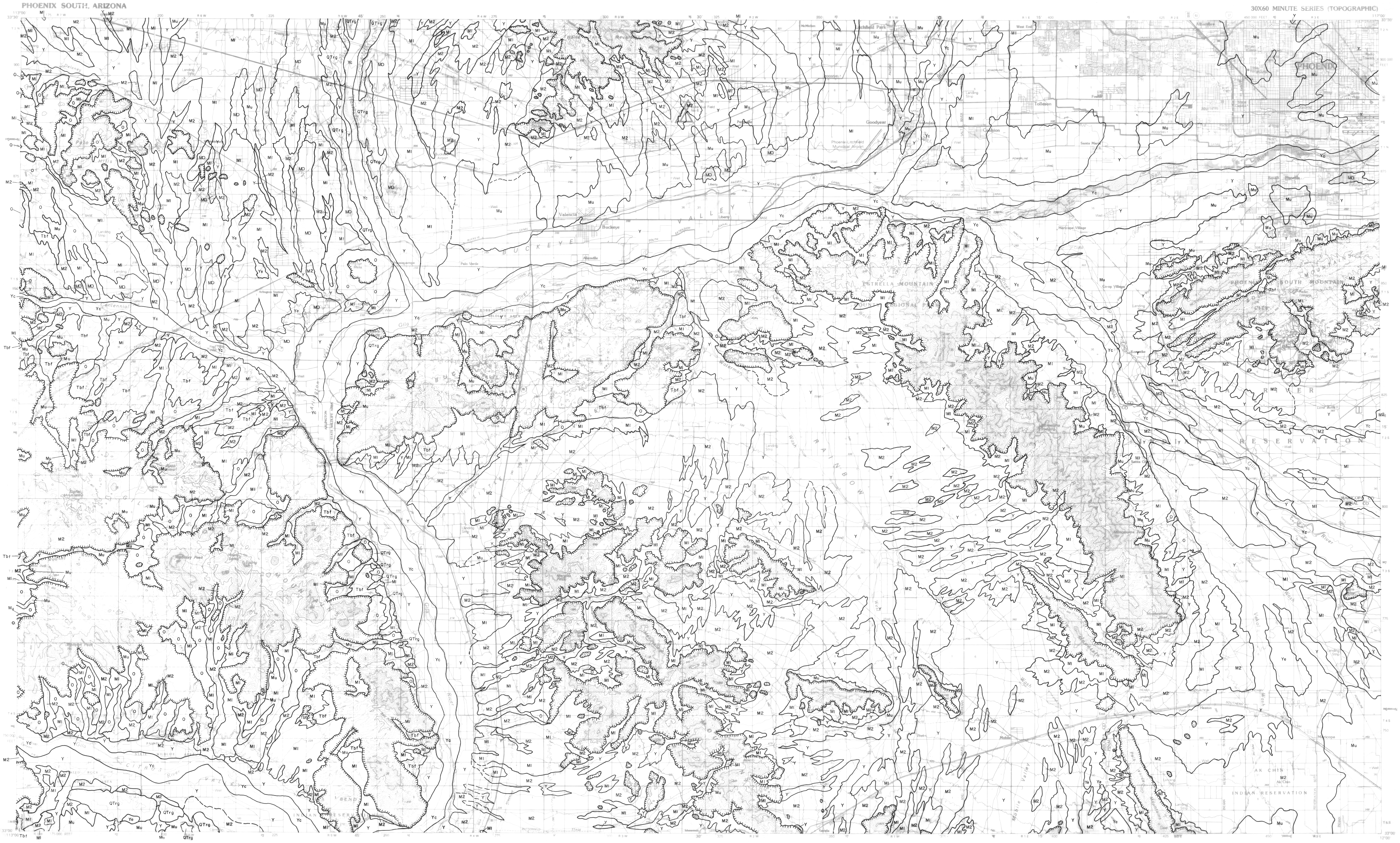

GEOLOGIC MAP OF QUATERNARY AND UPPER TERTIARY ALLUVIUM IN THE PHOENIX SOUTH 30' X 60' QUADRANGLE, ARIZONA

by Karen A. Demsey
1989

Scale 1:100,000

1 0 1 5 10 miles

1 0 1 5 10 15 kilometers

Introduction

This map depicts the general ages and distribution of Quaternary alluvium within the Phoenix South 30' x 60' quadrangle. The quadrangle is situated south and west of Phoenix, in the Sonoran Desert section of the Basin and Range Province. The physiography of the area is characterized by relatively small mountain ranges of low relief separated by wide, gently sloping piedmonts and basins. The area is drained by the Gila River, which meanders broadly across the map area. By indicating the distribution of alluvial deposits of different ages, this map provides a basis for evaluating the Quaternary geologic history of the area.

Alluvial deposits differentiated for this map are assigned to Quaternary and Upper Tertiary geologic units primarily on the basis of the estimated timing of cessation of major deposition on the corresponding depositional surfaces. Relative topographic positions of the geomorphic surfaces, extent of surface preservation, and degree of soil development are the principal criteria used to assess age of surface abandonment. The deposits and their associated surfaces and soils have been divided into the following map units according to relative age: a mainly upper Tertiary basin-fill unit (**Tbf**); a late Tertiary to early Quaternary river gravels unit (**QTrg**); an oldest Quaternary unit (**O**); four categories of middle Quaternary alluvium (MO --oldest, **M1**, **M2** --youngest, and **Mu**--undifferentiated); and three youngest Quaternary units (**Y** -- alluvial fans and large terraces, **Yc** -- active and recently active alluvium in major channels, and **Ye** -- eolian deposits). The estimated numerical ages of the surfaces are inferred largely from radiometric dates and geologic studies in southern Arizona (especially Bull, in press; Menges and McFadden, 1981; Morrison and Menges, 1982).

The mapping is based primarily on interpretation of U2 high-altitude aerial photographs (scale 1:129,000), supplemented locally by natural-color (1:24,000) aerial photographs. Unit designations and surface characteristics were checked at many 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) were used to evaluate surface ages and to delineate boundaries between Quaternary geologic units. This map forms the southern continuation of Quaternary geologic mapping in the Phoenix North 30' x 60' quadrangle (Demsey, 1988).

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Explanation of map units

Unit	Estimated age (years)
Yc	≤ 1000

Active and recently active channel deposits of major axial drainages. Primarily silt, sand, and fine gravel (hue 7.5 to 5 YR); local coarse gravel facies are associated with the larger stream; no soil development has occurred in any of the deposits.

Y 0 - 10,000

Represents deposits of inferred latest Quaternary age (Holocene; perhaps locally latest Pleistocene), including channels and low terraces of small drainages, young alluvial fans, and broad terraces of major drainages. Surfaces are primarily underlain by well-sorted sand and silt, with local occurrences of fine gravels; locally, deposits are coarser. Surfaces are very slightly (≤ 0.5 m) but abundantly dissected by active gullies and washes. Surface morphology is typically fine-grained and smooth; remnant bar-and-swale topography is preserved locally. Minimal soil development has occurred 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.

Ye 0 - 10,000

Represents deposits of eolian sand; limited to zones dominated by sand dunes. Eolian sands locally mantle surfaces of M1, M2, and Y units.

M2 10,000 - 250,000

Represents alluvium of inferred middle to latest Pleistocene age. Deposits are composed of silt, sand, and fine gravel to cobbles; 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 are lightly varnished. Soils on the surface remnants exhibit slightly to moderately developed textural B horizons (cambic or argillic horizons; hue 7.5 to 5 YR), typically above a stage II to III calcic horizon. Soil great groups are Camborthids and Haplargids.

M1 250,000 - 790,000

Alluvium of inferred early middle to middle Pleistocene age. Deposits include silt, sand, and fine gravel to large cobbles; in general, deposits are coarser and moderately sorted on the piedmonts, and generally finer grained (silt and sand) and well sorted in the basins (e.g., the large terraces of the Gila River in the Gila River Indian Reservation area). The surfaces are typically moderately dissected (generally ~3 to 6 m above active channels; locally greater on the Gila Bend Mountains piedmont). Gravelly surface remnants are generally rounded by erosion near edges, and have fine-grained or fine gravelly to cobbly mantles. Felsic clasts on the surfaces are lightly to moderately varnished, and mafic clasts are darkly varnished; the surface remnants are typically the darkest on a given 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; in some of the older M1 deposits the argillic horizons have been partially to extensively stripped. Soil great groups are Haplargids and Paleargids.

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 ~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 tyically stripped or reworked above the carbonate horizons. Soil great groups are Paleargids and Paleorthids.

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 mapping. In other places, this broader designation is used because of uncertainty in assigning the deposits to either a late or a middle Pleistocene age category. This unit is most widely shown adjacent to mountain fronts, but also within some of the broad terrace deposits in the Phoenix basin.

O 790,000 - 1,800,000 +

Deposits of inferred early Pleistocene age. This designation is restricted to alluvial deposits with preserved depositional surfaces occupying the highest topographic positions on the piedmonts and basins; an exception occurs on the southern piedmont of the Gila Bend Mountains where there are two distinct topographic positions (i.e., relative ages) of well-preserved "O" units; the higher remnants may be pre-Quaternary. Deposits are characteristically gravels, with lesser amounts of finer material; they typically unconformably overlie or grade downward into older basin fill deposits. The surfaces are typically deeply dissected (generally ~10 - 40 m above active channels, but locally, such as in the Gila Bend Mountains, 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, ≥ 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. Soil great groups are Paleorthids.

QTrg > 790,000

Inferred late Tertiary to early Quaternary deposits of very well rounded, well-sorted gravel, representing bedload material of major rivers. Deposits are typically darkly varnished or stained by weathering, and exhibit zones > 1 m thick strongly indurated with carbonate cement. Exposures of this unit occur adjacent to the modern courses of the Gila and Hassayampa rivers, and are commonly associated with slight topographic rises above surrounding surfaces.

Tbf > 1,800,000

Upper Tertiary (Miocene-Pliocene) to perhaps early Quaternary deposits of dominantly coarse gravels. Deposits are highly dissected (> 10 m above active channels) 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 thin veneers of younger alluvium.

Other map symbols

alluvial-unit contact (dashed where approximate)

bedrock-alluvial contact

Depositional patterns and controls

The map patterns associated with Quaternary deposits in the Phoenix South quadrangle are the result of the interaction between various factors controlling the supply, deposition, and preservation of the alluvium that makes up the intermontane areas. The more important controls on the Quaternary alluvial history include climate, lithology, and subtle changes in local base level.

The most prevalent landforms associated with the Quaternary deposits in this map area are alluvial fans, terraces, and channels of the piedmonts flanking the mountain ranges. The piedmont deposits consist of detritus shed from the mountains and thus reflect conditions that have affected the relatively small fluvial systems of these mountain ranges. Normal faulting associated with Basin and Range tectonism waned in this area about 10.5 to 6 Ma, and significant faulting ceased completely by the early Pliocene (Shafiqullah and others, 1980; Morrison and others, 1981). The originally closed basins became integrated with the Gila River system, in which exterior drainage was established relatively soon after the end of extensional tectonism (Eberly and Stanley, 1978; Shafiqullah and others, 1980). In the setting of general tectonic quiescence and base-level stability that has prevailed for the past approximately 2 m.y., Quaternary alluvial deposition on the piedmonts has occurred primarily in response to fluctuating climatic conditions.

Broad oscillations in Quaternary climate, including prolonged episodes of relatively wetter and (or) cooler conditions and relatively drier and (or) warmer conditions, have exerted a strong control on the geomorphic evolution of piedmonts in southern Arizona. The climatic changes are associated with significant changes in vegetation and in the rates of weathering, erosion, and sedimentation. The resulting instabilities in the drainage basins trigger pulses of deposition and erosion, and changes in loci of deposition on the piedmonts.

Large terrace deposits of the major axial drainages also form a significant component of the Quaternary alluvium in the map area. These terrace deposits are the result of factors that have affected sediment supply and transport from large drainage basin areas as well as factors that have controlled channel aggradation and entrenchment in the broad alluvial basins. The Gila, Salt, Agua Fria, and Hassayampa rivers are associated with broad gravel terraces of early middle Pleistocene to Holocene age. For example, the Phoenix basin and the alluvial plain of the Gila and Santa Cruz rivers south of the Phoenix basin are both composed primarily of broad terrace deposits. The abundant fine-grained deposits of the Gila River terraces are a source of significant eolian deposits in the Gila River Indian Reservation area.

The principally Upper Tertiary basin fill deposits (Tbf) represent the last major episodes of coarse-grained aggradation in the region (Menges and McFadden, 1981). The O map unit is interpreted to represent depositional 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). This unit commonly occurs as relatively small remnants near mountain fronts, which suggests a general basinward shift in loci of deposition since the episode of channel entrenchment in early Pleistocene time. The most extensive deposits of the O unit are along the Gila Bend Mountains, where local factors such as lithology and proximity to the Gila River have favored their preservation.

Deposits of middle and late Pleistocene age (units M1, MO, M2, and Mu) dominate most of the piedmonts and basins in the map area. The extent of these deposits reflects the broad time period 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 middle to late Pleistocene deposits over much of the area. The relative abundances of early middle to middle Pleistocene (MO and M1) and middle to latest Pleistocene (M2) piedmont deposits appears to be controlled at least in part by local lithology. Piedmonts that flank mountains with relatively resistant lithologies tend to be associated with coarser deposits and are dominated by middle Pleistocene and older Quaternary units. Mountains composed of less resistant lithologies are typically associated with piedmonts dominated by relatively fine grained, middle to latest Pleistocene and younger alluvium. These mountains probably produce more sediment, and the piedmont deposits are themselves more susceptible to subsequent erosion and reworking. For example, the piedmonts of the volcanic-dominated Palo Verde Hills and the basalt-dominated Gila Bend Mountains are both most abundant in M1 deposits and are the only piedmonts in the map area with a significant occurrence of O deposits. In contrast, the piedmonts of the granite-dominated White Tank Mountains, western Sierra Estrella, South Mountains, and eastern Maricopa Mountains are all most abundant in M2 and Y deposits.

Holocene deposits (Y) are generally finer grained and less voluminous than older deposits on a given piedmont. These younger deposits tend to occur farther from the mountains than older deposits on the piedmont, suggesting a general, progressive basinward shift of most deposition since the early Pleistocene. In some piedmont and basin areas (for example in Rainbow Valley), deposits of middle to latest Pleistocene age are commonly exposed in slight topographic rises within broad deposits of Holocene age, suggesting the younger alluvium is a relatively thin deposit over the older piedmont and basin deposits. The Holocene 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 conditions (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 conditions at the beginning of the Holocene, resulting in an episode of aggradation (Bull, 1979). The exclusively fine grained alluvium presently being transported in the active channels (Y and 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.

In addition to climate and lithology, minor changes in base level of the Gila River have apparently exerted an influence on the pattern of Quaternary deposition in the map area. Although the amount of downcutting has not been great, the effects of subtle channel entrenchment are nevertheless discernable. Piedmonts adjacent to different sides of a given mountain range may exhibit marked differences in degree of channel entrenchment, surface dissection, and dominant age of alluvium depending on their relative proximity to the Gila River. For example, the piedmonts on the eastern and northern sides of the Sierra Estrella and the western side of the Maricopa Mountains drain directly into the Gila River. These piedmonts are much more dissected and are generally composed of older alluvium, compared to the piedmonts flanking the other sides of these ranges, which are more indirectly linked to the Gila River. On the eastern side of the Sierra Estrella, near the distal end of the piedmont, are two exposures of inferred early Pleistocene (O) alluvium which appear to have been stripped of a previous mantle of younger alluvium due to erosion and downcutting of the adjacent river.

Further evidence of probable Quaternary downcutting by the Gila River is the abundance and depth of dissection of early to middle Pleistocene deposits on the Gila Bend Mountains piedmont, also flanked closely by the Gila River. The preservation of these older deposits may be favored in part by nearby downcutting and (or) lateral trimming by the Gila River. Additionally, the occurrence of broad middle Pleistocene-age deposits in the Phoenix basin, and the exposures of MO and QTrg units along the Hassayampa and Gila rivers bespeak of progressive downcutting of the Gila River since the earliest Quaternary.

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