million years (Scarborough, 1981).

The modern day physiography of the Basin and Range Province resulted from tectonic events that occurred during the last 17 million years. The Basin and Range disturbance is characterized by generally vertical movement along steep normal faults. The faulting is related to deep-seated extension resulting in the thinning and fragmentation of the earth's crust. The sedimentary and volcanic rocks have been steeply tilted to their present position, striking northwest-southeast with an average dip of 45°SW. Faulting is necessary to explain repetition of rock sequences, and younger rocks dipping toward older ones (see cross-sections).

A number of faults are shown on the geologic map. The evidence for the existence of such faults is strong, but none are directly observable. The evidence is: (1) the rotation of the bedding of the Camels Head Formation into variable and steep dip, and (2) the truncation of the Camels Head Formation along relatively abrupt and straight lines. All of these faults are interpreted to be high-angle dip-slip faults. Additional support for this interpretation comes from the myriad of small faults with this orientation and displacement that are observed within many of the buttes. The buried fault shown near McDowell and 52nd Street is based on the results of drilling interpreted by Atkinson and Hay (1983). It too is interpreted to be a high-angle fault.

Papago Park Pediment is probably bounded by faults to the east and west, for the depth to bedrock rapidly increases to either side. The pediment, together with Tempe Butte, Bell Butte, and Twin Buttes, forms part of a discontinuous bedrock link across the Phoenix Basin between South Mountains, and Camelback and Phoenix Mountains to the north. Erosion of these and other bedrock highlands has contributed more than 10,000 feet (3300 m) of alluvium to fill the adjoining basins.

SELECTED REFERENCES

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

Christenson, G. E., Welsch, D. G., and Péwé, T. L., 1978, Environmental geology of the McDowell Mountain 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.

Cordy, G. E., and Péwé, T. L., 1978, Geology of the west end of Camelback Mountain, Phoenix, Arizona: Geological Society of America, Abstracts with programs, 1978 Cordilleran Section meeting, volume 10, number 3, p. 100.

Damon, P. E., Shafiqullah, M., and Lynch, D. J., 1984, Late Cenozoic landscape development in the Basin and Range Province of Arizona, *in* Smiley, T. L., Nations, J. D., Péwé, T. L., and Schafer, J. P., Landscapes of Arizona: the geologic story: Tucson, Arizona, University of Arizona Press, p. 175-206.

Drosendahl, J. K., 1987, Environmental geology of the Rio Salado Development District, eastern part: unpublished Master of Science thesis, Arizona State University.

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.

Schulten, C. S., 1979, Environmental geology of the Tempe Quadrangle, Maricopa County, Arizona: unpublished Master of Science thesis, Arizona State University, 101 p.

Spearing, D. R., 1974, Summary sheets of sedimentary deposits with bibliographies — Alluvial fan deposits, sheet 1: Geological Society of America, 7 sheets.

Stuckless, J. S., and Naesar, C. W., 1972, Rb-Sr and fission-track age determinations in the Precambrian plutonic basement around the Superstition volcanic field, Arizona: United States Geological Survey Professional Paper 800-B, p. B191-B194.

EXPLANATION

Qsg / Qsgm — SALT RIVER SAND AND GRAVEL — Moderately to well sorted and well stratified, unconsolidated sand and gravel, locally interbedded with silt; exhibits cut-and-fill structures, lenticular bedding, parallel and cross-stratification, and imbrication of clasts. Clasts are well rounded, 2 to 12 in. (5 to 30 cm) in diameter, and consist of Tertiary volcanic rocks (36.3%), Precambrian metasedimentary and metavolcanic rocks (48.4%), and Precambrian granitic rocks (15.3%). Qsg - modern channel deposits, no caliche. Qsgm (cross sections only) - sand and gravel of the Mesa Terrace, strongly developed caliche.

Qefm / Qefl / Qefb — EXTREMELY FINE ALLUVIUM — Gray to tan, moderately-well sorted, well stratified, sandy silt, containing few to no clasts, averaging 25% sand, and 75% silt and clay. Qefm - moderately- to strongly-calichified silt over Mesa Terrace gravel. Qefl - weakly- to non-calichified silt over Lehi Terrace gravel. Qefb - non-calichified silt over bedrock.

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

Qfg — FINE ALLUVIUM — Gray to tan, moderately sorted, moderately stratified, weakly to moderately-calichified, gravelly sandy silt, averaging 20% gravel, with subangular to subrounded granitic clasts, generally not exceeding 1½ in. (3.8 cm), 40% sand, and 40% silt and clay.

Qsc — SLOPE COLLUVIUM — Gray, poorly sorted, strongly-calichified talus on lower bedrock slopes. Composed of angular blocks, 1/2 to 8 in. (1.3 to 20 cm) in diameter, matrix of silt and rock fragments.

Qpc — PEDIMENT COLLUVIUM-ALLUVIUM — Gray to white, very poorly sorted and stratified, strongly-calichified debris on bedrock surface. Composed of angular to subangular rock fragments, 1/4 to 12 in. (0.7 to 30 cm) in diameter, size generally decreasing towards outer edge of unit; silty matrix.

Tv — VOLCANIC ROCKS — Dark gray to grayish-pink, undifferentiated lava flows; consists of 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 siltstones; 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 include cross-bedding, channel scours and mud cracks. Type locality north side of Tempe Butte, Tempe, Arizona (SE 1/4, SE 1/4, NW 1/4, Sec. 15, T.1 N, R.4 E).

CAMELS HEAD FORMATION
Type locality west end of Camelback Mountain, Phoenix, Arizona (Paradise Valley Quadrangle) (Cordy, and others, 1977) (NW 1/4, SE 1/4, NW 1/4, Sec. 17, T.2 N, R.4 E).

Tcp — Papago Park Member — Bright to brownish red, 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. Exhibits graded bedding, parallel- and cross-stratification and local channel scour-and-fill structures. Type locality southeast part of Papago Park Pediment, Tempe Arizona (SE 1/4, SE 1/4, SW 1/4, Sec. 10, T.1 N, R.4 E).

Tcs — Stadium Breccia Member — Reddish brown, coarse-grained, poorly sorted and stratified, massive arkosic breccia. Clasts are angular to subangular, fresh and weathered, 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 clasts are almost entirely metarhyolite. Matrix is silt and fine sand with rock fragments, ferrugenous cement. Locally interbedded with sandstone layers, cut-and-fill structures present. Type locality Phoenix baseball stadium, Papago Park Pediment, Phoenix, Arizona (NE 1/4, NE 1/4, NW 1/4, Sec. 9, T.1 N, R.4 E).

Tcbb — Barnes Butte Breccia Member — Reddish-brown, coarse-grained, poorly sorted and stratified, massive arkosic breccia. Clasts are angular to subangular, generally fresh, 1/4 in. to 15 ft (0.7 to 4.5 m) in diameter, slightly imbricated; consists of clasts predominately of granite (70 to 85%), and of metarhyolite (10 to 20%) in a matrix of rock fragments and ferrugenous cement. Locally interlayered with finer-grained beds, channel scours common. Type locality Barnes Butte, Papago Park Pediment, Phoenix, Arizona (NE 1/4, SW 1/4, SW 1/4, Sec. 33, T.2 N, R.4 E).

Tcz — Zoo Breccia Member — Purple to reddish-brown, coarse-grained, unsorted, poorly stratified, massive breccia. Clasts are angular, fresh, 1/4 in. to 2 ft (0.7 to 60 cm) in diameter; contains clasts of metarhyolite (30 to 100%), granite (0 to 35%), and a small amount of a distinct dacite porphyry. Matrix of silt and clay, ferrugenous cement. Type locality Phoenix Zoo, Papago Park Pediment, Phoenix, Arizona (NE 1/4, NW 1/4, NW 1/4, Sec. 10, T.1 N, R.4 E).

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

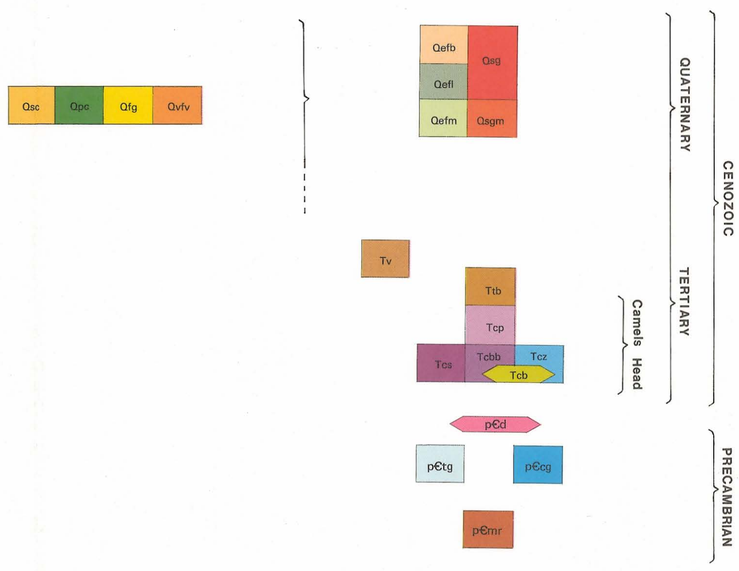
p€d — GREENSTONE DIKE — Green to greenish-black, highly altered and fractured, fine-grained intrusive rock.

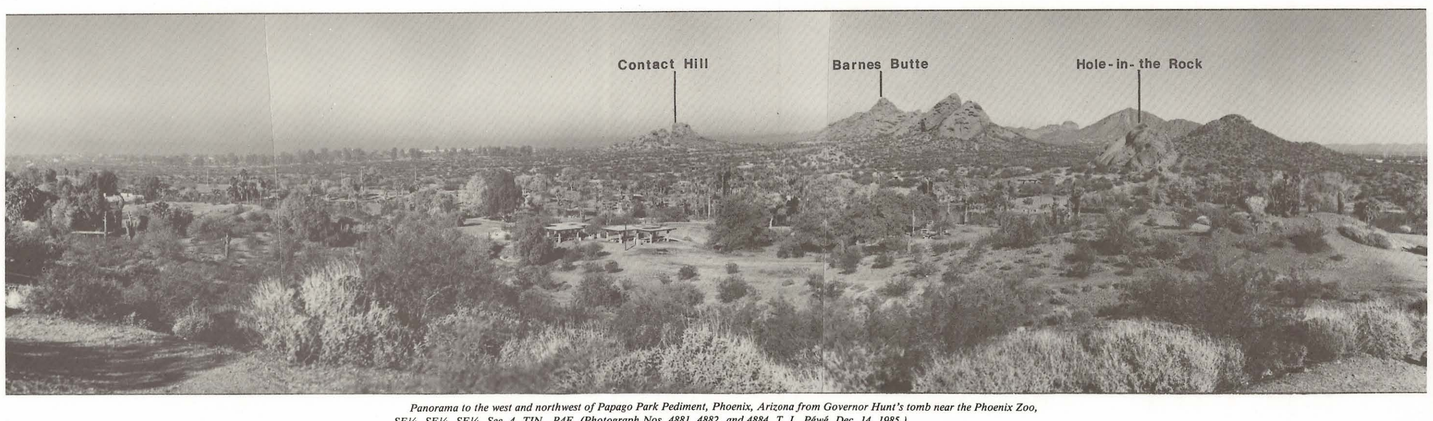
p€cg — CAMELBACK GRANITE — Pink, coarse-grained to porphyritic granite; contains large pink feldspar crystals, 1/4 to 3/4 in. (0.7 to 2.1 cm). Locally highly sheared with granulation and alteration of original minerals. Cut by veins of quartz, and dikes of aplite and greenstone; xenoliths of metarhyolite and a dark, fine-grained rock. Type locality Camelback Mountain, Phoenix, Arizona (Paradise Valley Quadrangle) (NE 1/4, NE 1/4, SE 1/4, Sec. 17, T.2 N, R.4 E).

p€tg — TOVREA GRANITE — Gray, coarse-grained, quartz-biotite granite; 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. Type locality Tovrea Castle, Papago Park Pediment, Phoenix, Arizona (SE 1/4, NE 1/4, NW 1/4, Sec. 8, T.1 N, R.4 E).

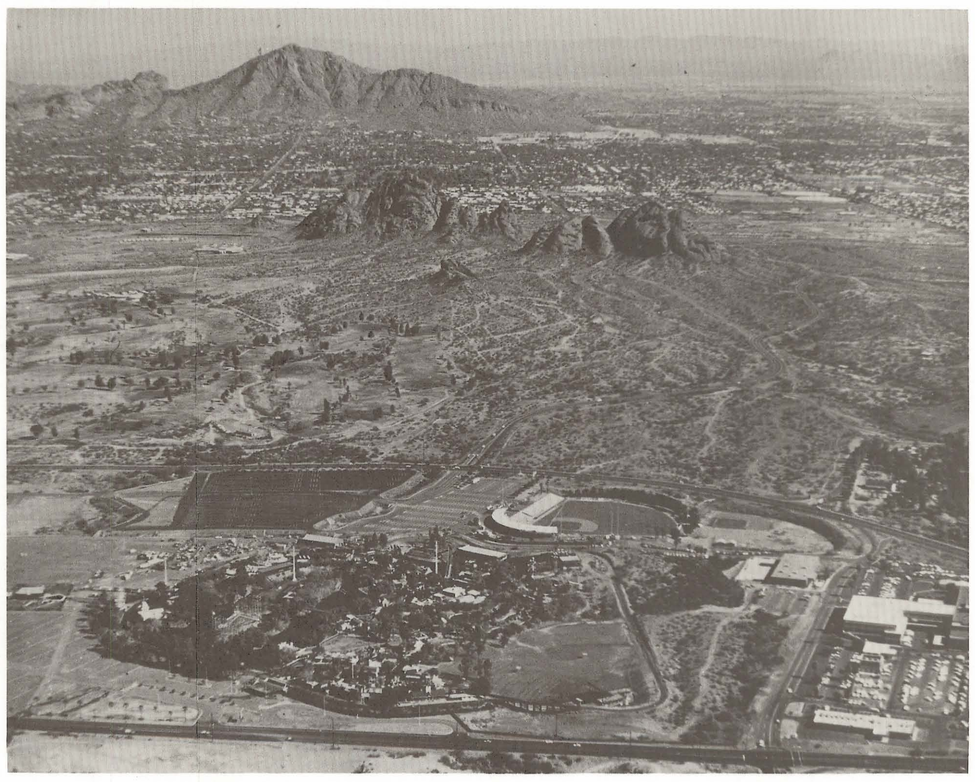
p€mr — METARHYOLITE — Gray to pink, orange-weathering, blocky, foliated, low-grade metamorphosed rhyolite; locally porphyritic; commonly layered, with flattened pumice inclusions; epidotized; locally cut by greenstone and aplite dikes.

TIME RELATION OF MAP UNITS





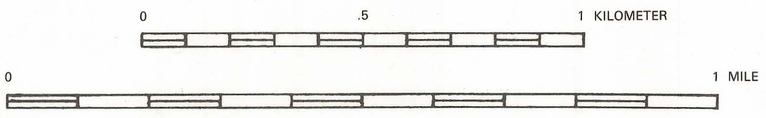
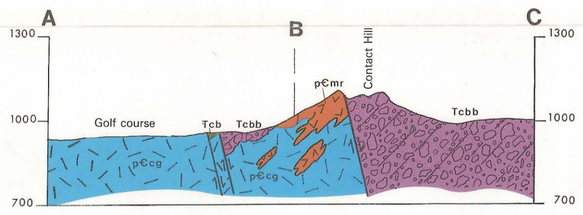
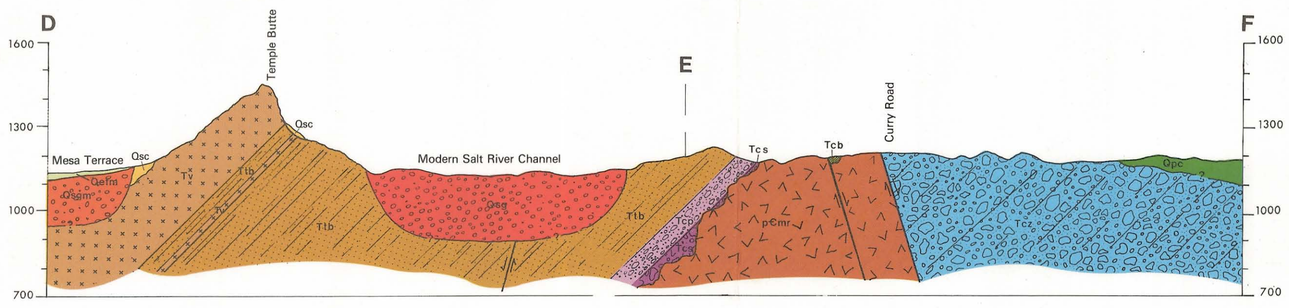
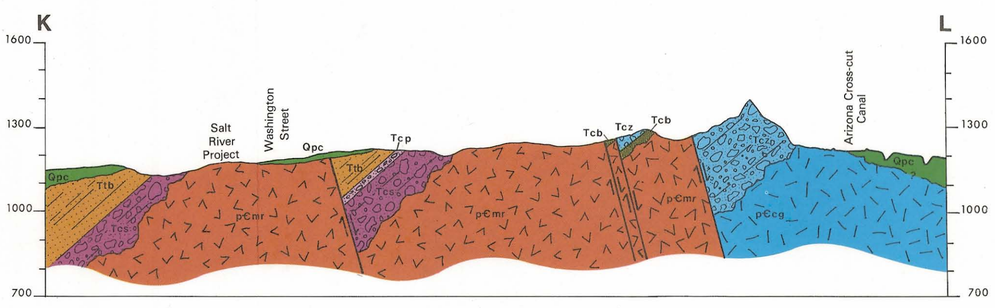
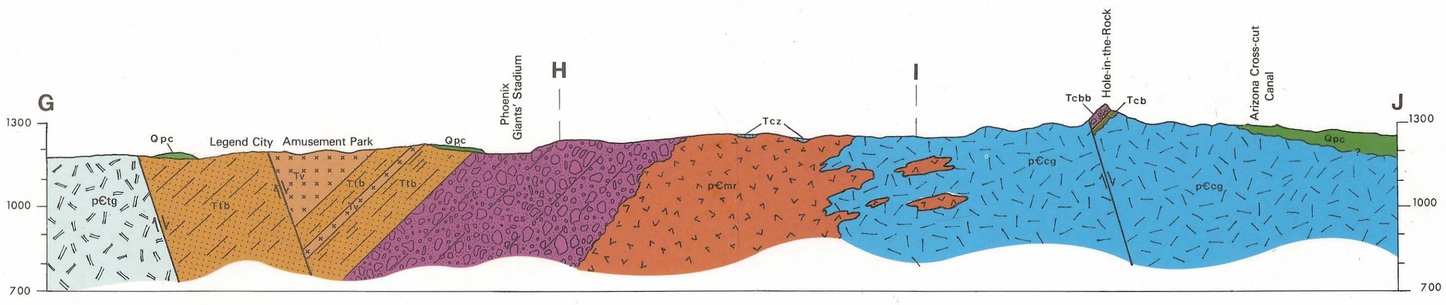
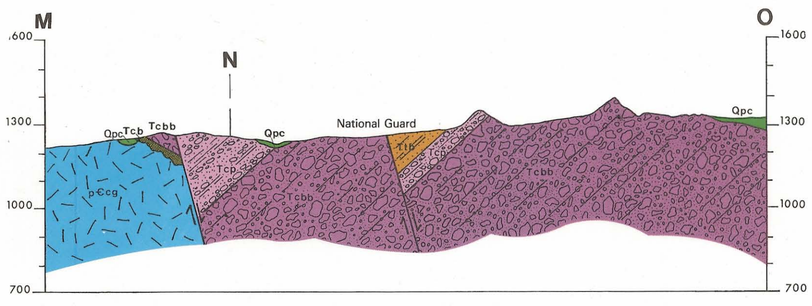
Panorama to the west and northwest of Papago Park Pediment, Phoenix, Arizona from Governor Hunt's tomb near the Phoenix Zoo, SE¼, SE¼, SE¼, Sec. 4, TIN., R4E. (Photograph Nos. 4881, 4882, and 4884, T. L. Péwé, Dec. 14, 1985.)



Airview to the north of Papago Park Pediment, Phoenix, Arizona from over the Salt River. Pediment extends in all directions from the small inselbergs in the center of the photograph. Pediment exposed in the State Park in the center of the photograph but covered by the Baseball Stadium, parking lot, and the amusement park in the foreground. Washington Street is at the base of the photograph (see map GI-2-B for location of view). (Photograph No. PK24, 281 by T. L. Péwé, April 8, 1981.)

GEOLOGIC CROSS SECTIONS

For location of cross sections, see Map GI-2-B

VERTICAL EXAGGERATION = 2 TIMES
Elevation in feet

SCALE