Surficial geologic map of the Casa Grande Quadrangle, Pinal County, Arizonav. 2.0

by

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Digital Geologic Map (169)
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SURFICIAL GEOLOGIC MAPS OF THE PICACHO BASIN

by

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Arizona Geological Survey
Open-File Report 90-2

1990

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EXPLANATION

Svmbols

,.,----,, contact

, - .. - ..-, gradational contact

,, , -1-... contact location uncertain

/ earth fissure

• • • • • • basinward pediment boundary

m area with debris flow potential

Unit decsriptions

Y2 -Active stream channels. Experience seasonal flooding and sediment transport. Sediment composed dominantly of fine sand, silt and clay in the gentle swales of the basin floor: in the well defined channels of the piedmont slope, sediments are sand and gravel size. Soils are not developed (Entisols).

Yl - Mid- to late Holocene basin terraces. Cover large areas in the southern Picacho Basin. Slight soil development (Camborthids), and stage I carbonate morphology (see Machette, 1985). This unit is, as are all basin terraces, composed predominantly of fine sediments (<2 mm). One exception is in the southern area of the Newman Peak quadrangle, where thin, well rounded gravels are exposed at the surface. Little or no desert varnish or pavement development.

M2 - Late Pleistocene-early Holocene basin terraces. Deposited by the ancestral Santa Cruz River and other axial streams. Soils on this surface typically contain argillic horizons (haplargid soils) and/or moderately developed (stage II) calcic horizons (calciorthid soils); large areas have strongly alkaline soils (natrargid soils).

Ml - Oldest terrace in the basin; mid-Pleistocene in age. Petrocalcic (stage III-IV) horizons and silica-cemented duripans common. Argillic horizons- may or may not be preserved (petrocalcic paleargids). Less extensive than other basin terraces. Found in widely scattered patches throughout the basin. Virtually all of the surface is cultivated, and hence any altitudinal difference between this and the other basin terraces has been destroyed.

yf2 Late Holocene alluvial fans. May experience flooding and sediment transport. Material is sand to boulder size. Occur on flanks of the Picacho and Casa Grande mountains. Typically found near the mountain fronts. *Soil* is not developed (Entisols).

Yf1 - Early to middle Holocene alluvial fans. Weakly to moderately developed soils (Camborthids). Common on the lower reaches of piedmonts. Incipient desert varnish is present. Little or no pavement development. Stream channels are incised less than I m into these deposits. This unit typically has finer sediments than older units or Yf2, being dominantly sand and gravel.

Mf2 Late Pleistocene alluvial fans. Surfaces have well-developed soils *with* argillic and/or stage II+ calcic horizons. Preserved only on the higher slopes of the piedmont, relatively close to the mountain front. Varnish moderately developed. Pavement is moderately developed, but discontinuous. Incised up to 2 m. Clast size ranges from sand to cobbles; this is significantly larger than in younger fans.

Mf1 Middle Pleistocene alluvial fans. Soils have petrocalcic horizons. Argillic horizons may or may not be present. These fans are found high on the piedmont slope. Varnish is well developed. Pavement also is well-developed, but discontinuous. Incised up to 3 m. Deposits are similar in size and sorting to Mf2.

of - Oldest alluvial fan in the basin (early(?) to middle Pleistocene). The unit is present only on the south side of Picacho Peak. Soil is poorly preserved, and petrocalcic horizons can be found at the surface. Pieces of these horizons are commonly scattered about surface. Pavement is discontinuous, depending on preservation. The unit is well dissected, up to 8 m. This is the highest surface in the Picacho basin, which also suggests great antiquity.

d- Vegetated, inactive eolian deposits and deflated areas. Occurs extensively *in* the Picacho Reservoir area. Soil, if any, is usually massive and alkaline. Deposits are composed of silt and fine sand.

Yp- Historic playa sediments deposited at Picacho Reservoir.

Y2/M2 Two symbols separated by a slash means the upper (younger) unit discontinuously veneers the lower (older) unit. YT2 may represent fine-grained deposits or may represent the stripped surface of the older unit.

Br- Bedrock (metasedimentary in the Casa Grande mountains, granite in the Picacho mountains, and silicic volcanics at Picacho Peak)

I. Quaternary landforms and history

The Picacho basin is a large and complex graben surrounded by horsts and half-horsts, which are now the Picacho, Casa Grande, Silverbell, and Sacaton mountains. It formed mainly in response to late Miocene extension. Internal drainage probably persisted until about 3 million years ago. Several thousand meters of sediments fill the basin; 2000 m of evaporites and claystone form the bulk of the basin fill (Scarborough and Pierce, 1978). The upper 200 meters or so of basin fill was deposited by a gradually aggrading, regionally integrated drainage system. Young alluvium of the Santa Cruz River is up to 30 m thick and is found within 3.2 km of the modern channel (Pool, 1986).

Although the Picacho basin does have external drainage, extremely low stream gradients and a lack of long-term downcutting have resulted in playa-like sediments, eolian deposits, and a lack of significant elevation differences between 'terraces. Unlike basins upstream, the Picacho basin has not been incised significantly during the Quaternary.

Three basic landform types are present in the Picacho basin: eolian landforms, basin terraces, and alluvial fans. Eolian landforms include relict dunes and deflation pits.

These landforms are typically found in the low-lying portions of the basin. In the Picacho Reservoir area they are extensive, creating a gently undulating to hummocky surface with a relatively low drainage density. Relief is up to about 2 m. Basin terraces are found low in the basin, and are _parallel to axial streams and roughly perpendicular to the regional slope. Older basin terraces tend to be elongate in plan view, owing to subsequent, adjacent erosion and deposition along subparallel drainages. The different ages of terraces can be distinguished only by soil profile development, due to lack of relief and due to surface destruction by agricultural activities. The surficial clasts of basin terraces generally are too fine to develop varnish or pavement.

Climatically induced changes in stream power have produced a series of alluvial fans which emanate from the mountains on the periphery of the basin and have steeper gradients than the basin terraces. Alluvial fans do not show large or abrupt elevation differences between ages; although older fans are higher on the piedmont slope, altitudinal differences between adjacent fans are subdued. Fan ages can be estimated by development of desert pavement, rock varnish, and soils, where exposed. The alluvial fans of greatest extent are those of Yfl designation (early to middle Holocene). These are found on the lower reaches of piedmonts. They are typically sandy and gravelly; they are much finer than the older units. The active fans (Yf2) are mostly adjacent to the mountain front, occurring between bedrock and Yfl. This situation implies that much material was removed from the mountains following the Pleistocene-Holocene transition, possibly due to decreased vegetation cover or to increased frequency of intense monsoon-type storms (Van Devender, et al, 1987).\

It is possible to roughly correlate alluvial fans in the Picacho basin with other fans in southern Arizona. Yf2 and Yfl corresponds to "Y" in McKittrick (1988) and Jackson (1989), a Holocene fan unit. Similarly, MF2 correlates with "M2". Mfl may correlate with "Ml". In the Picacho Peak area Of seems to correspond to "0" in the Tucson area, which is similar in its dissection and relative height.

terrace, "T4", in the Tucson basin, because of similar soil development.

Throughout the Quaternary, the Picacho basin has been dominated by discontinuous ephemeral streams. Indeed, the Santa Cruz River may be viewed as a large discontinuous ephemeral stream. Using Packard's (1974) nomenclature, the river's sheetflow environment would be in the southern Picacho basin; the fan/sheetflow environment is in the south and central portions; and the braided channel environment is in the west-central portion, in the Toltec Buttes area. All of these environments are within the "fan" segment of an ephemeral stream. This fan has shifted across the basin since at least the middle Pleistocene. A general pattern of fan migration can be seen in the distribution of the various surfaces. M1 is commonly found in the northeast; M2 is most extensive in the central and north central basin; Y1 is found primarily in the south-central and southwest parts of the basin, and Y2 is most abundant in the southernmost part of the basin (much of this is not within the mapped area). Thus the locus of deposition seems to have moved from the north and northeast to the south and southwest. This migration resembles the migration of smaller scale alluvial fans, which migrate to maintain a gradient sufficient to transport their sediment load. McClellan Wash has behaved similarly, but on a smaller scale.

II. Geologic hazards

Flooding

Because of the low relief within the basin, runoff during intense rainfall events was until recently probably not confined to channels. Agricultural activity has since channeled and diverted overland flow over most of the basin. In addition, arroyo-cutting has created discrete pathways so that even in non-agricultural areas, overland flow concentrates quickly into channels. Evidence for widespread overland flow is available in the stripped surfaces associated with recently formed arroyos. The fan-like form of the deposits from Santa Cruz River also testifies to former areas of shallow, widespread flooding. Channelization along with recently-formed arroyos probably eliminated most of the overland flow. There are some exceptions though, such as west of Picacho Peak, where Yf2 *is* deposited in wide, low, anastomosing channels barely *incised* (<0.5 m) *into* the older basin terraces.

Therefore the only areas affected by frequent flooding are those where Yf1, Yf2, and Yp and Yd are found. Recency of deposition, as determined by lack of varnish, pavement, or soil development, indicate a potential for flooding. While quantitative information on flood hazard *is* not available, it is evident that on the major fans, flooding is seasonal, and is somewhat less frequent on the smaller fans. The area immediately south of Picacho Reservoir is also prone to moderately frequent flooding. Historically, *it* has been a site of a shallow groundwater table, as evidenced abundant mesquite trees. Stream gradients and regional slope are especially low in this area. These features all *hint* that the area is subject to flooding of frequent, but as yet unquantified magnitude and distribution.

Debris flows

In the high, steep drainages of the Picacho Mountains lie the only areas with potential for debris for debris flows. Five major and at least 13 minor debris flows have occurred since 1972 (from aerial photographs), many of them occurring shortly after or during the October 1983 high rainfall event. The flows were limited to the upper portions of piedmont fans, however, and therefore potential hazards are apparently limited to the canyons and embayments within the mountain range. The low relief and limited drainage area of the Casa Grande mountains make debris flows in these areas very rare.

Slope, mountain heights, and proximity to debris flow channels or levees were used to determine those areas that have a potential for debris flows. These areas are outlined on the maps. All portions of active alluvial fans (Yf2) may be affected by debris flows, while on older fans, the hazard of debris flows *is* limited to the channels and their immediate vicinity. Recent debris flows have terminated relatively close to the mountain front, rather than extending out onto the piedmont.

Earth Fissures

Compaction-related earth fissures are extensive in the Picacho basin. The highest densities of fissures are around the perimeter of the basin. The highest potential for fissure development is probably in these areas. The fissures loosely follow the buried range-bounding faults, and near the Picacho Mountains have a significant vertical displacement component, up to 60 cm. Earth fissures begin typically as minute, hairline cracks in the ground (Slaff and others, 1989, in prep.). Overland flow quickly takes advantage of the discontinuities and concentrates along the fissure. Lateral and vertical erosion then proceeds rapidly, expanding fissure width to as much as 10 m and depth up to 4 m. As a result, erosion also occurs upslope from fissures, as vertical headcuts erode upslope. Damage resulting form earth fissures includes foundation cracks, disrupted highways, canals, and pipelines, arroyo-cutting and soil erosion, and vegetation destruction through concentration and removal of overland flow, or "piracy".

Soil related hazards

Soil shrink-swell and soil collapse are potential problems in the Picacho Basin. The Soil Conservation Service has determined relative hazards of soil shrink-swell *(Soil* Conservation Service, in prep.) in the area. The soils with the highest potential for shrink-swell commonly are in young basin terraces (YTI). This is due the high percentage of montmorillonite clay with the terraces. MT2 has soils with a moderate potential for shrink swell processes, but the distribution of these soils is irregular.

Potential for collapsing soils in the basin can be inferred from landforms in other basins known to have these soils. Holocene fan skirts and aprons commonly have collapsing soils (S. Slaff, 1986, unpub. report). The units *in* the Picacho basin *with* for potential collapse are thus Yf2 and YT1. These units are composed of relatively fine material which are quickly deposited, leaving the unstable clay bridges in tact. When wetted, the intergranular clay structure collapses (Beckwith, 1979). In addition, soils developed in granitic parent materials have the highest potential for collapse (Beckwith, 1979). Since the Picacho Mountains are composed mainly of granitoid rocks (Reynolds, 1988), it is likely that the Holocene fans emanating from them have some collapsing soils.

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