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# QUATERNARY GEOLOGY OF ALAMEDA COUNTY, AND PARTS OF CONTRA COSTA, SANTA CLARA, SAN MATEO, SAN FRANCISCO, STANISLAUS, AND SAN JOAQUIN COUNTIES, CALIFORNIA: A DIGITAL DATABASE

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## DISCUSSION

### INTRODUCTION

Alameda County is located at the northern end of the Diablo Range of Central California. It is bounded on the north by the south flank of Mount Diablo, one of the highest peaks in the Bay Area, reaching an elevation of 1173 meters (3,849 ft). San Francisco Bay forms the western boundary, the San Joaquin Valley borders it on the east and an arbitrary line from the Bay into the Diablo Range forms the southern boundary. Alameda is one of the nine Bay Area counties tributary to San Francisco Bay. Most of the country is mountainous with steep rugged topography. Alameda County is covered by twenty-eight 7.5' topographic Quadrangles which are shown on the index map (alq_quad or Sheet 2).

The Quaternary deposits in Alameda County comprise three distinct depositional environments. One, forming a transgressive sequence of alluvial fan and fan-delta facies, is mapped in the western one-third of the county. The second, forming only alluvial fan facies, is mapped in the Livermore Valley and San Joaquin Valley in the eastern part of the county. The third, forming a combination of Eolian dune and estuarine facies, is restricted to the Alameda Island area in the northwestern corner of the county.

### MAPPING METHODS

Geological units were mapped on 1:24,000 scale U.S. Geological Survey topographic maps using 1939 black and white aerial photographs showing the county before much development had taken place. The mapping was supplemented with 1:12,000- and 1:24,000-scale color aerial photography flown in 1965 and 1974 respectively. The mapping was also aided by observations made on turn of the century topographic maps at 1:62,500-scale with 25 foot (7.6 m) contour intervals. These maps were most useful in recognizing natural stream channels which have since been modified. The position of water boundaries, the stream channel to water transition, the length and position of mapped stream channels (see below), the distribution of artificial levees, and the apparent distribution of artificial fill were plotted to conform with the most recent 1:24,000 scale topographic maps.

Mapping units were delineated by: 1) landform morphology, 2) relative topographic position, 3) relative preservation of surface morphology, 4) tonal contrasts on aerial photographs, 5) relative soil profile development (compiled from the U.S. Soil Conservation Service, 1917), and 6) other features such as differences in vegetation density and type. Landform morphology refers to the shape of a particular landscape element. Examples are the distinctive conical shape of alluvial fans and the shape of levees that usually border active stream channels, sloping away from them to blend into flat basin deposits. Other criteria listed in the description of geological units are also used to distinguish one element from another, but they are particularly useful for delineating units within a specific landscape element. A surface on an alluvial fan, for example, might be differentiated from another because of its higher topographic position, greater drainage density, and stronger soil profile development. Geologic units defined this way are called allostratigraphic units (American Association of Petroleum Geologists Bulletin, 1983).

The ca 1850 A.D. shoreline of Nichols and Wright (1971) is inferred to be the contact between estuarine mud (Qhbm) and continental deposits. At the 1850 shoreline, the thickness of the estuarine mud (Qhbm) is zero. The boundary between the estuarine mud and the time equivalent peaty muck

(Qhpm) in the northeast section of the county is arbitrarily placed at the confluence of the Sacramento and San Joaquin Rivers.

The geological units shown on this map provide information on texture, environment of deposition, and age. The contacts between units are, in most cases, not sharp but diffuse and may span a few meters. Very little information is available regarding the thickness of the geologic units.

No bedrock units have been mapped; bedrock outcrop is simply labeled "br". Other geologic features, such as folds and faults, have not been mapped. A few large landslides are shown, but this map does not show most of the landslides in the area. See Nilsen and others (1979) for a landslide inventory, and Graymer, Jones, and Brabb (1996) for a geologic map emphasizing bedrock units and geologic structures.

## DESCRIPTION OF MAP UNITS

The Quaternary deposits of Alameda County are described from youngest to oldest, beginning from the Bay and ascending the alluvial fans to bedrock.

af **Artificial Fill (Historic)**--Man made deposit of various materials and ages. Some are compacted and quite firm, but fills made before 1965 are nearly everywhere not compacted and consist simply of dumped materials.

alf **Artificial Levee Fill (Historic)**--Man made deposit of various materials and ages, forming artificial levees as much as 20 feet (6.5 meters) high. Some are compacted and quite firm, but fills made before 1965 are almost everywhere not compacted and consist simply of dumped materials. The distribution of levee fill conforms to levees shown on the most recent U.S. Geological Survey 7.5 minute quadrangle maps.

GP **Gravel Pits (Historic)**--Excavations in stream channels and Holocene alluvium for the purpose of extracting sand and gravel for aggregate in construction industries.

Qhasc **Artificial Stream Channels (Historic)**--Modified stream channels, usually where streams have been straightened and realigned, but also including those channels in the San Joaquin Valley and delta that are confined within artificial dikes and levees.

Qhbm **Bay Mud (Holocene)**--Water saturated estuarine mud, predominantly gray, green and blue clay and silty clay underlying marshlands and tidal mud flats of San Francisco Bay and Carquinez Strait. The upper surface is covered with cordgrass (*Spartina sp.*) and pickleweed (*Salicornia sp.*). The mud also contains a few lenses of well-sorted, fine sand and silt, a few shelly layers (oysters), and peat. The mud interfingers with and grades into fine-grained deposits at the distal edge of Holocene fans, and was deposited during the post-Wisconsin rise in sea-level, about 12 ka to present (Imbrie and others, 1984). Estimated thickness: 0-40 m. In places it rests unconformably on bedrock.

Qhpm **Peat and Peaty mud (Holocene)**--Water saturated peat and mud deposited in tidal wetlands in response to the post-Wisconsin rise in sea level. These deposits are the time equivalents of the bay mud (Qhbm), and they are found only in the northeast section of the county. The unit consists in large part of the decomposed remains of roots and rhizome, particularly *Scirpus acutus* (tule), *Pharagmites australis* (common reed), *Distichlis spicata* (salt grass) and *Typha slatifolia* (cattail).

Qhsc **Stream Channel Deposits (Holocene)**--Poorly to well-sorted sand, silt, silty sand, or sandy gravel with minor cobbles. Cobbles are more common in the mountainous valleys. Many stream channels are presently lined with concrete or rip rap. Engineering works such as diversion dams, drop structures, energy dissipaters and percolation ponds also modify the original channel. Many stream channels have been straightened, and these are labeled Qhasc. This straightening is especially prevalent in the lower reaches of streams entering the estuary. The mapped distribution of stream channel deposits is controlled by the depiction of major creeks on the most recent U.S. Geological Survey 7.5 minute quadrangles. Only those deposits related to major creeks are mapped. In some places these deposits are under shallow water for some or all of the year, as a result of reservoir release and annual variation in rainfall.

Qhl **Natural Levee Deposits (Holocene)**--Loose, moderately to well-sorted sandy or clayey silt grading to sandy or silty clay. These deposits are porous and permeable and provide conduits for transport of ground water. Levee deposits border stream channels, usually both banks, and slope away to flatter floodplains and basins. Levee deposits are best developed along San Pablo and Wildcat Creeks on the Richmond Bay Plain, along the valley of Walnut Creek and along Marsh Creek in the San Joaquin Valley. Abandoned levee systems have also been mapped.

Qhfp1 Qhfp2 **Alluvial terrace deposits (Holocene) --** Qhfp1 and Qhfp2 are the first and second erosional terraces, respectively, cut into Qhfp and Qhl deposits. Deposits are generally less than one meter thick and consist of rounded gravel and historic artifacts in a clayey silt matrix. In several areas these terraces have been used for landfills.

Qhb **Basin Deposits (Holocene)**--Very fine silty clay to clay deposits occupying flat-floored basins at the distal edge of alluvial fans adjacent to the bay mud (Qhbm). Also occupying flat areas in the Brentwood dune field where the basin deposits bury older eroded sand dunes (Qds).

Qhbs **Floodbasin Deposits (salt-affected) (Holocene)**--Clay to very fine silty-clay deposits similar to the Qhb deposits except that they contain carbonate nodules and iron - stained mottles (Soil Conservation Service, 1958). These deposits may have been formed by the interaction of bicarbonate - rich upland water and saline water of the San Francisco Bay estuary. With minor exceptions, salt - affected basin deposits are in contact with estuary deposits, Qhbm.

Qhbr **Beach Ridge Deposits (Holocene) --** Long narrow ridge of probably well sorted sand inferred from 1939 imagery. Observed between Emeryville and Berkeley, these deposits are now beneath the Interstate 80 roadbed.

Qhaf1 **Younger Alluvial Fan Deposits (Holocene) --** Brown, poorly-sorted, dense, sandy or gravelly clay. Small fans at mountain fronts have a probable debris flow origin. Larger Qhaf1 fans away from mountain fronts may represent the modern loci of deposition for Qhaf.

Qhaf **Alluvial Fan and Fluvial Deposits (Holocene)**--Alluvial fan deposits are brown or tan, medium dense to dense, gravely sand or sandy gravel that generally grades upward, to sandy or silty clay. Near the distal fan edges, the fluvial deposits are typically brown, never reddish, medium dense sand that fines upward to sandy or silty clay. The best developed Holocene alluvial fans in Contra Costa County are on the Richmond Bay Plain and the fans of Sand and Deer Creeks in the Brentwood Area. All other alluvial fans and fluvial deposits are confined to narrow valley floors. Several Holocene fans along the south shore of the Carquinez Strait have bulbous surface morphology, are short, overlap older Pleistocene surfaces, and may be debris flows.

Qms **Merritt Sand (Pleistocene and Holocene) --** Fine-grained, very well sorted, well-drained eolian deposits of western Alameda County. The Merritt Sand outcrops in three large areas in Oakland and Alameda. It is probably time-correlative with Qds, but displays different morphology. The Merritt Sand forms large sheets up to 15 meters high with yardang morphology.

Qls **Landslide deposits (Pleistocene and/or Holocene) --** Poorly sorted clay, silt, sand, and gravel. Only a few very large landslides have been mapped. For a more complete map of landslide deposits, see Nilsen and others (1979).

Qpaf **Alluvial Fans and Fluvial Deposits (Pleistocene)**--Brown dense gravely and clayey sand or clayey gravel that fines upward to sandy clay. These deposits display various sorting and are located along most stream channels in the county. All Qpaf deposits can be related to modern stream courses. They are distinguished from younger alluvial fans and fluvial deposits by higher topographic position, greater degree of dissection, and stronger soil profile development. They are less permeable than Holocene deposits, and locally contain fresh water mollusks and extinct late Pleistocene vertebrate fossils. They are overlain by Holocene deposits on lower parts of the alluvial plain, and incised by channels that are partly filled with Holocene alluvium on higher parts of the alluvial plain. Maximum thickness is unknown but at least 50 m.

Qpaf1 Qpaf2 **Alluvial Terrace Deposits (Pleistocene)**--Qpaf1 and Qpaf2 are the first and second Pleistocene alluvial terraces, respectively. Deposits consist of crudely - bedded, clast - supported, gravels, cobbles, and boulders with a sandy matrix. Clasts as much as 35 cm intermediate diameter are present. Coarse sand lenses may be locally present.

Pleistocene terrace deposits are cut into Qpaf alluvial fan deposits a few meters and lie up to several meters above Holocene deposits. These terrace deposits are so similar in lithology and texture as to be almost identical. They are distinguished for mapping purposes based on topographic position (the highest is the oldest) and degree of dissection and soil profile development. The highest terrace displays the thickest argillic B horizon as well as the dark A horizon (Mollic epipedon). The sequence is best observed along both banks of Arroyo Valle south of Livermore. The terraces on left (south-west) bank are more continuous than on the right (north-east). Each terrace represents the cutting and filling of previous deposits.

Qmt **Marine Terrace Deposits (Pleistocene)**--Three small outcrops of marine terraces are located about 5 m above present mean sea level and are characterized by a thin (<0.5 m thick) bed of oysters at their base. The terraces are located on the south shore of San Pablo Bay in the extreme northwest Contra Costa County at Lone Tree Point, Wilson Point, and an unnamed outcrop in between. The oyster beds unconformably overlie the Cierbo Sandstone of Miocene Age, and are in turn overlain by about 5 m of greenish-gray silty mudstone. The oysters have been dated by the Uranium-Thorium method (Helley and others, 1993) and are of last interglacial age, approximately 125 ka.

Qpoaf **Older Alluvial Fan deposits (Pleistocene) --** Brown dense gravely and clayey sand or clayey gravel that fines upward to sandy clay. These deposits display various sorting qualities. All Qpoaf deposits can be related to modern stream courses. They are distinguished from younger alluvial fans and fluvial deposits by higher topographic position, greater degree of dissection, and stronger profile development. They are less permeable than younger deposits, and locally contain fresh water mollusks and extinct Pleistocene vertebrate fossils.

QTl **Livermore gravels (Pliocene and Pleistocene) --** Poorly to moderately consolidated, indistinctly bedded, cobble conglomerate, gray conglomeratic sandstone, and gray coarse-grained sandstone. Also includes some siltstone and claystone. Clasts contain mostly graywacke, chert, and metamorphic rocks probably derived from the Franciscan complex.

QTi **Irvington Gravels of Savage (1951) (Pliocene(?) and Pleistocene) --** Poorly to well consolidated, distinctly bedded pebbles and cobbles, gray pebbly sand, and gray, coarse-grained, cross-bedded sand. Cobbles and pebbles are well- to sub-rounded, and as much as 25 cm in diameter, and consist of about 60 percent micaceous sandstone, 35 percent metamorphic and volcanic rocks and chert probably derived from the Franciscan complex, and 5 percent black laminated chert and cherty shale derived from the Claremont Formation. A large suite of early Pleistocene vertebrate fossils from this unit was described by Savage (1951).

QTp **Packwood Gravels of Crittenden (1951) (Pliocene and Pleistocene) --** This rock unit generally consists of gravel to cobble (rare) silty and fine sandy conglomerate, fine silty sandstone, gravely to fine sandy siltstone, and minor olive-green claystone beds. Noteworthy is the presence of numerous nonmarine red beds in the unit. This unit differs from all other gravels in that the clasts are composed almost entirely of detritus derived from conglomerates and sandstone of the Cretaceous Great Valley Sequence. The base of this unit is interbedded with and coeval to part of the 2.6-4 Ma Silver Creek gravels (M. Wills and D. Andersen, Cal. State Univ. San Jose, personal comm., 1995). However, the top of the unit postdates and overlaps the Silver Creek thrust, which postdates the deposition of the Silver Creek Gravels

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