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DEPARTMENT OF THE INTERIOR
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PHOENIX NORTH QUADRANGLE
ARIZONA
1:100 000-SCALE SERIES (PLANIMETRIC)

GEOLOGIC MAP OF QUATERNARY AND UPPER TERTIARY ALLUVIUM IN THE PHOENIX NORTH 30' X 60' QUADRANGLE, ARIZONA

by Karen A. Demsey
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Scale 1:100,000

1 0 1 5 10 miles

1 0 1 5 10 15 kilometers

Introduction

The Phoenix North 30' x 60' quadrangle covers an area in south-central Arizona that straddles the boundary between the Sonoran Desert and Mexican Highland sections of the Basin and Range Province. The semiarid climate and the subdued or quiescent tectonic regime that have prevailed during Quaternary time within this area have resulted in the predominance of broad basins and piedmonts in much of the map area. Basinward transport and deposition of material derived from adjacent mountains and higher piedmont deposits have been the predominant geologic processes active in this area during the Quaternary.

Alluvial deposits differentiated for this map are assigned to Quaternary and Upper Tertiary geologic units primarily on the basis of the estimated ages of abandonment of major deposition on the corresponding surfaces, as evidenced by the relative topographic positions of the geomorphic surfaces, degree of surface preservation, and soil development. The deposits and their associated surfaces and soils have been divided into the following map units according to relative ages: a mainly pre-Quaternary basin-fill unit (Tbf); a late Tertiary to early Quaternary river gravels unit (QTrg); an oldest Quaternary unit (O); a "middle to old" Quaternary unit (MO); three categories of middle Quaternary alluvium (M1 -- older, M2 -- younger, and Mu -- undifferentiated); and two youngest Quaternary units (Y -- alluvial fans and large terraces, and Yc -- active alluvial in major channels). The estimated numerical ages of the surfaces are inferred largely from radiometric dates and geologic studies in southern Arizona (especially Bull, in press, and Morrison and Menges, 1982). This map indicates the distribution of alluvial deposits of different ages, and thereby provides a basis for evaluating the Quaternary geologic history of the area.

The mapping is based primarily on interpretation of U2 high-altitude aerial photographs (scale 1:125,000), supplemented locally by natural-color (1:24,000) and black-and-white (1:30,000) aerial photographs. Unit designations and surface characteristics were checked at several sites in the field. In the highly urbanized Phoenix metropolitan area, and in extensive agricultural tracts in the Phoenix basin, Soil Conservation Service soil surveys (Soil Conservation Service, 1974; 1977; 1986) were used to evaluate surface ages and to delineate boundaries between Quaternary geologic units.

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Explanation of map units

The distinguishing features of the map units described below represent the criteria on which the mapping is based. The estimated ages assigned to the map units are also given. The ages ascribed to map units on the Phoenix North quadrangle are based on morphologic and pedologic similarities between these units and Quaternary alluvial units defined and locally dated by investigators working in adjacent regions. The correlations were most extensively drawn from mapping of Quaternary deposits and surfaces along the lower Colorado River (Bull, in press). No dates have been obtained directly for the units in the Phoenix North quadrangle, and therefore the age assignments here are approximations. However, the time scale adopted for these units represents a reasonable interpretation of available evidence regarding timing of major depositional pulses and rates of soil formation in the southwestern United States.

Unit	Estimated age (years)
Yc	≤ 1000

Confined to active and recently active deposits of major axial drainages. Primarily sand and silt (hue 7.5 to 5 YR); no soil development has occurred in any of the deposits.

Y	0 - 10,000

Represents deposits of inferred latest Quaternary (Holocene; perhaps locally latest Pleistocene) age, including large terraces of major drainages. Surfaces are primarily underlain by well-sorted sand and silt, with local occurrences of fine gravels. Surfaces are very slightly -- ≤ 0.5 m -- but abundantly dissected by active gullies and washes. Typically fine-grained and smooth in appearance; remnant bar-and-swale topography preserved locally. Incipient to light varnish on mafic clasts where a surface pavement occurs. Minimal soil development in these deposits -- the most strongly developed profiles contain cambic horizons (hue 7.5 YR) over stage I to II calcic horizons (see Machette, 1985, for description of morphologic stages of calcic-horizon development). Soil great groups are typically Torriorthents, Calciorthids, or Camborthids.

M2	10,000 - 250,000

Represents alluvium of inferred latest to middle Pleistocene age. Surfaces are underlain by deposits of sand and silt to medium gravels; generally well-sorted. Surfaces are slightly to moderately dissected -- ~1 to 4 m above active channels. Remnants typically have smooth and fine-grained surfaces or a fine gravel lag. Mafic clasts on the surfaces are moderately to darkly varnished; felsic clasts appear lightly varnished. Soils on the remnants exhibit slightly- to moderately developed textural B horizons (cambic to argillic horizons) that are typically above a stage II to III calcic horizon. Soil great groups are Camborthids to Haplargids.

M1	250,000 - 790,000

Alluvium of inferred middle to early middle Pleistocene age. Deposits include sand and fine gravels to large cobbles; in general, moderately sorted. The surfaces are moderately dissected -- ~3 to 6 m above active channels (dissection is greater -- up to ~60 m -- in the north-central part of the map, in the vicinity of the Agua Fria River). Surface remnants are generally rounded by erosion near edges, and have fine-grained or fine gravelly to cobbly cappings. Clasts on the surfaces are moderately to darkly varnished, and the surface remnants typically appear among the darkest on the piedmont. Underlying soils are characterized by moderately to very strongly developed argillic horizons (hue 5 to 2.5 YR), commonly overlying a stage III to IV calcic horizon. Soil great groups are Haplargids to Paleargids.

Mu	10,000 - 790,000

Undifferentiated M1 and M2 units; in some places Mu represents areas in which the two units are mixed to a degree that precludes their differentiation or generalization at the present scale of sapping. In other places, this broader designation is used because of uncertainty in assigning the deposits to either a late- or middle Pleistocene age category.

MO	500,000 - 1,000,000 (?)

Areas dominated by inferred early middle Pleistocene to early Pleistocene deposits; these deposits are abundantly dissected such that underlying deposits (of inferred early Pleistocene age) are also significantly exposed within this map unit. The deposits include silt, sand, and fine gravels to cobbles. Deposits are dissected up to a depth of about 10 m. Surface morphology is typified by broadly rounded ridges and intervening swales. Soils developed in the deposits typically exhibit very well developed carbonate horizons (stages III to IV); argillic horizons are strongly developed (hue 5 YR) where preserved locally, but the soils are more typically somewhat stripped or reworked above the carbonate horizons. Soil great groups are Paleargids and Paleorthids.

O	790,000 - 1,800,000

Deposits of inferred early Pleistocene age; this designation is restricted to alluvial deposits with preserved surfaces occupying the highest topographic position on the piedmonts and basins. Deposits are characteristically coarse gravels, with lesser amounts of finer material; typically unconformably overlie or grade downward into older basin fill. The surfaces are relatively deeply dissected -- up to ~90 m above active channels. Gross morphology of these deposits is typified by broad, well-rounded ridges and intervening swales or ravines. Surface remnants are typically covered with abundant fragments of pedogenic carbonate (many ≥ 5 mm thick), derived from brecciated laminar petrocalcic horizons and carbonate clast-coatings. The fragments and coated clasts commonly impart a light-colored appearance to these remnants. Soils are generally stripped by erosion down to exposed remnants of stage IV to VI petrocalcic horizons; in a few places (e.g., along the Hassayampa River) very strongly developed argillic horizons (5 - 2.5 YR) are preserved. Soil great groups are Paleorthids and Paleargids.

QTrg	> 790,000

Inferred late Tertiary to early Quaternary deposits of very well rounded, well-sorted gravel, representing bedload material of major rivers. Deposits typically exhibit zones > 1 m thick strongly indurated with carbonate cement. Exposures of this unit occur adjacent to the modern course of the Hassayampa river.

Tbf	> 1,800,000

Upper Tertiary (Miocene-Pliocene) to early Quaternary deposits of dominantly coarse gravels. Deposits are highly dissected -- > 10 m -- and original depositional surfaces are not preserved; exposures typically exhibit a carbonate-indurated zone several meters thick near the top. In places (especially near mountain fronts) deposits are unconformably overlain by veneers of younger alluvium.

Other map symbols

~~~ alluvial-unit contact

bedrock-alluvial contact

Depositional patterns and controls

The mapped distribution of Quaternary and Upper Tertiary alluvial units in this area reflects the local late Cenozoic tectonic and climatic settings. Basin and Range deformation declined in the Sonoran Desert section approximately 10.5 to 6 Ma, and significant faulting ceased completely by early in the Pliocene (Shafiqullah and others, 1980; Morrison and others, 1981). In the Mexican Highland section major faulting ceased before approximately 3 Ma (Shafiqullah and others, 1980), but a few faults may have been active during the Quaternary (Morrison, 1985). The principally Upper Tertiary basin fill deposits represent the last major episodes of coarse-grained aggradation in the region (Menges and McFadden, 1981). The present-day landscape is consequently dominated by relatively low, highly embayed mountain ranges, and wide, planar intermontane areas. Integration of previously closed basins into the exterior drainage system of the Gila River (into which the channels on this map drain) was accomplished relatively soon after the end of basin-and-Range deformation (Eberly and Stanley, 1978; Shafiqullah and others, 1980); thus relative stability of base level has presumably been maintained in this area during the Quaternary.

In this setting of general tectonic and base-level stability, climate has exerted the strongest control on Quaternary alluvial deposition. With the onset of the Pleistocene, major, prolonged climatic oscillations and periodic changes in the rates of weathering, erosion, and sedimentation; these fluctuations contributed to periods of enhanced sediment supply, episodic abandonment of alluvial surfaces and shifts in the loci of deposition within the basins. The O map unit is interpreted to represent surfaces abandoned as a result of a crossing of the threshold from deposition to erosion (Bull, 1979) near the beginning of the Pleistocene (Menges and McFadden, 1981; Morrison, 1985). Relatively small remnants of these oldest Quaternary surfaces are found adjacent to mountain fronts, where the coarseness of the deposits and entrenchment of the channels has favored their isolation and preservation above younger units. Unit O deposits of the greatest areal extent in this map area correspond to presumed early Pleistocene terraces of the Agua Fria river. In piedmont and basin areas where extensive erosion and removal of older deposits has occurred (most strikingly along the Hassayampa River), the original surfaces corresponding to O and MO deposits have been completely stripped, exposing the underlying Upper Tertiary or oldest Quaternary deposits (Tbf and QTrg).

Deposits of middle and late Pleistocene age (units MO, M1, M2, and Mu) dominate most of the piedmonts and basins in the map area. This condition reflects the broad time periods these units represent, but also indicates that the interaction of local controls on deposition and erosion during the Quaternary has favored the relative abundance of mid- to late-Pleistocene age deposits over much of the area. The preponderance of MO and M1 surfaces in the central and northeastern parts of the map area is especially notable. Their broad extent and the strongly developed soils on these remnants (many have petrocalcic horizons) suggest that significant alluvial deposition over much of these areas has not occurred since the early to early-middle Pleistocene.

Holocene deposits (Y) occur as alluvial fans on some of the piedmonts -- primarily those flanking the Vulture, Hieroglyphic, White Tank, and Phoenix mountains. The surfaces are primarily underlain by sand and silt, presumably derived from long-term weathering of the mountains during a period of somewhat more effective moisture (i.e., cooler and [or] wetter climate) in the late Pleistocene. The material was supplied to the piedmont with the onset of relatively more arid conditins during the Holocene, resulting in an episode of aggradation (Bull, 1979). Unit Y deposits also occur in broad areas within the Phoenix basin; here the deposits may reflect less of a depositional pulse than a condition favoring erosion and transport of fine-grained alluvium from piedmont areas toward the basins during the Holocene. The exclusively fine-grained alluvium presently being transported in active channels (Yc) may also be largely reworked from older deposits, and reflects the conditions of reduced sediment supply and stream transport capacity during the last few thousand years.

The relative distribution of Quaternary alluvium of different ages varies markedly within the map area. One general pattern may be characterized as an apron-like piedmont exhibiting predominantly middle to young Quaternary surfaces, and relatively minor topographic relief, bespeaking overall aggradation and lateral shifting of loci of deposition. This general depositional pattern is seen on the piedmonts flanking the south sides of the Belmont and Vulture mountains, the White Tank Mountains, and the southeast side of the Hieroglyphic Mountains. This pattern contrasts with that seen where broad, inclined remnants of early- to early-middle Pleistocene age surfaces predominate, as they do along the Agua Fria River, on the Hassayampa Plain, and on the piedmonts of the New River Mountains and the southeast side of the Hieroglyphic Mountains. In further contrast, Quaternary surfaces have been extensively eroded along the entrenched Hassayampa River and on the piedmont area between the eastern side of the Vulture Mountains and the western side of the Hieroglyphic Mountains.

Tectonic factors may have had a significant sense on the observed distribution of Quaternary and Upper Tertiary deposits in the northeastern and north-central portions of the map area. A broad uplift or warping of the mountain areas of the Mexican Highland near its transition into the Sonoran Desert section of the Basin and Range Province could perhaps account for the significant entrenchment of the major drainages, the uplifting and resultant preservation near the mountain fronts of broad older Quaternary surfaces, and the extensive erosion and stripping of Quaternary and Upper Tertiary deposits in this transition zone (Menges, 1983). A similar tectonic perturbation has been suggested to explain the upstream preservation and downstream burial of Pleistocene terraces along the Salt River (Pewe, 1978).

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