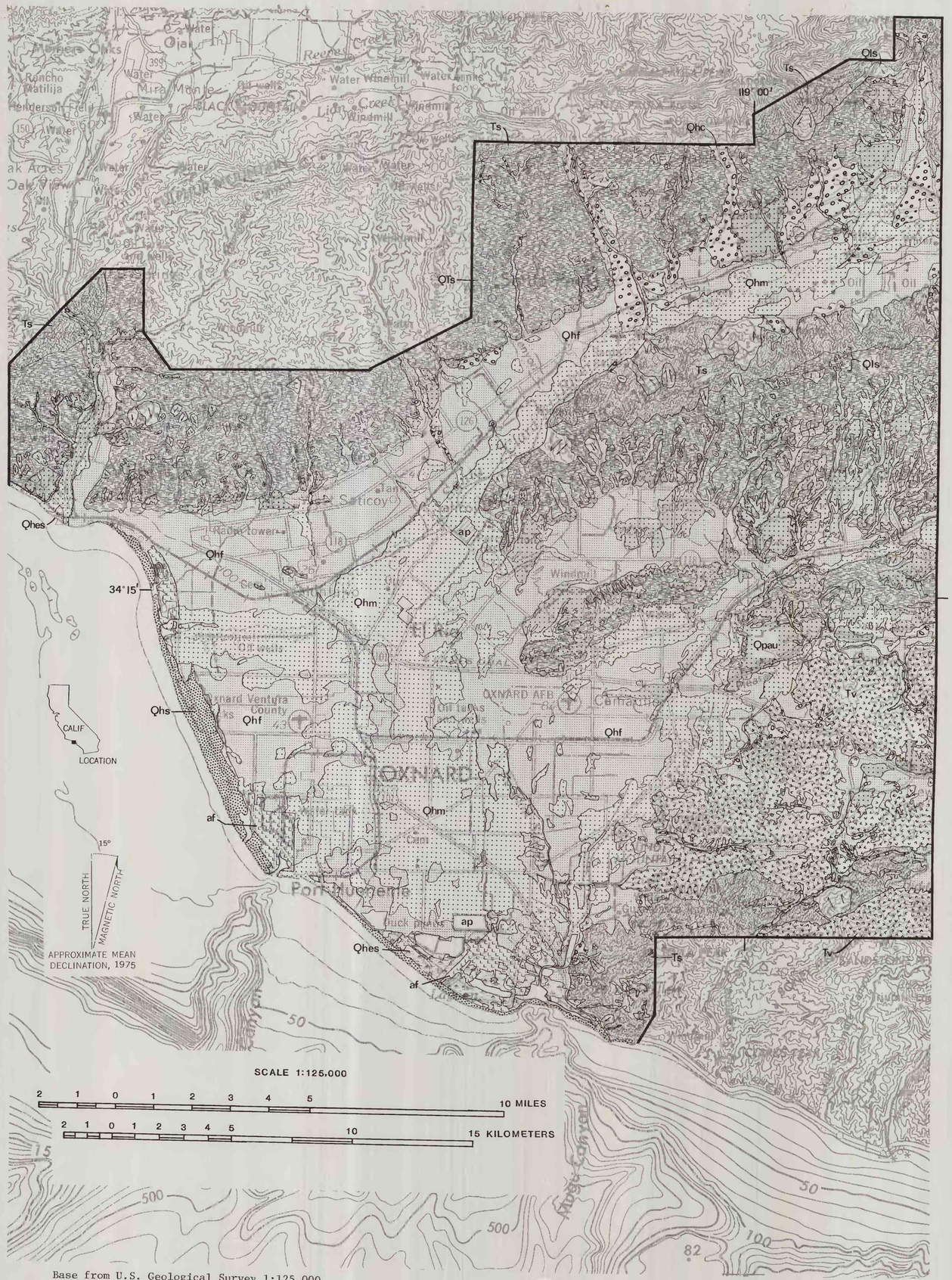
DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

OPEN FILE REPORT
78-1065



Base from U.S. Geological Survey 1:125,000
Los Angeles, 1968.

PRELIMINARY MAP SHOWING SURFICIAL MATERIALS OF THE VENTURA-OXNARD PLAIN AREA,

CALIFORNIA

BY GAIL McCOY AND A.M. SARNA-WOJCICKI

INTRODUCTION

This map is a compilation of existing information on the areal distribution of surficial materials in the Oxnard-Ventura Area. The main purpose of the map is to characterize surficial materials with respect to textural characteristics (primarily grain size) and degree of induration. Information presented here is intended to serve as a basis for further studies in earthquake hazard zonation, particularly in studies of response of surficial materials to seismic shaking.

In the absence of systematic geological engineering studies of sedimentary deposits and rocks of this area, we have used our field observations and published soils and geologic mapping in an attempt to characterize the surface materials. This study is restricted to materials exposed at the surface, and does not include subsurface information. Consequently, no data on the thickness of units is presented. A study now in progress involves compilation of existing subsurface information and construction of representative cross-sections across the study area. Information used in compiling this map has been derived from two primary sources: U.S. Department of Agriculture soil series maps (Edwards and others. 1970) for deposits of the alluvial plains, and geologic mapping compiled by the California Division of Mines and Geology (Weber and others, 1973) for the upland areas.

METHODS

Soil units were traced from U.S. Department of Agriculture soil maps (Edwards and others, 1970) onto 7½ minute U.S.G.S. topographic maps (scale of 1:24,000) and were grouped according to age and textural categories (see below). Since unrectified aerial photographs (at an approximate scale of 1:24,000) are used as base in the U.S.D.A. soil maps, there is a certain error involved in transferring soil contacts onto the topographic base. This error is estimated at approximately 0.1 mile (0.16 km) or less. Bedrock units were generalized from a 1:48,000 scale geologic map (Weber and others, 1973), and transferred onto the 1:24,000 topographic base using a Keuffel and Esser Kargl reflecting projector. The base maps were photographically reduced to the present scale of 1:125,000. Final transfer and generalization of data was done at this scale, using a light table.

ALLUVIAL PLAINS

The essentially flat-lying alluvial plains of the Oxnard-Ventura area and the Santa Clara River valley are of special interest from the point of view of seismic zonation, since these areas, presently undergoing rapid development, are known to have shown liquefaction and associated effects during past earthquakes. Except locali; (Sarna-Wojcicki and others, 1976), there have been no attempts in published geologic maps to subdivide Quaternary alluvium of the lowlands in this area on the basis of age or textural criteria. Published soil maps of the lowland areas (Edwards and others, 1970), however, contain much of the basic age and textural information needed for such a subdivision, when combined with appropriate geologic information (Lajoie and Helley, 1975).

Soil survey information (Edwards and others, 1970) has been interpreted and adapted to the present map by grouping soil units into age and textural categories. Following the usage of Lajoie and Helley (1975), a major distinction is made here between alluvial soils which have a pronounced weathering profile ("B" horizon developed at the surface), and alluvium that does not. Soils of the flat-lying alluvial plains generally do not have a well-formed weathering profile, or "B" horizon. Formation of such a profile requires a considerable amount of time, on the order of thousands of years. Absence of such a weathering profile in soils of the alluvial plains attests to the youthfulness of these deposits. In addition, surfaces of these deposits are closely adjusted to stream gradients and to the present sea level, indicating that these deposits are products of the modern stream regime, initiated several thousand years ago after the last ice age when the rising oceans reached their present levels.

Soils developed on alluvium which has a strongly developed weathering profile, or "B" horizon, are most frequently associated with marine terraces, stream terraces, or uplifted alluvial fans. These landscape features are situated at the lower slopes of foothills surrounding the alluvial plains, and are clearly out of adjustment with the modern drainage systems. Alluvium associated with these landscape features is older, as indicated by presence of the "B" horizon, and the position of these features above modern streams and alluvial plains. These features were formed, for the most part, before the end of the last glacial period. In this map, alluvium lacking "B" horizons is inferred to be Holocene in age (formed 10,000 years ago or less), while alluvium having developed "B" horizons is considered to be late Pleistocene in age (formed prior to about 10,000 years ago) (Lajoie and Helley, 1975).

Holocene alluvium is further subdivided here according to grain size into coarse-, medium-, and fine-grained categories (see Explanation). Areas underlain by soils containing gravel or cobbles and pebbles, together with finer material, are characterized as coarse-grained alluvium. Areas underlain by soils containing mostly sand, together with smaller amounts of finer material (sand, loamy sand, sandy loam, and sandy clay loam; see fig. 1) are characterized as medium-grained alluvium. Areas underlain by soils which contain dominantly fine material such as silt and clay (fig. 1) are characterized as fine-grained alluvium. In general, fine-grained alluvium is more cohesive than coarser alluvium of the same age.

Late Pleistocene alluvium (areas underlain by soils with a well-developed weathering profile, or "B" horizon) in the Oxnard-Ventura area exhibits the same spectrum of textural types described above for Holocene alluvium. Pleistocene alluvium covers a small portion of the study area, however; these deposits consequently are grouped into a single category for purposes of representation at the present scale.

In general, late Pleistocene alluvium is more cohesive than Holocene alluvium owing to the cementing action of clays and chemical precipitates deposited within the weathered soil profile. Most profiles of this kind, however, are usually only several feet thick, and thicker layers of Holocene and late Pleistocene alluvium should not differ much in cohesion and induration and, consequently, in seismic response characteristics.

UPLAND AREAS

Information regarding surface materials for the upland areas surrounding the Oxnard-Ventura plain and Santa Clara River valley was obtained from Preliminary Report 14 of the California Division of Mines and Geology (Weber and others, 1973), a compilation of published and unpublished geologic mapping in southern Ventura County. Geologic units mapped in that report are grouped into three broad categories based on age and inferred degree of induration. Sediments and rocks of a given age category generally are better indurated than younger materials. This is because older materials have usually been buried more deeply and for longer periods of time, before being exhumed by erosion. This results in greater compaction, a higher number of grain-to-grain contacts, more opportunity for infiltration of voids with finer materials and chemical cementation and, consequently, better cohesion and induration. Owing to the heterogeneous nature of geologic materials (sediments and rocks), however, individual beds or lenses within a given age category here may be as well or less indurated than beds in a younger category.

A large part of the upland areas is composed of mid-Quaternary to late Tertiary sedimentary strata that are deformed (faulted, tilted, and folded). These rocks are exposed at the surface in the hills north and northeast of Ventura, at South Mountain, in the Camarillo Hills, and in the Las Posas Hills and western Santa Monica Mountains. These strata are both marine and non-marine in origin, and are the least consolidated and indurated rocks in the upland areas, excluding small areas of Holocene and late Pleistocene alluvium. With respect to texture and grain size, these strata exhibit the same range as Holocene and late Pleistocene alluvium. Grain-size differences are difficult to represent at the present map scale, since adjacent strata even in a single exposure often have widely-differing grain sizes. Consequently, these rocks are grouped into a single, undifferentiated category. These rocks are generally less indurated than older Tertiary rocks. On steep slopes, these rocks are highly prone to landsliding, and a considerable percentage of the upland areas underlain by these rocks consists of both active and dormant landslides. The exact age of rocks in this category is uncertain, but most likely is from about 0.5 to 5 million years before present.

Older Tertiary sedimentary rocks (about 5 to 65 million years old), both marine and non-marine in origin, outcrop at higher elevations in the upland areas. These rocks also are tilted, faulted, and folded. Older Tertiary rocks in general are better indurated than younger rocks, but are also frequently fractured and jointed, so that larger exposures on steeper slopes are susceptible to landsliding. These rocks are also very variable in coherence and degree of induration, and individual beds may be less coherent and indurated than younger materials.

Tertiary volcanic rocks, outcropping in the southern part of the mapped area (western Santa Monica Mountains) are also deformed. These rocks are generally better indurated than other rocks in the area. Volcanic flow rocks are probably the best indurated, but they are also frequently jointed and fractured, which reduces their coherence in large exposures and on steep slopes. Deeply weathered volcanic flow rocks may be as soft and incoherent as sedimentary rocks. Mapped together with the volcanic flow rocks are numerous beds of sedimentary rock containing clasts of reworked volcanic material of various grain sizes. These beds have essentially identical physical properties to older Tertiary sedimentary rocks of comparable texture.

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EXPLANATION OF MAP SYMBOLS

HOLOCENE

af ap — Artificial fill (af): Various natural and artificial materials. Specific materials used for filling vary from site to site. Texture, particle size, and degree of induration will depend on materials used and type of treatment applied (grouting, tamping), if any. Artificial ponds (ap): Areas used for wild fowl and infiltration ponds. Original surface materials unknown but probably similar to those in areas adjacent to ponds.

Qhm Qhf Qhes Qhs Qls — Holocene sedimentary deposits (less than about 10,000 years), with soil zones lacking a "B" horizon. Generally flat-lying or nearly so. Coarse-grained alluvium (Qhc) loose, gravelly sand and sandy gravel, particles generally not coarser than pebble-sized, in a matrix of sand and silt. Very permeable. Found along stream channels in upland areas and in fans at base of upland areas. Often grades downslope into: Medium-grained alluvium (Qhm) loose, medium- to fine sand containing variable amounts of silt. Poorly- to fairly well-sorted. Generally permeable. Occurs along stream channels and levees of alluvial plains and on gently sloping fans. Grades laterally and downslope in low alluvial plains into: Fine-grained alluvium (Qhf) loose to compact silt and clay, with variable amounts of fine sand and organic material. Somewhat permeable to impermeable. Occurs adjacent to stream channels of alluvial plains as "overbank" deposits from floods and elsewhere in closed basins and coastal plains, where stream gradients are low. In coastal areas, may grade oceanward into: Estuarine sediments (Qhes) loose, soft, water-saturated muds, mixtures of silt, clay, sand, and organic material, in various proportions. Poorly sorted. Occur in low-lying areas protected from the surf and accessible to high tides, particularly areas behind beach barriers, where streams debouch into the ocean. Locally may contain stringers of well-sorted silt and sand, and beds of peat. May grade laterally and oceanward into: Eolian sand and beach sand (Qhs) loose, well-sorted fine- to medium-grained sand. Locally may contain lenses of gravelly sand, or silts and clays. Occurs along coastal beaches and dune areas immediately landward from the coast. Also occurs in dunes in the more arid parts of inland areas. Landslide colluvium (Qls) Generally incoherent, poorly sorted material derived by downslope movement of bedrock materials in hilly and mountainous areas. Degree of coherence and texture vary widely with type of landslide and bedrock. Colluvium is less coherent and more comminuted than parent bedrock. Older landslide colluvium may be late Pleistocene in age.

PLEISTOCENE

Qpau — Late Pleistocene alluvium, undifferentiated: (about 10,000 years to several hundred thousand years), with soil zones showing "B" horizon development. Pleistocene deposits generally are better compacted and consolidated than Holocene deposits of comparable texture and grain size due to cementing action of clays in "B" horizon and below. Generally flat-lying or nearly so. Late Pleistocene alluvium occurs as stream terraces along the sides of many stream valleys, as marine terraces, uplifted along the coastal areas, or as uplifted alluvial fans along the bases of uplifted mountains and hills. The original constructional landforms may be obscured or modified by erosion. These deposits include the same spectrum of textural and grain-size types as described for Holocene deposits. For ease of presentation at the present scale, these categories are grouped into one.

QTs — Middle- to early-Pleistocene and late Tertiary sedimentary deposits, undifferentiated (about several hundred thousand to several million years). Includes both marine and non-marine deposits. Sediments in this category are generally as well, or better, indurated than Holocene or late Pleistocene sedimentary deposits. Unlike Holocene and late Pleistocene sediments, these Middle- to early-Pleistocene and late Tertiary sedimentary deposits commonly are deformed (tilted, folded, and faulted), and the original constructional landforms have been essentially obliterated by erosion and other geologic processes. These deposits occur in low hills and foothills bordering the low-lying alluvial plains. They include the same spectrum of textural and grain-size types as described for Holocene and Pleistocene sedimentary deposits. For ease of presentation at the present scale, these categories are grouped into one.

Ts — Tertiary sedimentary rocks, undifferentiated. Marine and non-marine sedimentary rocks (2 to 65 million years). These rocks range widely in texture, grain size, degree of induration, and other physical properties. In general, they are better indurated than younger surficial deposits, but vary considerably, even within a single formation. Individual beds may be less indurated than younger deposits. These rocks are exposed in hilly and mountainous areas. In the area of the map, these rocks are deformed (tilted, folded, and faulted), and the original constructional landforms have been obliterated by erosion and other geologic processes.

Tv — Tertiary volcanic rocks, undifferentiated. Volcanic flow rocks, pyroclastic rocks, and reworked volcanic material (2 to 65 million years). These rocks range widely in texture, grain size, degree of induration, and other physical properties. In general, they are as well, or better indurated than Tertiary sedimentary rocks, but vary considerably, even within a single formation. Individual beds may be less indurated or consolidated than Tertiary sedimentary rocks or younger deposits. These rocks are exposed in hilly and mountainous areas. In the area of the map these rocks have been deformed (tilted, folded, and faulted), and the original constructional landforms have been obliterated by erosion and other geologic processes.

QUATERNARY

TERTIARY

Sandy alluvium

Fine to very fine-grained alluvium

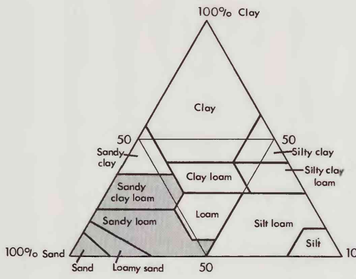

Fig. Soil textural classes plotted on a triangular diagram, showing combination of soil-types that form the medium- and fine-grained soils of the mapping units. Modified from a diagram by Birkeland (1974).

Table 1. List of Soil and Bedrock Units

Soil and bedrock units on this map have been defined in terms of age and grain-size of the surficial materials. Mapping units have been formed from the listed soil units (Edwards and others, 1970) or bedrock units (Weber and others, 1973). Certain of the units on the soil surveys were not defined in relation to specific types of soil. These units, including pits or dumps, terrace escarpments and areas of badlands or gullies, were assigned to their underlying bedrock or soil unit.

SOIL UNITS

(Alluvial Plains)

Soils of inferred Holocene age

Coarse-grained alluvium
- Anacapa gravelly sandy loam
- Cortina stony sandy loam
- Cortina very stony sandy loam
- Garretson gravelly loam
- Mocho gravelly loam
- Vina gravelly loam

Medium-grained alluvium
- Anacapa sandy loam
- Camarillo sandy loam
- Camarillo loam with sandy substratum
- Corralitos loamy sand
- Hueneme loamy sand with loamy substratum
- Hueneme sandy loam
- Metz loamy fine sand
- Metz loamy sand
- Metz loamy sand with loamy substratum
- Pico sandy loam
- Pico loam with sandy substratum
- riverwash
- sandy alluvial land

Fine-grained alluvium
- Camarillo loam
- Cropley clay
- Cropley clay—calcareous variant
- Garretson loam
- Garretson silty loam—calcareous variant
- Mocho loam
- Mocho clay loam
- Pacheco silty clay loam
- Salinas clay loam
- Sorrento loam
- Sorrento silty clay loam
- Sorrento clay loam—heavy variant
- Vina loam
- Vina silty clay loam

Soils of inferred late Pleistocene age

Alluvium, undifferentiated
- Azule loam
- Azule gravelly loam
- Huerhuero very fine sandy loam
- Ojai very fine sandy loam
- Ojai stony fine sandy loam
- Rincon silty clay loam
- Zamora loam

BEDROCK UNITS

(Uplands)

Middle- to early-Pleistocene and late Tertiary age units

Sedimentary deposits, undifferentiated
- San Pedro Formation
- Saugus Formation
- Santa Barbara Formation
- Pico Formation

Tertiary age units

Sedimentary rocks, undifferentiated
- Santa Margarita Formation
- Monterey Formation
- "Burnt Shale" of the Monterey Formation
- Rincon Formation
- Topanga Formation
- Vaqueros Formation
- Sespe Formation
- Coldwater Formation
- Cozy Dell Formation
- Matilija Formation

Volcanic rocks, undifferentiated
- Conejo and other volcanics; ranging from basalt to andesite and dacite in composition, occurring as flows, volcanic sedimentary rocks and intrusions.

This report is preliminary and has not been edited or reviewed for conformity with Geological Survey standards and nomenclature.

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