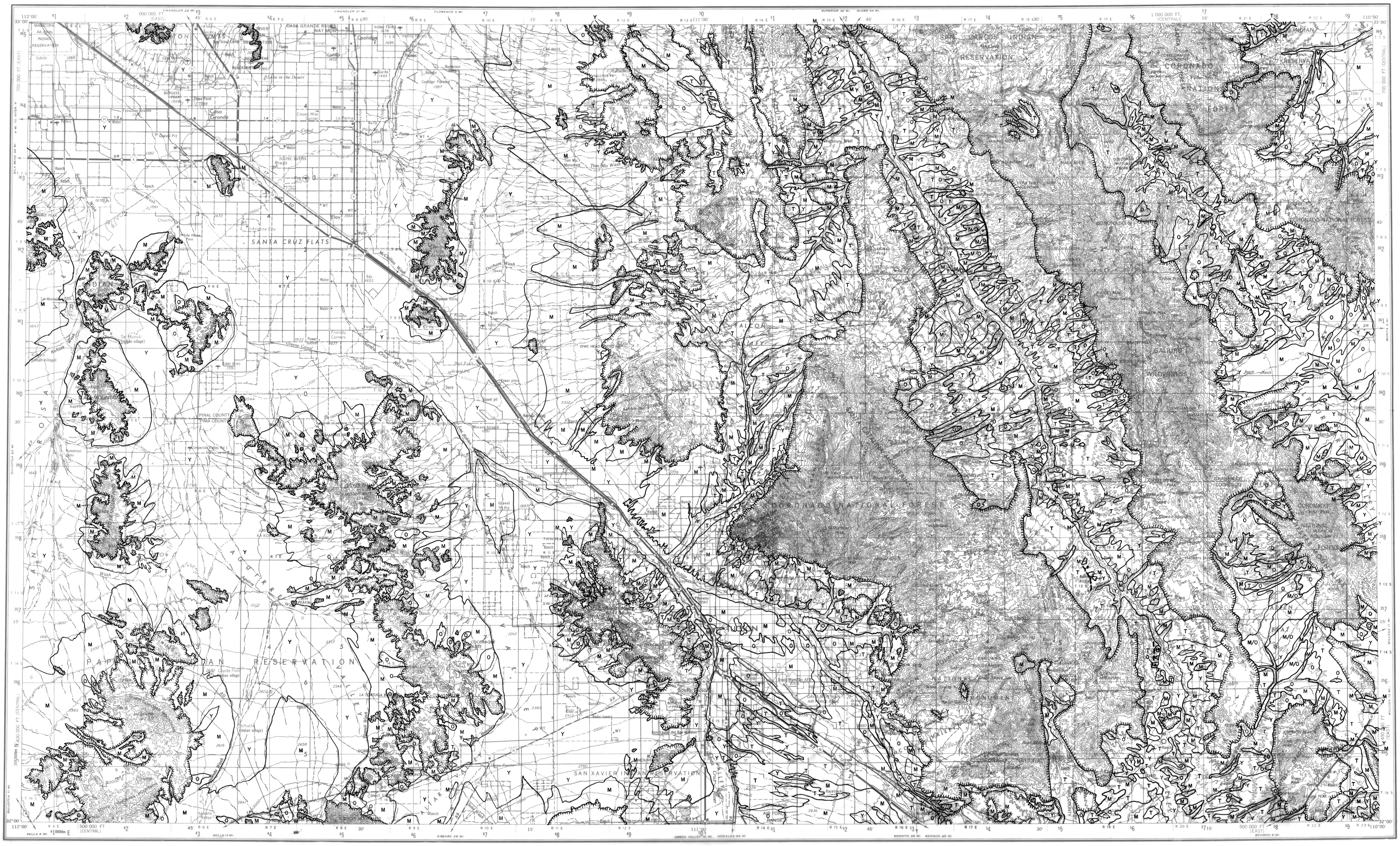

GEOLOGIC MAP OF QUATERNARY AND UPPER TERTIARY DEPOSITS TUCSON 1° X 2° QUADRANGLE, ARIZONA

by

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SCALE 1:250,000

MI. 0 5 10 15 20

KM 0 5 10 15 20 25 30

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INTRODUCTION

The Tucson 1° X 2° quadrangle exhibits a wide variety of basin landforms and late Cenozoic surficial geologic deposits. Several factors contribute to this diversity. The Tucson quadrangle spans the transition between the relatively low ranges and typically undissected basins of south-central Arizona and the higher ranges and typically dissected basins of southeastern Arizona. Dissected basins have been dominated by base-level lowering of axial streams and their tributaries, while undissected basins have had relatively stable base-levels. The higher ranges of the eastern half of the quadrangle receive more precipitation due to orographic lifting of moist air. This is superimposed on a distinct regional climatic gradient, with increasing annual precipitation and cooler annual temperatures from west to east across the quadrangle. Lithologies vary dramatically both within mountain ranges and between ranges; in some cases, rock type appears to profoundly affect piedmont evolution.

Given these potential sources of variability in late Cenozoic landscape development, it is rather surprising that a set of geomorphic criteria were found to be appropriate for mapping surficial units based on their relative ages in all portions of the Tucson quadrangle. Surface-age assignments and correlations of surfaces between basins were based on a combination of geomorphic criteria recognizable on 1:129,000-scale black-and-white aerial photographs. Criteria include relative topographic position, surface dissection, surface tone (color or shade), and surface texture (relative smoothness). Surface and soil characteristics and geomorphic relationships were field-checked on a reconnaissance basis. The surficial deposits of the Tucson metropolitan area represented on this map are generalized from 1:24,000-scale maps (McKittrick, 1988; Jackson, in prep.).

Map units are defined rather broadly and are designed to encompass a substantial range of surface ages. The youngest unit (unit Y, of Holocene age) is most readily mapped due to its distinctive surface characteristics and proximity to active stream systems. The oldest unit (unit O, probably early Pleistocene or Pliocene in age) can also be mapped fairly easily, as it is defined in part by its being the highest preserved depositional surface in any particular area. The middle unit (unit M, of middle or late Pleistocene age) encompasses all surfaces between the obviously young (Y) and very old (O) surfaces. More detailed maps of surficial deposits in Arizona (Demsey, 1988a, b; McKittrick, 1988; Jackson, in prep.) recognize two distinct units within the M deposits. Limited time available for field-checking dictated grouping deposits of intermediate age in one unit. Unit T comprises geologically young deposits whose original capping depositional surface has been completely removed by erosion. These basin-filling sediments range from coarse proximal fan facies to fine-grained playa or lacustrine deposits.

Numerical age estimates attached to Quaternary units described below are based primarily on soil development and geomorphic characteristics of surfaces. Several soils chronosequences have been developed in or near the Tucson quadrangle (McFadden, 1981; Katzer and Schuster, 1984; Pearthree and Calvo, 1987). Numerical age estimates for soils in these chronosequences are based on correlation with Holocene through middle Pleistocene soils of the Las Cruces area in southern New Mexico (Gile et al, 1981). Ages of some of the youngest deposits (Unit Y) are locally constrained by radiocarbon dates or archeological evidence (Haynes and Huckell, 1986; Waters and Fields, 1986; Waters, 1987a, b). The highest levels of basin-fill deposits (Unit T) apparently vary in age from latest Miocene to early Pleistocene (Scarborough, 1975; Johnson and others, 1975; Menges and McFadden, 1981).

MAP UNITS

Unit **Estimated Age**

Y **0 to 10 ka**
(ka is thousands of years before present)

Unit Y is composed of active stream channels, low stream terraces, and relatively undissected alluvial fans. Stream terraces and fans are typically less than 2 m above active stream channels. Initial depositional topography is usually well preserved. Soils formed in these deposits range from undeveloped to moderately developed. The youngest deposits in this category are active or recently abandoned stream channels or fans. These deposits have essentially no soil development. Older deposits include low stream terraces and abandoned alluvial fans. The surfaces associated with these deposits have been stable long enough to permit modest soil development, typically manifested as thin accumulations of calcium carbonate on bottoms of or coating gravel clasts, or as fine filaments, and development of soil A horizons. The oldest deposits in this category usually show some evidence of clay accumulation in soil B horizons (cambic or weak argillic horizons). Soil B and A horizons generally have not been reddened relative to the initial color of the sediments; hues of 7.5 YR and 10 YR typify these deposits.

M **10 to 790 ka**

Unit M is composed of inactive alluvial fan and terrace deposits. These fans and terraces typically are found from 1 to 10 m above active stream channels. Fan and terrace dissection ranges from minimal to extensive, depending on the age of the surface and proximity to base-level fall. Initial depositional topography is substantially smoothed, and may be completely obliterated on older surfaces. Soils formed in these deposits characteristically have significant clay accumulations (argillic horizons), with clay loam or clay textures. Soils are reddened relative to initial deposit colors, with 5 YR to 2.5 YR maximum hues. Calcium carbonate accumulations are quite variable, ranging from minimal to cemented pans, depending on calcium carbonate content of the parent material and soil leaching conditions. Clasts exposed on fan and terrace surfaces commonly have well-developed, black or brown rock varnish, especially in the more arid western portion of the Tucson quadrangle. Original fan or terrace shapes are usually fairly well preserved. Unit M deposits occupy intermediate topographic positions at the margins of many basins, higher than unit Y but inset below the oldest deposits in the basin (units O or T). In central portions of basins, unit M deposits are usually either the topographically highest deposits or are shallowly buried by unit Y deposits.

O **790 to 2000+ ka**

Unit O includes the oldest deposits in any given basin whose primary depositional surface is preserved and exposed. These units are predominantly remnants of alluvial fans preserved near basin margins/mountain fringes; locally, they are terrace remnants related to axial stream drainages or are extensive piedmont surfaces. Unit O deposits are moderately to deeply dissected (10 to 100 m). They typically lie atop the highest levels of basin fill (unit T) in a basin, although locally in the San Pedro Valley basin fill deposits are found higher than deposits interpreted to be unit O. Soil properties and surface characteristics are quite variable, depending on preservation and local climate. Where original depositional surfaces are well preserved, soils have strong clay accumulations (clay or heavy clay textures) and reddened hues (5 YR to 10 R). Unit O surfaces that been subject to substantial erosion may have little or no preserved argillic horizon. Calcium carbonate accumulations depend on climate and parent material. Massive, cemented petrocalcic horizons with laminar caps are typical of unit O in most of the Tucson quadrangle. However, unit O may have modest calcium accumulations in higher altitude portions of the eastern part of the quadrangle due to deep leaching during relatively moist intervals of the Quaternary. Clasts found on unit O surfaces are predominantly resistant lithologies, because less resistant lithologies have been completely weathered. Fragments of pedogenic carbonate derived from petrocalcic horizons litter some unit O surfaces.

T **0.79 to 10 Ma**

Exposed portions of the relatively thick accumulations of terrigenous material deposited in the present physiographic basins of southern Arizona (see Scarborough and Peirce, 1978) are mapped as unit T. These basin-fill deposits typically range from coarse proximal fan gravels adjacent to mountain fronts to finer-grained distal fan and axial stream gravels; playa or lacustrine silts and clays are found in the interiors of some basins. The surficial expression of T units is moderately to deeply dissected, ridge-and-ravine topography, where the original capping depositional surface has been completely removed by erosion. Exopsed deposits range in thickness from about 5 to 200 m. Soil development is minimal to moderate. It does not reflect the age of the deposits, but rather is limited by local erosion rates. Ages of these deposits are constrained in a few areas. They are probably primarily of Pliocene age, although some date to the late Miocene and some may be as young as early Pleistocene in age (Cooley, 1968; Scarborough, 1975; Johnson and others, 1975; Menges and McFadden, 1981).

10+ Ma

A hachured line encloses all pre-basin-fill units. It includes many types of bedrock, and also middle Miocene and older terrigenous sediments. Bedrock is exposed in mountain ranges, pediments, and some areas of deep dissection around basin margins.

Possible Quaternary fault. Faults mapped in the San Pedro Valley that clearly involve basin-fill deposits (unit T), have a strong geomorphic expression, and have Quaternary deposits associated with them on the downthrown side of the fault (units M or O).

DISCUSSION

Variations in regional basin physiography reflect differences in the Quaternary geologic evolution of various portions of the Tucson quadrangle. There has been very little overt tectonism (i.e., faulting or volcanism) during the Quaternary; fluvial erosion and deposition have been the dominant geologic processes. The eastern half of the Tucson quadrangle (approximately the area east of the Tucson basin, Tortolita Mountains, and Tortilla Mountains) is topographically higher and generally has been subject to more intense basin erosion than has the western half. Deposition of the Quaternary geologic units of the eastern half of the quadrangle has been superimposed on long-term downcutting by fluvial systems. Therefore, there typically is substantial topographic relief between geologic units of different ages and younger deposits are inset below older deposits throughout the basins. In these situations, older Quaternary geologic units (M, O, and T) dominate the surficial geology and young deposits (Y) are restricted to areas adjacent to active stream systems.

In the western portion of the Tucson quadrangle, where basin dissection generally has not been important during the Quaternary, the distribution of Quaternary geologic units is quite different. The central portions of most of the basins in the western half of the Tucson quadrangle are predominantly comprised of young deposits (Y). These deposits are probably relatively thin in all cases, as older M deposits commonly outcrop or are visible in gullies across the basins. Piedmont areas adjacent to mountain ranges typically contain Y, M, and locally O and T deposits; M deposits usually dominate these areas. The Tucson basin is located at the transition between the dissected eastern and undissected western portions of the Tucson quadrangle. Dissection in the basin is modest and variable, but generally increases to the east and south. Older deposits (M and O) comprise most of the surficial geology of the basin; O deposits are relatively extensive and Y deposits are restricted to small alluvial fans and terraces.

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