INTRODUCTORY STATEMENT

Environmental studies prior to development, whether for residential, industrial, or recreational purposes, have value to planners, engineers, public officials, and developers. Environmental geology is one such area of study and recognition of geologic hazards and delineation of geologic factors which would facilitate, impede, or preclude development will significantly reduce construction and maintenance costs. From a detailed geologic base map, coupled with field tests and laboratory analyses, derivative environmental geology maps can be made which aid in achieving an efficient use of the land and available geologic resources.

The Tempe Quadrangle covers a 66 square mile (170 square km) area in eastern Maricopa County, Arizona, and includes parts of the Cities of Tempe, Scottsdale, and Phoenix. The study of the environmental geology of the Tempe Quadrangle was undertaken by Cathy S. Wellendorf, James T. Bales, Jr., and Troy L. Péwé, of the Department of Geology at Arizona State University, and was sponsored in part by the cities included within the study area to serve as an aid in the planning and development of these cities. Mapping was done on a topographic base map at a scale of 1:24,000. The following maps were constructed for this study.

GI-2-A-Geologic map—Prior to the evaluation of the environmental aspects, it is necessary to map the geology. Bedrock units are differentiated on the basis of hand sample and microscopic studies. The unconsolidated rocks are distinguished by field observation of the coarse fraction, and by mechanically separating the material according to size-gradations. Each rock unit is briefly described and identified on the map. On the reverse side of this sheet is a statement concerning the general geology of the area.

GI-2-B-Geologic map of Papago Park Pediment—The 7.5 square mile (19 square km) area of Papago Park Pediment in the center of the quadrangle is mapped in detail at a scale of approximately 1:8,000. This area contains most of the bedrock exposures within the quadrangle, and is at a large scale so that the detailed rock distribution and structure can be shown.

GI-2-C-Geologic cross sections of Papago Park Pediment.

GI-2-D-Landforms—The outline and description of the various landforms in the study area are presented in this map. The distinguishing characteristics in terms of surface morphology as well as the nature of the underlying deposits are given for each landform and the landform map is an important base map from which interpretations on other derivative maps are made.

GI-2-E-Flooding—The flooding map delineates the areal extent of the statistical 10 year, 100 year, and standard project floods for the Salt River and several tributary washes and canals. A graph of flooding frequencies is presented for a better understanding of the statistical method of rating flood flows. A map showing the extent of historical flooding of the Salt River in the area is printed on the reverse side.

GI-2-F-Ground Water—Water supply is always a major consideration in urban planning, especially in arid regions. The depth to ground water table, historical information on water levels in selected wells, chemical analysis of the water in these wells, and recharge areas are shown on this map. On the reverse side is presented information regarding decline of the water table and direction of ground water flow. This map presents information on the total decline of the water table in recent years, and the increase in the rate of decline.

GI-2-G-Caliche—Excavation into caliche has increased construction costs in the valley. However, calichified colluvium forms a firm foundation for construction purposes. The development of caliche in the Salt River gravel determines its suitability as a material resource, and its usefulness for dry wells. This map shows the distribution of caliche and its degree of development.

GI-2-H-Depth to river gravel—This map shows the distribution and approximate depth to buried deposits of river gravel. The gravel deposits are a valuable material resource for construction and for location of building foundations. In addition, permeable subsurface terrace gravels are used as a receptical for runoff through dry wells.

GI-2-I-Geological hazards—Certain natural geologic processes are considered hazardous by man because of the potential damage to structures and life. This map delineates areas of potential hazards arising from expansive soils, earth fissures, earthquakes, and slope instability.

GI-2-J-Dry well conditions—A dry well is a vertical shaft into permeable material used for disposal of surface runoff in places where surface recharge areas have been rendered impermeable by concrete or asphalt cover. Poorly located dry wells have been placed into impermeable bedrock, silt, and caliche. This map evaluates the suitability for dry well operation by considering depth to river gravel or sand, distribution of caliche and flooding, and depth to ground water.

GI-2-K-Material resources—The distribution of various sources of consolidated and unconsolidated materials are evaluated for their potential use. The unconsoldated material may be useful as a decorative material, concrete aggregate, and road construction material, depending on grain-size distribution, lithology, and Atterberg limits. Bedrock units may be useful as building stone, decorative stone, road construction material, and riprap.

GI-2-L-Excavation and construction conditions—Information presented independently on previous maps is summarized for evaluation of the construction and excavation conditions. Prior knowledge of the geologic constraints on excavation and an awareness of the hazards at a particular site can prevent unexpected construction and maintenance costs. On the reverse side is a data sheet in which results of engineering tests, mechanical analyses, and X-ray analyses performed on the unconsolidated rocks are presented. Consolidated rocks were tested for their unconfined compressive strength. The data are presented in tabular form and were useful when deriving several of the maps.

It is important to note these maps were constructed only for broad scale general planning; they do not preclude the necessity of local site investigation.

U.S. GEOLOGICAL SURVEY
ORTHOPHOTOMAP 1:24,000 SERIES
TEMPE QUADRANGLE, NOV. 1972

SCALE 1:24 000

1 ½ 0 1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 .5 0 1 KILOMETER

CONTOUR INTERVAL 10 FEET
DATUM IS MEAN SEA LEVEL

GEOLOGIC TIME SCALE

ERA	PERIOD	EPOCH	DISTINCTIVE FEATURES	YEARS BEFORE THE PRESENT	LOCAL EVENTS OF THE TEMPE QUADRANGLE
CENOZOIC	QUATERNARY	RECENT	Modern man	11 thousand	Stream incision and terrace development; erosion of Papago Park Pediment; formation of caliche.
		PLEISTOCENE	Early man; glaciation	1.8 to 2 million	
	TERTIARY	PLIOCENE	Large carnivores	5 ± 1 million	Mid-Miocene Orogeny; deposition of red beds and lava flows; Basin and Range faulting.
		MIOCENE	Abundant grazing mammals	25 ± 1 million	
		OLIGOCENE	Large running mammals	36 ± 2 million	
		EOCENE	Modern types of mammals	54 ± 2 million	
		PALEOCENE	First placental mammals	63 ± 2 million	
MESOZOIC	CRETACEOUS		First flowering plants; climax of dinosaurs and ammonites, followed by extinction.	135 ± 5 million	Rocks of these ages are not present in the Tempe Quadrangle.
	JURASSIC		First birds, first true mammals. Many dinosaurs and ammonites.	190 ± 5 million	
	TRIASSIC		First dinosaurs; abundant cycads and conifers.	230 ± 10 million	
PALEOZOIC	PERMIAN		Extinction of many kinds of marine animals, including trilobites. Continental glaciation in Southern Hemisphere.	280 ± 10 million	
	CARBONIFEROUS	PENNSYLVANIAN	Great coal swamps; conifers. First reptiles.	310 ± 10 million	
		MISSISSIPPIAN	Sharks and amphibians. Large-scale trees and seed ferns.	345 ± 10 million	
	DEVONIAN		First amphibians; fishes very abundant.	405 ± 10 million	
	SILURIAN		First terrestrial plants.	425 ± 10 million	
	ORDOVICIAN		First fishes. Marine invertebrates dominant.	500 ± 10 million	
	CAMBRIAN		First abundant record of marine life. Trilobites and brachiopods dominant.	600 ± 50 million	
PRECAMBRIAN	PROTEROZOIC (Younger)		Fossils extremely rare.		Extrusion and metamorphism of silicic volcanic rocks; emplacement of granitic intrusive rocks.
	ARCHEOZOIC (Older)		Primitive aquatic plants. Oldest algae dated at 2.7 billion years. Oldest known rock, 3.3 billion years.		

GLOSSARY

Aggradation— *the buildup of a floodplain or alluvial fan surface by deposition.*

Alluvial fan— *gently sloping wedge of alluvium deposited by a stream at the base of a mountain as it emerges onto a nearly level plain or broad valley.*

Alluvium— *unconsolidated material (gravel, sand, silt, and clay) deposited by a stream.*

Aquifer— *a water-bearing stratum or body of rock below the surface of the earth capable of yielding water.*

Atterberg limits— *liquid limit (LL), plastic limit (PL), and plasticity index (PI), where LL is the moisture content above which a soil readily becomes a liquid upon stirring, PL is the minimum moisture content at which a soil acts as a plastic solid, and PI = LL - PL.*

Base course— *layer of coarse material over sub-grade and sub-base in road construction which serves to distribute load and provide drainage.*

Caliche— *secondary accumulation of calcium carbonate in the near-surface horizon of a soil in arid and semi-arid environments.*

Coarse aggregate— *the coarse fraction of a mass of unconsolidated rock material, mechanically separated for use in concrete, roads, and other construction.*

Clay— *fine-grained, unconsolidated material smaller than 0.005 mm.*

Colluvium— *mass of broken rock fragments deposited at the base of steep slopes by gravity movement, mainly masswasting.*

Compaction— *reduction of pore space or the process of moving toward solidification of unconsolidated material by mechanical or natural processes.*

Compressive strength— *measure of the ability of rock to resist pressure from loading.*

Compressibility— *time-dependent reduction in pore space of unconsolidated material as a result of loading and settlement.*

Contour line— *a line connecting points of equal elevation on a topographic map.*

Differential subsidence— *irregular sinking of the land surface due to uneven compaction of the underlying nonuniform materials.*

Dip— *vertical angle between the horizontal and a planar feature, such as a layer of rock, which is being measured.*

Dry well— *vertical shaft into permeable material for disposal of surface runoff water.*

Expansive soils— *unconsolidated material containing variable amounts of certain clay minerals, smectites (such as montmorillonite) which expand when wetted and shrink when dried.*

Fault— *fracture zone in rock along which displacement has occurred.*

Gravel— *rock particles from 76 mm to 4.76 mm in diameter (Unified Soil Classification).*

Ground water— *subsurface water in the saturated zone.*

Grus— *accumulation of rock fragments resulting from the weathering of granitic rock by granular disintegration.*

Igneous rocks— *rock that solidified from molten material (magma).*

Joint— *a fracture or parting in a rock along which there has been no displacement.*

Laminated— *consisting of thin, distinct, parallel layers.*

Lithology— *the physical characteristics of a rock.*

Metamorphic rock— *a rock derived from pre-existing rocks by changes in the temperature, pressure, shear stress, and chemical environment at depth below the earth's surface.*

Pediment— *a relatively smooth, eroded bedrock surface locally covered by a thin veneer of alluvium, and formed by erosion of granitic rocks at the base of a mountain front.*

River run— *term used in the field for river deposits of sand and gravel.*

Road metal— *coarse aggregate used in road surfacing, usually mixed to form an asphalt or concrete wearing surface.*

Sand— *rock fragments ranging in size from 4.76 mm to 0.074 mm in diameter (Unified Soil Classification).*

Shear strength— *internal resistance to sliding of one part of rock relative to another across the plane separating the parts.*

Silt— *fine-grained, unconsolidated material ranging in size from 0.074 mm to 0.005 mm.*

Stream incision— *flat-bottomed, steep-walled trench cut below the surface of a fan, pediment, or floodplain by a stream.*

Strike— *bearing or direction of a horizontal line imposed on an inclined plane, such as a layer of rock.*

Sub-base— *layer of porous material used in road construction placed between the base course and subgrade layers.*

Sub-grade— *foundation material upon which a road is built. Underlies sub-base and base course.*

Terrace— *relatively flat area or bench bounded by a front and rear scarp which results from a stream eroding or incising a channel into the previously deposited floodplain.*

Topographic map— *map which shows relief by means of contour lines.*

Water table— *the upper surface of the zone of saturation of ground water.*