QUATERNARY GEOLOGIC MAP OF THE MILPITAS QUADRANGLE, ALAMEDA AND SANTA CLARA COUNTIES, CALIFORNIA

by

E. J. Helley[1] and J. R. Wesling[2]

Open-File Report 89-671

This map is preliminary and has not been reviewed for conformity with U.S. Geological Survey editorial standards or with the North American Stratigraphic Code. Any use of trade, product or firm names is for descriptive purposes only and does not imply endorsement by the U.S. Government.

[1]U.S. Geological Survey
345 Middlefield Road
Menlo Park, California 94063

[2]Geomatrix Inc., One Market Plaza
Spear Street Tower, Suite 717
San Francisco, California 94015

INTRODUCTION

The Milpitas 7.5 minute quadrangle is located in the Santa Clara Valley at the south end of San Francisco Bay and covers an area that includes the northernmost Santa Clara County and southernmost Alameda County. The quadrangle is between 37°22'30" and 37°30'00" north latitude and 121°52'30" and 122°00'00" west longitude and is the northwesternmost quadrangle in the San Jose 100,000 scale quadrangle. The Santa Clara Valley is part of a long, northwest-southeast-trending structural depression within the central Coast Ranges of California located between the San Andreas fault to the west and the Hayward and Calaveras faults to the east.

The Hayward fault lies along the northern end of the Diablo Range and the eastern margin of the Milpitas quadrangle. The rapid increase in relief to the east of this fault is an effect of a vertical component of displacement on the Hayward Fault (Dibblee, 1972). Historic movement on the Hayward fault in 1836 and 1868 (Borcherdt and others, 1975) has been horizontal (right-lateral strike slip or right slip, for short, where land west of the fault has moved to the northwest relative to the largely hilly terrane, to the east of the fault). Some component of vertical displacement on this fault, however, must have occurred, in view of the contrast in topographic relief on either side of the fault.

The southernmost part of San Francisaco Bay and adjoining marshlands lie within the northwestern part of the Milpitas quadrangle. The southern half of the Milpitas quadrangle is almost all underlain by Holocene alluvium and delta deposits of two main drainages, the Guadalupe River and Coyote Creek. The Guadalupe River is the larger of the two and has left deposits over a larger area. Both fluvial systems drain from south to north within their lower reaches, where they cross the Milpitas quadrangle but they drain different areas in their upper reaches. The Guadalupe River drains from the Santa Cruz Mountains to the west while Coyote Creek drains from the Diablo Range, to the east.

MAPPING METHODS

Geologic mapping of urban areas is difficult, because much of the land is covered by buildings, pavement, and fill. Therefore, alternative mapping techniques are required. We mapped geologic units using black and white aerial photographs that were taken in 1939 before much development had taken place in this area. Additionally, the mapping was supplemented with 1:12,000 and 1:24,000 scale color aerial photographs made in 1965 and 1974, respectively. 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 (complied from U.S. Soil Conservation Service, 1958) and 6) other features such as differences in vegetation density and type. The geologic map units shown on this map represent both texture and environments of deposition. The contacts between units are in most cases not sharp and are diffuse and may span tens of feet (a few meters).

Landform morphology refers to the shape of a particular landscape element, such as the distinctive conical shape of alluvial fans. Other criteria listed in the description of geologic units also are used to distinguish one landscape 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). Attempts were made to check units and contacts in the field. Many geologic units and the contacts between them are presently covered or obscured because of the extensive urban cover (buildings, pavement, channeled drainages, quarries, and landfill).

The index map shows additional sources of data used to construct this map. Bedrock geology and landslides in the northeast corner of the quadrangle were compiled from the work of Crittenden (1951) and Dibblee (1972); Helley mapped additional landslides to supplement Dibblee's mapping. For additional information on landslides in the map area, the reader is referred to Nilsen (1975). The mapping of the Soil Conservation Service (1958), Helley and Brabb (1971), and Helley and Lajoie (1979) were consulted during aerial photograph interpretation and field phases of this study. The 1896 A.D. shoreline of Nichols and Wright (1971) as shown is inferred to be the contact between estuary and continental deposits. In addition, the margin of bay mud (estuary deposits) as indicated by unpublished data of Sarna-Wojcicki (1966) is shown on the index map and on the quadrangle; it is based, however on engineering properties and not on the environment of deposition.

DISCUSSION

Much of the area of the Milpitas quadrangle, as mentioned, is modified by land use activities of man. For example, there is very little pristine marsh remaining in this area, since dikes and levees were constructed to convert marshlands to salt evaporators. Salt gathering was done in this area by native Americans prior to occupation by European settlers (Ver Planck, 1958). Salt evaporators are underlain by Holocene estuary deposits (bay mud) which is covered by a thin veneer of salt where they are dry. Saline estuary water enter the evaporation system to the north of the Milpitas quadrangle. By the time waters reach the area of the Milpitas quadrangle the brines become enriched in halite (NaCl), calcite ($CaCO_3$), gypsum ($CaSO_4 2H_2O$), sylvite (KCl), and small amounts of several magnesium salts (Ver Planck, 1958).

The dikes and levees that surround salt evaporators are of particular importance, because saline water may flood adjacent low-lying areas in the event of a dike failure. The levees and dikes are composed mostly of bay mud. The levees are constructed with dragline bucket dredges by piling up bay mud in three wide, parallel rows. The dredges operate continuously to maintain the levee network in this area.

The transgressive clays and silts (the "bay mud") that were deposited in San Francisco Bay during the rise in sea-level resulting from deglaciation of the last ice age are assumed to have zero thickness along the 1850 A.D. shoreline and thicken considerably to the northwest (Nichols and Wright, 1971; Atwater and others, 1977). Nichols and Wright (1971) estimated the position of the 1850 A.D. shoreline from mid-19th century maps of the U.S. Coast and Geodetic Survey. They mapped the shoreline as the landward margin of pickleweed and saltgrass marsh (<u>Salicornia pacifica</u> and <u>Distichlis spicata</u>).

The stream channels of the Guadalupe River and Coyote Creek are large enough to be delineated at the scale of this map. Their original courses as of 1939 are shown on the map along with their present courses (on topographic base map). Both stream channels have been straightened and lined with concrete and rip rap since 1939. Note the higher sinuosity of both streams along their lower courses, a likely response to the late Holocene rise in sea level that culminated in a stable(?) coastline, as shown by the 1850 A.D. shoreline.

Natural levee deposits are easily defined by topographic contours on maps and tonal contrasts on aerial photographs. These deposits are more-or-less symmetrically distributed on either side of the channel of Coyote Creek, while the levee deposits of the Guadalupe River are considerably wider on the eastern side of the channel.

Acknowledgments

We thank A. M. Sarna-Wojcicki for providing data on the extent of bay mud. Partial support of Wesling was provided by U.S. Geological Survey National Earthquake Hazard Reduction Program Grant No. 14-08-0001-G1359.

DESCRIPTION OF MAP UNITS

Qha — Artificial Fill--Sanitary landfill, composed of gravel, sand, silt and clay with a heterogenous mixture of man-made refuse of organic and inorganic materials. The largest area of landfill is located just west of the mouth of Coyote Creek in the north central part of the quadrangle. Additional smaller areas of landfill such as dikes, levees and other artificial barriers to the movement of bay waters are shown by large dots. Many additional areas of artificial fill too small to show at the scale of this map are present within the area of the Milpitas quadrangle.

Salt Evaporators — Areas enclosed completely within levees--Underlain by Holocene bay mud, Qhbm, covered in places by a thin veneer of salt where they are dry. Saline estuarine waters enter the evaporation system to the north of the Milpitas quadrangle. By the time these waters reach the Milpitas area, they become brines, enriched in salts such as halite (NaCl), calcite ($CaCO_3$), gypsum ($CaSO_4.2H_2O$), sylvite (KCl) and small amounts of several magnesium salts (Ver Planck, 1958).

Qhsc — STREAM CHANNEL DEPOSITS (HOLOCENE)--Poorly- to well-sorted sandy silt, silty sand, sand, or sandy gravel with minor cobbles. Many stream channels are presently lined with concrete or rip rap.

Qhl NATURAL LEVEE DEPOSITS (HOLOCENE)--Loose, moderate- to well-sorted sandy or clayey silt grading to sandy or silty clay. Levee deposits border the channels of Guadalupe River, Coyote Creek, and the lower course of Saratoga Creek. Textures of Qhl deposits along Coyote Creek tend to be coarser (sandy or clayey silt) than those along the Guadalupe River (sandy or silty clay). Levee deposits are generally well drained. We noted little change in grain-size with distance downstream within the map area.

Qhfp FLOODPLAIN DEPOSITS (HOLOCENE)--Medium to dark gray, dense, sandy to silty clay. Lenses of coarser material (silt, sand, and pebbles) may be locally present. Floodplain deposits are found between levee deposits of Coyote Creek and Guadalupe River.

Qhfp1, Qhfp2 ALLUVIAL TERRACE DEPOSITS (HOLOCENE)--Qhfp1 and Qhfp2 are the first and second erosional terrances, respectively, cut into Qhfp and Qhl deposits. Deposits are generally less than 75 cm in thickness and consist of rounded gravel and historic artifacts in a clayey silt matrix. In several areas, these terraces have been used for landfills. The largest and most extensive of these terraces are found along Coyote Creek.

Qhb FLOODBASIN DEPOSITS (HOLOCENE)--Organic-rich clay to very fine silty-clay deposits occupying the lowest topographic positions either between the Holocene levee deposits or Holocene floodplain deposits.

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 one exception, salt-affected basin deposits are in contact with estuary deposits, Qhbm.

Qhbm ESTUARY DEPOSITS (bay mud) (HOLOCENE)--Water-saturated estuarine mud consisting predominantly of clay and silty clay underlying tidal mudflats, marshland and salt evaporators of San Francisco bay. Qhbm deposits may contain shelly and peaty layers and interfingers with basin deposits Qhb and salt-affected basin deposits Qhbs. Estuary sediments were deposited during and after Holocene sea level rise. Thickness of Holocene bay mud varies from approximately 0 m to 10 m in this area (Sarna-Wojcicki, 1966, unpub. data).

Qhaf — ALLUVIAL FAN DEPOSITS (HOLOCENE)--Near the distal fan edges (as in the Milpitas quadrangle), deposits are typically brown, medium dense, gravelly sand or clayey gravel that grade upward to sandy or silty clay. Sediment near the heads of these fans are typically brown or tan, medium dense to dense, gravelly sand or sandy gravel that grades upward to sandy or silty clay. Alluvial fan surfaces typically have slopes of 0.005 to 0.009 (5 to 9 m/km) within the Milpitas qudrangle.

$Qhaf_1$ — ALLUVIAL FAN DEPOSITS (HOLOCENE)--Brown, poorly-sorted, dense, sandy or gravelly clay. $Qhaf_1$ deposits may have a debris flow origin or may represent the modern loci of deposition for Qhaf.

Qls — LANDSLIDE DEPOSITS (direction of Movement shown by arrow)--(PLEISTOCENE AND/OR HOLOCENE)--Landslide materials consist of poorly sorted mixtures of clay, silt, sand, gravel and boulders. Landslide deposits were mapped only in the upland areas, and most were taken directly from Dibblee (1972). Helley added some additional landslides to supplement Dibblee's mapping.

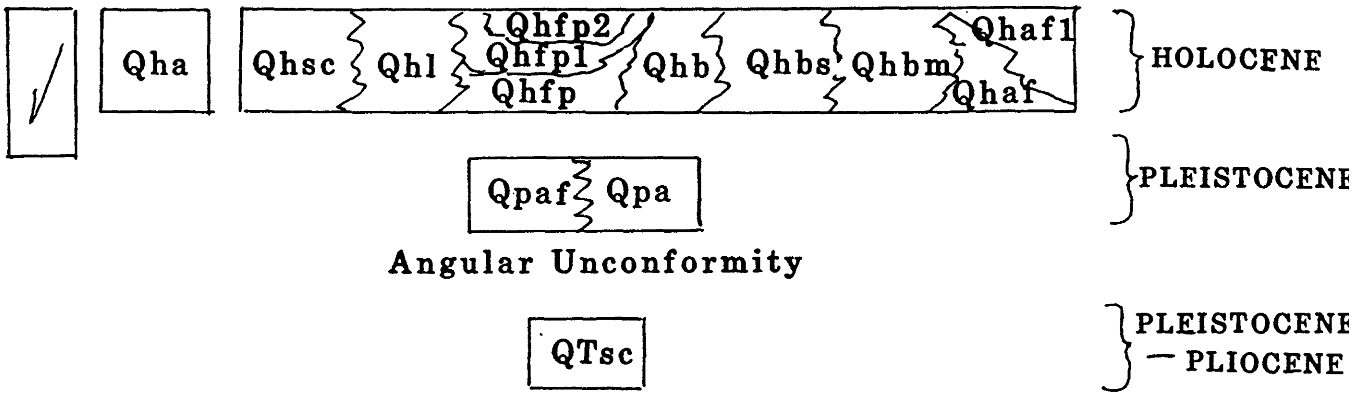
Qpaf — ALLUVIAL FAN DEPOSITS (PLEISTOCENE)--Tan to reddish brown, dense, gravelly and clayey sand or clayey gravel that grades upward to a sandy clay. Qpaf deposits are restricted to areas along the mountain front at the northeast corner of the quadrangle. Alluvial fan surfaces typically have slopes (toward the basin) of about 0.011 to 0.023 (11 to 23 m/km).

Qpa ALLUVIAL DEPOSITS (PLEISTOCENE)--Poorly sorted, poorly bedded tan to reddish brown gravels, clayey sand or clayey gravel. Like their alluvial fan equivalents, they are distinctly redder than younger deposits. Pleistocene alluvial deposits are restricted to upland valleys in the northeast corner of the quadrangle. These deposits are inferred to be in fault contact with the Pleistocene alluvial fan deposits (Qpaf) just east of Fremont (Helley and Lajoie, 1979).

QTsc SANTA CLARA FORMATION (PLIOCENE AND PLEISTOCENE) (Crittenden, 1951)--The unconsolidated sediments of the Santa Clara Formation crop out almost continuously along the northeast corner of the Santa Clara Valley. Where exposed, the Santa Clara Formation consists of poorly-sorted gravel, pebbly sandstone, siltstone, and clay. A diagnostic component is angular clasts of Monterey chert, Tm, (see below). Elsewhere, the Santa Clara Formation is poorly exposed and defines a subdued, generally gently-rolling, hilly landscape with abundant landslide scars. The Santa Clara is deformed with a relatively constant northwest strike and northeast dip. (Crittenden, 1951, p. 43).

UNDIFFERENTIATED BEDROCK--Consolidated rocks older than the Santa Clara Formation (QTsc). See Crittenden, 1951, and Dibblee, 1972, for further information.

CORRELATION OF MAP UNITS



Undifferentiated Bedrock

EXPLANATION OF MAP SYMBOLS

Qha--Artificial Fill ......-Dike 1850 shoreline

Qhsc--Stream Channel Deposits

Qhl--Holocene Levee Deposits

Qhfp--Holocene Flood Plain Deposits

Qhfp1, Qhfp2--Holocene Terrace Deposits

Qhb--Holocene Basin Deposits

Qhbs--Holocene Basin Deposits (salt-affected)

Qhbm--Holocene Estuary Deposits (Bay Mud) (salt evaporators are underlain chiefly by bay mud)

Qhaf--Holocene Alluvial Fan Deposits

Qhal--Holocene Alluvial Fan Deposits (Younger)

Qls--Holocene and Pleistocene Landslide Deposits

Qpaf--Pleistocene Alluvial Fan Deposits

Qpa--Pleistocene Alluvial Deposits

Angular Unconformity

QTsc--Pliocene and Pleistocene Santa Clara Formation (Crittenden, 1951; Dibblee, 1972)

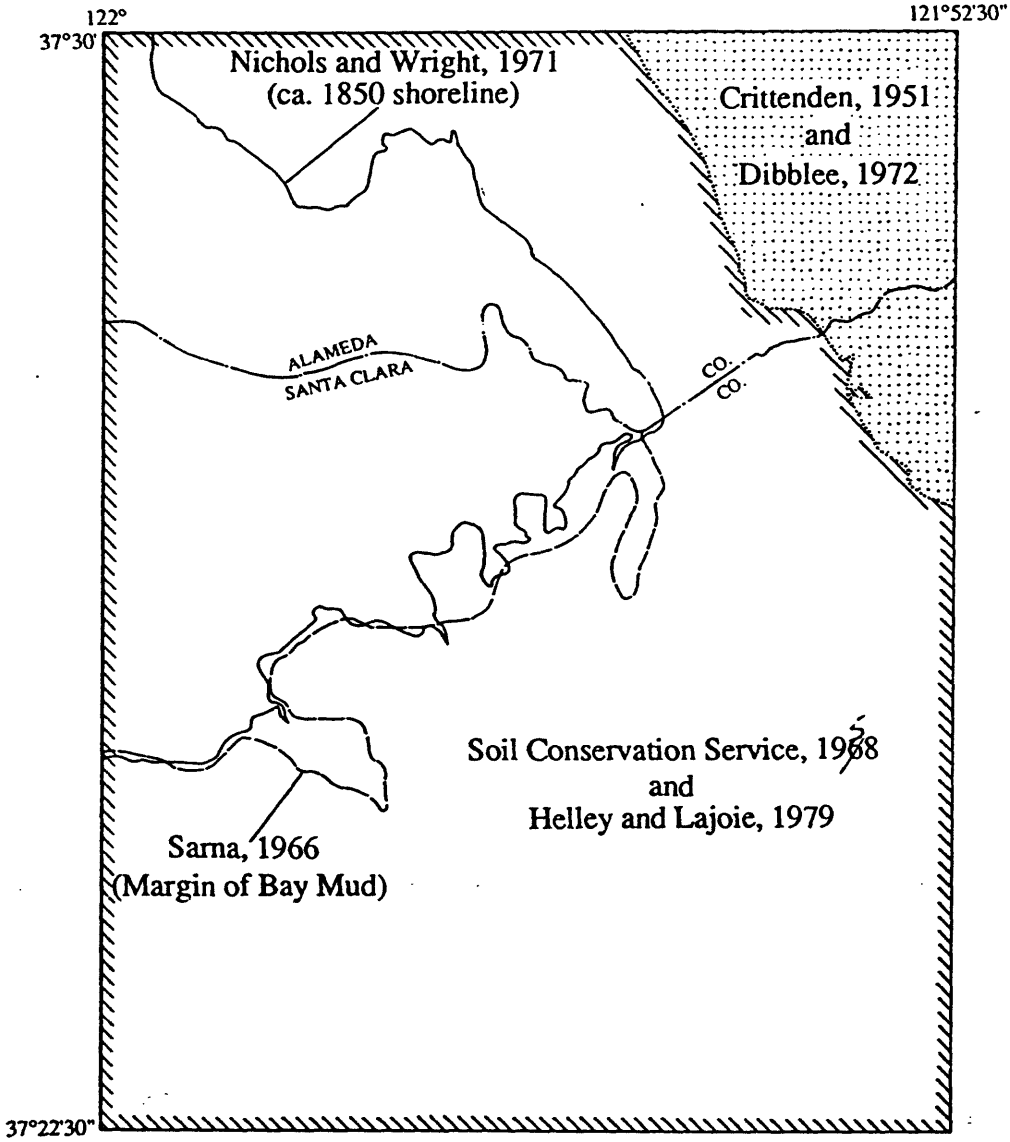
Unconformity

Undifferentiated Bedrock

Unconformity

Geologic Contact, approximately located

Fault, dashed where approximately located



Index map showing sources of geologic data

REFERENCES

American Association of Petroleum Geologists Bulletin, 1983, V. 67, no. 5, pp. 865-867.

Atwater, B.F., Hedel, C.W., and Helley, E.J., 1977, Late Quaternary depositional history, Holocene sea-level changes, and vertical crustal movement, southern San Francisco Bay, California: U.S. Geological Survey Professional Paper 1014, 15 p.

Borcherdt, R.D., 1975, editor, Studies for seismic zonation of the San Francisco Bay region: U.S. Geological Survey Professional paper 941-A, 102 p.

Crittenden, Max D., Jr., 1951, Geology of the San Jose-Mount Hamilton area, California: California Division of Mines and Geology Bulletin 157, 67 p.

Dibblee, T.W., Jr., 1972, Preliminary Geologic Map of the Milpitas Quadrangle, California, 1:24,000.

Helley, E.J. and Brabb, E.E., 1971, Geologic map of late Cenozoic deposits, Santa Clara County, California: U.S. Geological Survey Miscellaneous Field Studies Map MF-335, 3-sheets, 1:62,500.

Helley, E.J., and Lajoie, K.R., 1979, Flatland deposits of the San Francisco Bay region, California - their geology and engineering properties, and their importance to comprehensive planning: U.S. Geological Survey Professional Paper 943, 88 p.

Munsell Color Company, Inc., 1954, Munsell soil color chart: Baltimore, Maryland.

Nichols, D.R., and Wright, N.A., 1971, Preliminary map of historic margins of marshlands, San Francisco Bay, California, 1:125,000.

Nilsen, T.H., 1975, Preliminary photointerpretation map of landslide and other surficial deposits of the Milpitas 7>' quadrangle, Alameda and Santa Clara Counties, California: U.S. Geological Survey Open-File Map 75-277-31, 1:24,000.

Sarna-Wojcicki, A.M., 1966, Areal extent and thickness of bay mud in northern Santa Clara County, unpublished report to Santa Clara County Planning Department, 1:24,000.

U.S. Soil Conservation Service, 1958, Soil Survey of the Santa Clara Area, California, Washington D.C., U.S. Government Printing Office, 202 p.

Ver Planck, W.E., 1958, Salt in California: California Division of Mines and Geology Bulletin 175, 168 p.