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Geologic Map of the Newark 7.5 Minute Quadrangle, Alameda County, California

by

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INTRODUCTION

The Newark 7.5 minute quadrangle is located along the east shore of south San Francisco Bay, California. San Francisco Bay fills a northwest-trending structural depression in the central Coast Ranges that lies roughly between the San Andreas fault to the west and the Hayward fault to the east. The Newark quadrangle lies in the southeastern corner of the San Francisco 1:100,000 scale quadrangle (index map) between 37°30'-37°37'30" north latitude and 122°00' and 122°7'30" west longitude. The quadrangle is underlain by Quaternary alluvial deposits, except for the northeast corner of the quadrangle and the Coyote Hills. In the Diablo Range in the northeast corner of the quadrangle, Jurassic to Miocene sedimentary and volcanic rocks crop out just east of the Hayward fault zone. The Hayward fault zone juxtaposes these rocks with Quaternary sediment. This fault has displayed right-lateral surface rupture during earthquakes in 1836(?) and 1868 and is presently undergoing aseismic creep (Lienkaemper and others, 1991). In the west-central portion of the quadrangle at the Coyote Hills, an elongate mass of contorted rocks of the Franciscan Complex protrude through the sediments of the bay plain. These rocks extend in a northwest-southeast direction about 5 mi (8 km) and rise almost 300 ft (100 m) above sea-level. In 1850 the bay almost completely surrounded the hills.

The Franciscan Complex of the Coyote Hills consist of greenstone, graywacke, radiolarian chert and serpentinite. Minor amounts of limestone have been observed but are not shown on this map. Mesozoic mudstone, conglomerate, and sandstone in the Diablo

Range are overlain by Miocene strata and all are complexly deformed. Miocene rocks are composed of sandstone, chert, shale, alluvial deposits, and volcanic rocks. The rest of the quadrangle is covered by alluvial fan deposits that grade to bay mud downslope. Most of this alluvial sediment was derived from Alameda Creek but a smaller, dissected fan that issues from Dry Creek covers the northeast one-quarter of the quadrangle.

Alameda Creek, with a drainage area of 633 mi^2 (1640 km^2) is by far the largest drainage basin contributing to the alluvial plains along the east side of San Francisco Bay and displays the best developed alluvial-fan system. Alameda Creek is a prime example of an antecedent stream, that is, a stream that existed prior to present topography. Alameda Creek heads in a valley, flows through it and across the Diablo Range in a deeply incised tortuous canyon (Niles Canyon), rather than flowing through the low part of the range 3.5 mi (5.6 km) to the south at Mission Pass. Incision of Alameda Creek probably began with the onset of the Coast Ranges orogeny during the mid-Pleistocene, about one-half million years ago. Alameda Creek's down-cutting kept pace with this uplift, carving a bedrock-floored canyon which it maintains today. The alluvial fan built by Alameda Creek is the largest along the east side of San Francisco Bay and is as much as 750 ft (225 m) thick (C. Kolterman, personal commun. 1991). As with all streams crossing the active Hayward fault, the channel of Alameda Creek is deflected northward by the right-lateral movement along the fault zone. The fluvial system of Alameda Creek was large enough to generate a complete, progressive suite of deposits: fan, levee, floodplain, floodbasin, and bay mud. Before societal development, at the turn of the century, Alameda Creek had two main distributary channels which bifurcated at the east central border of the quadrangle. One flowed north and west around the north end of the Coyote Hills, and the other flowed south and west, reaching the bay south of the Coyote Hills. Currently, only the northern channel is active. We show the bay margin as it was shown on the 1850 shoreline map of Nichols and Wright (1971). The tidal channels are taken from that same work.

Mapping Methods

Standard Quaternary geologic mapping methods were used to delineate geologic contacts over much of the quadrangle. Additionally, the contact mapping was supplemented with study of 1:20,000-scale black and white aerial photographs taken in 1939. Quaternary map units were delineated on the photos by: 1) landform morphology, 2) relative topographic position, 3) relative degree of preservation of surface morphology, 4) spectral signature of rock units on aerial photos, 5) relative soil profile development (compiled from U.S. Department of Agriculture, 1917) and other features such as differences in vegetation density and type. Also, pre-development topographic maps of the 19th century were used to delineate old stream channels and shorelines. The index map shows additional sources of data used to construct this map. The geology of the Coyote Hills was taken from Snetsinger (1976) with independent field checks by Miller and Helley. Miller is responsible for the bedrock mapping in the northeastern corner of the quadrangle, while the responsibility for the Quaternary mapping rests with Helley.

STRUCTURE

Geologic units and structures of the Newark quadrangle, in combination with geophysical and drill-hole data, define four northwest-trending structural zones. From east to west, they are (1) the Diablo Range, (2) a zone of alluvial fans grading west to alluvial plains, (3) the Coyote Hills, and (4) muds of San Francisco Bay. The Hayward fault zone separates structural zones 1 and 2, and faults inferred by Snetsinger (1976) bound both sides of zone 3. Compared to zone 1, in which many rock units and structures are mapped, little is known about the structural configuration of the other zones.

San Francisco Bay occupies a structural depression marked by downbowed and (or) down-faulted sediment as young as middle Pleistocene, and therefore is probably currently subsiding. The Coyote Hills represent a thin horst block (zone 3) within the overall structural depression, according to Snetsinger (1976). Down-faulted bedrock on the northeast side of the hills is about 600 ft (200 m) deep under alluvial materials (Hazelwood, 1976).

The Hayward fault zone forms the east boundary of the alluvial fans and plains (zone 3) in the Newark quadrangle, but to the southeast the fault zone diverges from the topographic front of the Diablo Range (Hall 1958; Lienkaemper and others, 1991) and cuts across alluvial fans. The Hayward fault zone consists of one known active strand and as many as three subparallel strands that generally lie east of the active strand. The active strand is marked by shutter ridges, offset streams and cultural features, and active creep, and was the locus of surface rupture during the 1868 earthquake of approximately magnitude 6.8 (Lienkaemper and others, 1991). Evidence for parallel fault strands in the eastern part of the fault zone is less abundant. For the most part, the fault traces are defined by linear features such as topographic benches and narrow ridges. At the Masonic Home, the eastern fault trace was superbly exposed during field studies in 1991 as a gouge zone in bedrock, greater than 3 m wide, at the former site of a small building. The subparallelism and proximity of eastern fault strands to the active western fault of the Hayward zone raise the possibility that all fault strand are part of the zone.

East of the Hayward fault zone (structural zone 1) lie rocks typical of the Diablo Range. Within zone 1, two main structural blocks in the Newark quadrangle are separated by the Chabot fault. The western block consists of Jurassic and Lower Cretaceous strata that are overlain by Miocene strata. The eastern block consists of Cretaceous strata, named the Niles Canyon Formation by Hall (1958) in continuous exposures to the east. Strata in both blocks are folded into eastward-overturned, tightly appressed folds with axes that plunge gently northwest and southeast. The Briones Formation and Moraga Volcanics in the western block occupy the core of a tight syncline that is truncated by the Chabot fault. Small-scale folds, thrust faults, and fractures are common in many outcrops in the western block. Faults locally cut out part of the Miocene section. For instance, the Orinda Formation and Briones Formation lie between the Moraga Volcanics and the Claremont Shale 1 km to the southeast of the Newark quadrangle (D.M. Miller, 1991, unpubl. mapping), yet the Moraga lies directly against the Claremont Shale in the Newark quadrangle. Although part of the truncation of section may owe to unconformities, the pronounced excision of both the Briones and Orinda suggests tectonic causes. Faults may have acted together with folding, locally cutting out strata as the syncline formed. We have found no direct evidence for faults at the base of the Miocene section, suggesting that it lies unconformbly on the Mesozoic strata. Structure in the eastern block also consists of tight folds, best delineated in adjacent quadrangles (Hall, 1958).

Jones and Curtis (1991) considered the Chabot fault to be a normal fault that dips east where they studied the structure to the north in the Berkeley Hills, and they further stated that the fault is thought to be early Cenozoic. However, in the Newark quadrangle and the adjacent Hayward quadrangle (Robinson, 1956), the Chabot fault dips steeply west and cuts a syncline that deformed strata as young as the upper Miocene Moraga Volcanics. The remarkably continuous and nearly straight trace of the fault is more consistent with strike-slip origin; such an origin also explains local reverse (Robinson, 1956; Hall, 1958) and normal (Jones and Curtis, 1991) offsets.

GEOLOGIC HAZARDS

An understanding of the geology of the Newark quadrangle has a variety of social benefits in terms of land use and geologic hazards. At present, about 250,000 people live within the borders of the Newark quadrangle. The quadrangle is traversed by Interstate Highway 880, State Route 84 leading to the Dumbarton Bridge across the bay, the Southern Pacific Rail Lines and the Bay Area Rapid Transit System. The Hetch Hetchy aqueduct also crosses the southern part of the quadrangle; it transports water from the Sierra Nevada to the San Francisco Water District. Also, many heavy and light industrial facilities are located here.

The most important geologic hazard in the Newark quadrangle is risk to life and property from an earthquake generated by the Hayward fault, which is capable of producing a magnitude 7 event. Surface rupture likely would occur immediately along the known trace of the fault, while severe shaking would occur in areas underlain by saturated, loose, thick sediments. Liquefaction is probable in nearby areas, particularly those underlain by saturated bay muds and basin deposits containing granular layers, mostly along the bay margins and along stream levees. Artificial levees containing salt evaporators may also fail, causing local flooding along the bay margins.

Although not life-threatening, aseismic creep is presently destroying foundations, roads, curbs, and other engineered structures along the Hayward fault zone. Knowledge of the creep zone must be integrated into construction plans for transportation corridors, utility lines, and residences.

Far less traumatic than earthquakes, but still very important, are hazards concerning ground water. Water pumped from the Alameda Creek fan supplies a large part of the municipal and industrial needs of the Fremont area. Large overdrafts have allowed the intrusion of salt water from the bay to contaminate the groundwater supplies as well as adversely affecting agriculture, especially orchard production. Ground water has also been contaminated by accidental spills of industrial chemicals, such as solvents, lubricants, and fuels. Geologic maps showing permeable sediment are useful in predicting the pathways for migration of contaminating fluids. As shown on the map, many percolation ponds (pp) have been constructed to aid in replenishing ground water supplies as well as flushing salt water. The ancient stream channels and levees are excellent sites for recharge.

Landslides (Qls) are slope failures confined to the upland areas. These are poorly sorted, jumbled masses of rock and sediment ranging from boulders to clay. The Moraga Formation (Tm) is more susceptible to landsliding than other upland map units.

Acknowledgments

We thank V.M. Seiders for sharing pebble-count data for conglomerate in the lower part of the Great Valley Sequence and E.E. Brabb and D.L. Jones for informative field excursions. The review of this manuscript by J.A. Bartow improved it considerably.

Description of Map Units

Qhasc **Artificial stream channels (Holocene)**--Modified channels straightened and lined with riprap for flood control and recharge of groundwater.

Qhaf **Alluvial fan and fluvial deposits (Holocene)**--Alluvium present in the far apex area in the northeast corner of the quadrangle. Mostly consists of fluvial matrix-supported sandy gravels in channels that dissect an older Pleistocene alluvial fan (Qpaf). These light tan to brown loose sands and gravels were derived from the sedimentary rocks of the Dry Creek drainage basin. One small patch of Qhaf deposits is found in the northwest corner of the Newark quadrangle but it is part of the alluvial fan of San Lorenzo Creek, most of which lies to the north in the Hayward quadrangle.

Qhsc **Natural stream channels (Holocene)**--Deposits in stream channels; coarse cobble to boulder beds at fan heads, becoming gravelly and sandy at midfan and silty to clayey near the bay margins. Flow is mostly unidirectional from east to west, however, the lower reach of Patterson Creek is affected by the tides of San Francisco Bay. Channel patterns were taken from topographic maps of 1896.

$Qhsc_1$ **Tidal stream channels (Holocene)**--Formerly like unit Qhsc until drowned by rising sea level. Differs from Qhsc mainly by bidirectional current flow and sediment transport. Present channels filled with bay mud (Qhbm) but probably contain coarser sediments at depths of a few meters.

Qhl **Levee deposits (Holocene)**--Loosely consolidated, light-colored, moderate, well-sorted sandy or clayey silt grading downstream to sandy or silty clay. Levee deposits border the major stream channels of Alameda Creek with a lesser levee along Dry Creek near its confluence with Alameda Creek. Levee deposits are generally well drained and permeable. The old predevelopment southern channel of Alameda Creek is of importance because it provides a pathway for shallow groundwater and its contents.

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 levees and the flat floodbasin deposits.

Qhb **Floodbasin deposits (Holocene)--**Dark organic-rich clay to very fine silty clay deposits occupying the lowest topographic positions between levees and floodplains. Deposits grade downslope to bay muds.

Qhbs **Floodbasin deposits (salt-affected) (Holocene)**--Clay to very fine silty clay deposits similar to unit Qhb deposits except that they contain carbonate nodules and iron-stained mottles. The mottles and nodules may have been formed by interaction of bicarbonate-rich upland waters and saline water of San Francisco Bay estuary. These deposits can be corrosive to unprotected cultural materials such as piers, piles, and other conduit.

Qhbm **Estuary deposits (Bay mud) (Holocene)**--Water-saturated estuarine mud consisting mainly of clay and silty clay underlying tidal mudflats, marshland, and salt evaporators of San Francisco Bay. Bay mud may contain shelly and peaty layers and interfinger with basin deposits (Qhb) and salt-affected basin deposits (Qhbs). Bay mud was deposited during and after the Holocene sea-level rise at about 10 ka. The thickness of bay mud in the Newark quadrangle varies from 0 to 60 feet (20 m). Bay mud is a very weak foundation material.

Qpaf **Alluvial fan deposits (Pleistocene)**--Dark-brown to reddish brown, upward to sandy clay. Qpaf deposits represent dissected remnants on the Dry Creek alluvial fan in the northeast corner of the Newark Quadrangle and were probably deposited by an older Dry Creek fluvial system. The only other exposure of unit Qpaf is in the southeast corner of the quadrangle and, in contrast to Dry Creek, this remnant displays no relationship to modern drainage. Qpaf deposits are as much as tens of meters thick.

Qls **Landslide deposits (Quaternary)**--Poorly sorted, jumbled rock and soil masses formed as massive landslides and surficial soil slippage.

Qhc **Colluvium (Quaternary)--Fine grained sediments transported** by slope processes found in the upland areas of the Coyote Hills and Foothills of the Diablo Range.

Tm **Moraga Volcanics of Jones and Curtis (1991) (Miocene)**--Altered basalt flows, tuff, and rhyolitic flows interbedded with fluvial arkosic sandstone and conglomerate. Eastern outcrops are thick-bedded to massive blue-gray rhyodacite, assigned by Hall (1958) to the Leona Rhyolite. Rhyodacite is as much as 150 m thick, and here included in the Moraga Volcanics because it dips steeply, concordant with underlying rocks of the Moraga, rather than lying nonconformably upon deformed strata as the Leona Rhyolite does to the north (Case, 1968; Robinson, 1956).

Tb **Briones Formation (Miocene)**--Poorly bedded, homogenous, tan friable, coarse-grained sandstone. Basal beds in several places are conglomerate, cemented by calcite; clasts are composed of volcanic rocks, calcareous algal mats, and fragments of Claremont Shale. Rests in channels cut into underlying Claremont Shale. Middle to upper part in most places forms bold outcrops; consists of calcite-cemented sandstone containing thick-walled pectins and calcareous algal mats. Sandstone typically arkosic to subarkosic; lithic grains common.

Tc

Claremont Shale (Miocene)--Olive green to yellow-brown siliceous shale and thin highly siliceous bands of chert(?). Typically is laminated. Locally interbedded with sandstone identical to Briones Formation near top of unit.

Great Valley Sequence (Cretaceous and Jurassic)--Divided into:

Kgv

Upper part (Cretaceous)--Brown subarkosic sandstone and mudstone. Mostly thin-bedded to laminated. Less common hard, gray arkosic sandstone. Mica is common constituent of all rocks. Limestone concretions(?) up to 2 m in diameter. Rare rip-up clasts of limestone. Sandstone forms 10-m-thick massive beds in places. Continuous with the Niles Canyon Formation of Hall (1958).

JKs

Lower part (Cretaceous and Jurassic)--Brown arkosic and lithic sandstone, dark brown and green mudstone, and conglomerate. Most rocks bear conspicuous mica. Siliceous nodules locally present. Conglomerate (c) present as lenses and as massive unit, locally mappable. Clasts mainly chert, greenstone, sedimentary rocks, and granodiorite; limestone less common. Conglomerate assigned to the Oakland Conglomerate by Hall (1958); remainder of unit assigned to the Knoxville

Formation by Hall (1958). Case (1968) restricted Oakland Conglomerate to felsic-clast-bearing Upper Cretaceous strata. On the basis of clast composition and stratigraphic position, we consider this conglomerate to be older than the restricted Oakland Conglomerate of Case (1968).

Franciscan Complex of the Coyote Hills (Cretaceous and Jurassic)--Divided into (relative age not known):

| gs | **Greenstone**--Altered mafic volcanic rocks, dark green in color.

| ch | **Chert**--Red radiolarian ribbon chert with minor siliceous shale interbeds; highly deformed and contorted.

| gw | **Graywacke**--Tan to brown, medium- to fine-grained, clayey sandstone. Includes minor shale.

| sp | **Serpentinite**--Green rock composed mostly of serpentine. found at the south end of the hills and at a small isolated oval outcrop 128 meters further southeast.

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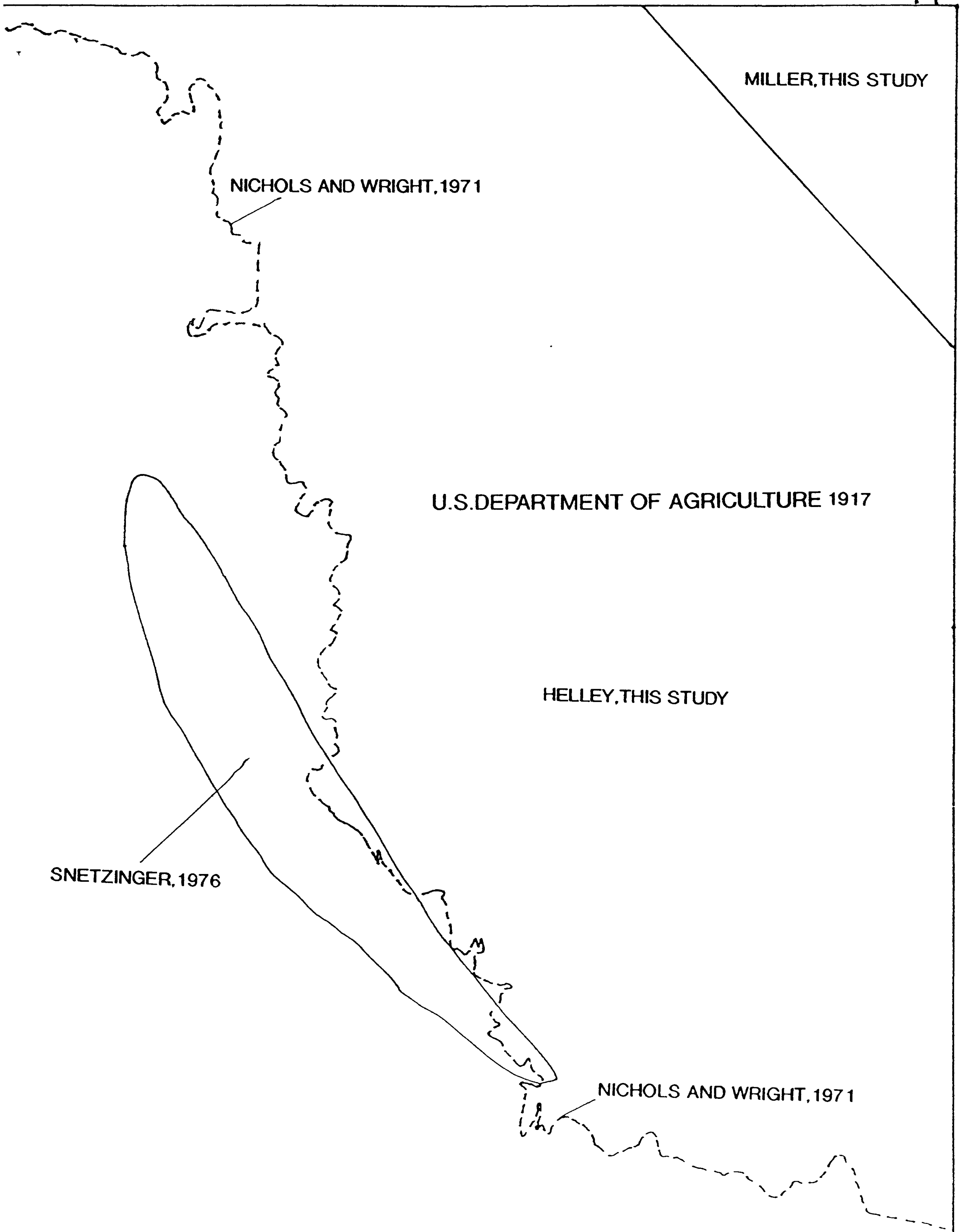
123° — 122°

38° — 37°30'

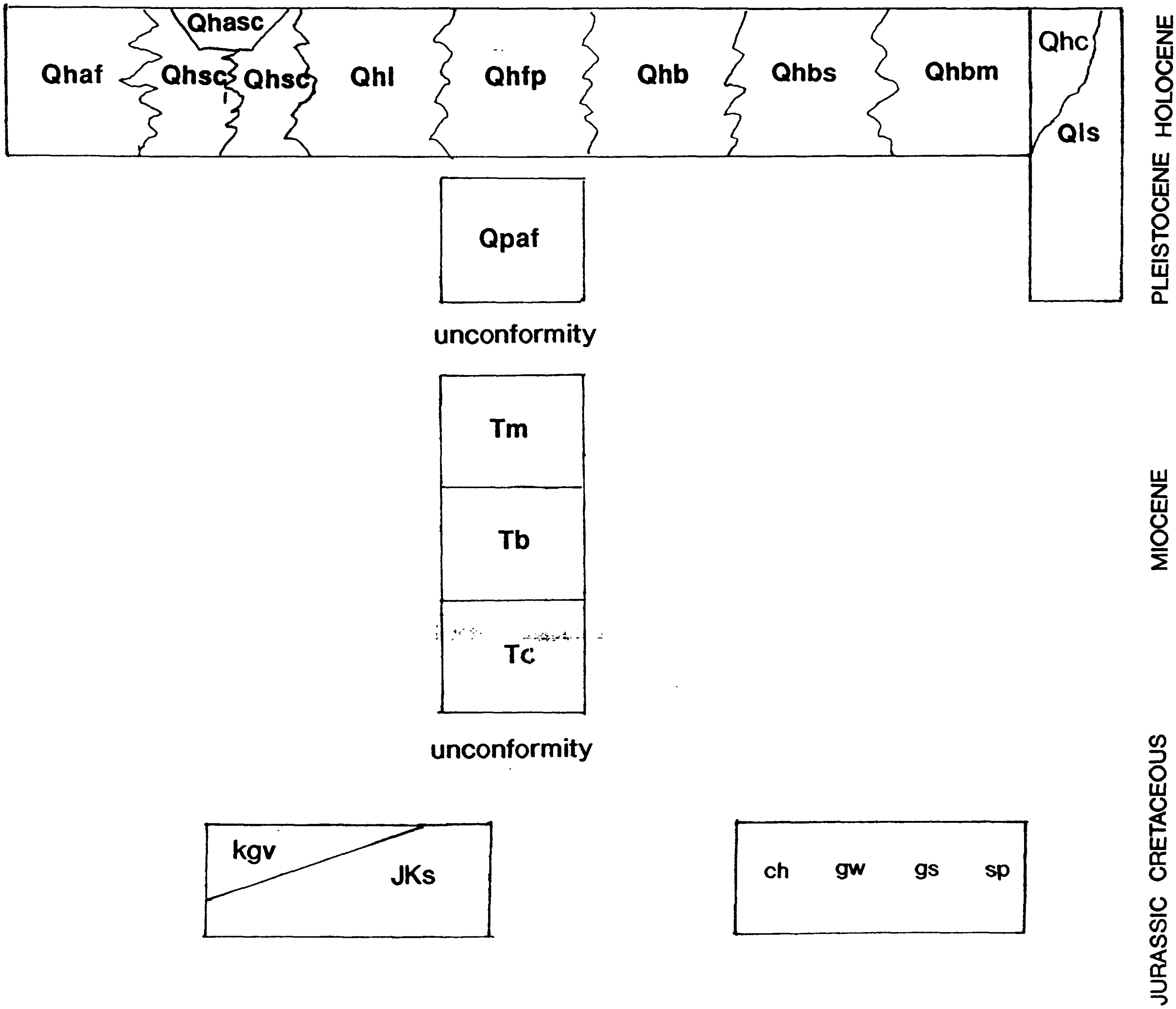
	DOUBLE POINT	BOLINAS	SAN RAFAEL	SAN QUENTIN	RICHMOND	BRIONES VALLEY	WALNUT CREEK
			POINT BONITA	SAN FRANCISO NORTH	OAKLAND WEST	OAKLAND EAST	LAS TRAMPAS RIDGE
				SAN FRANCISCO SOUTH	HUNTERS POINT	SAN LEANDRO	HAYWARD
				MONTARA MOUNTAIN	SAN MATEO	REDWOOD POINT	NEWARK

INDEX MAP OF 7.5' QUADRANGLES IN THE 1:100,000 SAN FRANCISCO QUADRANGLE

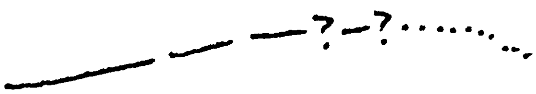


INDEX MAP SHOWING SOURCES OF GEOLOGIC DATA

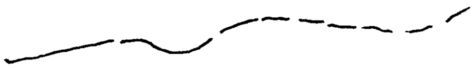
CORRELATION OF MAP UNITS



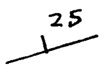
MAP SYMBOLS



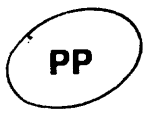
Fault, dashed where location uncertain, queried where defined only by subtle lineament, dotted where concealed



Geologic contact, dashed where uncertain



Strike and dip of bedding; facing direction unknown



Percolation pond

Landslide; arrow shows direction of movement