U.S. DEPARTMENT OF THE INTERIOR

U.S. GEOLOGICAL SURVEY

A Compilation of the Geology and Measured and Estimated Shear-Wave Velocity Profiles at Strong-Motion Stations that Recorded the Loma Prieta, California, Earthquake

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Open-File Report 91-311

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Introduction

Ground shaking produced by the Loma Prieta earthquake was recorded at 90 free-field strong-motion accelerograph stations. These recordings demonstrate once again the strong correlations between both amplitude and frequency content of ground motion and the near-surface geologic materials underlying the instrument stations (U.S. Geological Survey Staff, 1990). At a given distance, accelerations at sites on alluvium were generally greater than those at rock sites, and accelerations at most sites on Bay mud were much larger than those at alluvial sites. Joyner and Fumal (1985) have advocated using near-surface shear-wave velocity as a means of quantifying these variations in site geology rather than the simple rock-soil classifications used in the past.

Prior to the earthquake, shear-wave velocity had been measured to depths of 20 to 105 meters at fourteen sites, principally stations of the Gilroy and APEEL arrays (Gibbs et al., 1975, 1976, 1977; Fumal et al., 1982; Shannon and Wilson, Inc., and Agbabian Associates, 1980). Since the earthquake, several agencies, including the U.S. Geological Survey and the Electric Power Research Institute, have proposed drilling boreholes to depths of 30 to 195 meters at 25-30 additional sites for the purposes of investigating near-surface geology and obtaining downhole shear-wave velocity measurements. It is unlikely that analysis of data from these new sites will be completed before winter 1992. In response to demand for shear-wave velocity data, I have collected data from the previously investigated sites into this report. In addition, I am providing estimates of shear-wave velocity for the upper 30 meters at the remaining seventy-six sites. This is intended to be an interim report; I plan to issue a revised report when data analysis for the new sites is complete.

Geologic Maps

Each station was plotted on the best available large-scale (1:12,000 to 1:125,000) geologic map (Figures 1-55). In addition, I personally visited about 70 of the sites. This served as the basis for estimating the shear-wave velocity profile at each site where velocity had not been measured. Because of time constraints, I made no attempt to gather borehole data at these sites although such data would allow me to improve the velocity estimates. I will do this for the revised report.

Velocity Profiles

Measured velocity profiles and geologic logs for the stations of the Gilroy and APEEL arrays along with those for Gilroy-Gavilan College and Hollister City Hall are shown in Figures 56-69.

During the past two decades, the U.S. Geological Survey has made downhole measurements of shear-wave velocity at over 70 sites in the San Francisco Bay region. These sites were grouped according to geologic map unit. As most of the boreholes penetrated to a depth of 30 meters, an average shear-wave velocity profile was calculated to this depth for each map unit. These calculated profiles were used directly to provide estimated profiles for most of the strong-motion stations on rock and alluvium. These estimated profiles appear in Figures 70-95 as showing mean velocity and standard deviation for each depth interval along with the average velocity to a depth of 30 meters. For some sites, mostly on rock units, a single measured profile was judged to most closely approximate the estimated profile at that site. These profiles appear in Figures 70-95 as showing the velocity for each depth interval without standard deviations.

Estimated velocity profiles for sites underlain by artificial fill and Bay mud are shown in Figures 96-103. For some of these sites a velocity profile was constructed using the estimated thickness of the Bay mud from the map of McDonald et al. (1978) and average velocities for fill, Bay mud, and the underlying sediments and rock. At other Bay mud sites, a velocity profile was constructed using borehole data and velocity data from similar or nearby sites.

References

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McDonald, S.D., Nichols, D.R., Wright, N.A., and Atwater, B.F., 1978, Map showing thickness of young Bay mud, southern San Francisco Bay: U.S. Geological Survey Miscellaneous

Field Studies Map MF-976.

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U.S. Geological Survey Staff, 1990, The Loma Prieta, California, earthquake: An anticipated event: Science, v. 247, p. 286-293.

Stations are grouped in the following table according to geologic map unit. Within each group they are listed according to distance from the rupture. For an alphabetical cross-reference, see page viii.

Station	Geologic Map Unit	Geologic Map page	Velocity Profile page
Corralitos	Landslide derived from shale of Highland Way	2	125
Lexington Dam abutment	Sandstone of Franciscan assemblage	4	126
Gilroy #1	Sandstone of Franciscan assemblage	6	111
Saratoga - Aloha Ave.	Santa Clara Formation	8	127
Santa Cruz - UCSC	Metasedimentary rocks (schist)	10	128
Gilroy #6 - San Ysidro	Up. Cret. and/or Paleo-Eocene rocks	12	112
Hollister SAGO	Quartz monzonite	14	129
Cherry Flat Reservoir	Chert of Franciscan assemblage	16	130
SAGO South	Granodiorite	14	129
Stanford Linear Accelerator	Santa Clara Fm./Miocene sandstone	18	131
Woodside Fire Station	Butano (?) sandstone	20	132
Monterey City Hall	Granodiorite	22	129
APEEL #9 Crystal Springs	Santa Clara formation	24	113
APEEL #7 Pulgas Water Temple	Butano (?) sandstone	24	114
APEEL #10 Skyline Blvd.	Butano sandstone	24	115
Belmont 2-story office bldg.	Sandstone of Franciscan assemblage	24	126
Hayward - CSUH stadium	Leona Rhyolite	26	116
Hayward City Hall FF-S	Gabbro - diabase	26	163
Hayward City Hall FF-N	Gabbro - diabase	26	162
Patterson Pass Road	Cierbo Sandstone	28	134
LLNL Site 300	Neroly Fm.	30	134
So. San Francisco-Sierra Pt.	Sandstone at San Bruno Mountain	32	135
Bear Valley #7 - Pinnacles	Rhyolite	34	136
San Francisco - 1295 Shafter	Chert of Franciscan assemblage	54	130
San Francisco - Diamond Hts.	Sandstone and shale of Franciscan assemblage	36	126
Piedmont Jr. High School	Sandstone and shale of Franciscan assemblage	38	126
San Francisco - Rincon Hill	Sandstone and shale of Franciscan assemblage	40	126
Yerba Buena Island	Sandstone and shale of Franciscan assemblage	42	159
San Francisco - Pacific Hts.	Sandstone and shale of Franciscan assemblage	40	126
San Francisco-Telegraph Hill	Sandstone and shale of Franciscan assemblage	40	126

Station	Geologic Map Unit	Geologic Map page	Velocity Profile page
San Francisco - Presidio	Serpentinite	44	133
Berkeley - Strawberry Canyon	Claremont shale	46	137
Berkeley - Memorial Stadium	Sheared rocks of Franciscan assemblage	46	138
Berkeley - Lawrence Berkeley Lab.	Upper Cretaceous shale	46	139
San Francisco - Cliff House	Sandstone of Franciscan assemblage	56	126
Golden Gate Bridge	Surficial deposits/Serpentinite	44	133
Point Bonita	Sandstone and shale of Franciscan assemblage	48	126
Richmond City Hall Prking Lot	Plio-Pleistocene alluvium	50	127
Mare Island	Holo. Bay mud/Cretaceous shale and sandstone	52	140
Gilroy - Gavilan College	Late Pleistocene alluvium	6,62	117
Saratoga - West Valley College	Late Pleistocene coarse-grained alluvium	8	141
San Jose - Santa Teresa Hills	Late Pleistocene alluvium	58	142
Anderson Dam downstream	Late Pleistocene alluvium	58,66	142
Coyote Lake Dam downstream	Late Pleistocene very coarse-grained alluvium	60	143
Gilroy #7 - Mantelli Ranch	Late Pleistocene alluvium	62	160
Halls Valley	Late Pleistocene alluvium	58,84	142
Fremont - Mission San Jose	Late Pleistocene fine-grained alluvium	64	144
Fremont - Emerson Court	Late Pleistocene fine-grained alluvium	64	144
Sunol Fire Station	Late Pleistocene alluvium	68	142
APEEL 2E John Muir School	Late Pleistocene fine-grained alluvium	70	118
Hayward BART parking lot	Late Pleistocene alluvium	70	142
Sandia National Lab.	Late Pleistocene alluvium	28,68	142
LLNL East gate	Late Pleistocene alluvium	28,68	142
LLNL NW corner	Late Pleistocene alluvium	28,68	142
Oakland 2-story office bldg.	Merritt Sand	70,72	145
Big Sur	Late Pleistocene alluvium	74	146
Berkeley 2-story hospital	Late Pleistocene fine-grained alluvium	70	144
Capitola	Holocene alluvium	76	147
Gilroy 2 - HWY 101 Motel	Holocene coarse-grained alluvium	62	119
Gilroy Old Firehouse	Holocene coarse-grained alluvium	62	149

Station	Geologic Map Unit	Geologic Map page	Velocity Profile page
Gilroy 3 - Sewage Treatment Plant	Holocene fine-grained alluvium	62	120
Gilroy 4 - San Ysidro School	Holocene medium-grained alluvium	62	121
Hollister Airport	Holocene fine-grained alluvium	78	122
Agnew	Holocene fine-grained alluvium	64	148
Sunnyvale - Colton Ave.	Holocene fine-grained alluvium	64	148
Hollister City Hall	Holocene fine-grained alluvium	78	122
Hollister - South and Pine	Holocene fine-grained alluvium	78	122
Milpitas 2-story bldg.	Holocene fine-grained alluvium	64	148
Salinas	Holocene alluvium	80	147
Calaveras Reservoir South	Holocene coarse-grained alluvium	64,82	149
Bear Valley 12 - Williams	Holocene alluvium	86	147
Bear Valley 5 - Callens	Holocene alluvium	88	147
Dublin Fire Station	Holocene fine-grained alluvium	68	148
Bear Valley 10 - Webb	Holocene alluvium	90	161
Livermore - Fagundes Ranch	Holo. fine-grained alluvium/Plio. siltstone	68,92	150
Los Banos	Holocene alluvium	94	147
Greenfield	Holocene alluvium	96	147
Tracy sewage treatment plant	Holocene alluvium	98	147
Bitterwater	Holocene alluvium	100	147
Olema	Holocene coarse-grained alluvium	102	149
Palo Alto 2-story office bldg.	Artificial fill/Holocene Bay mud (8 m)	104	151
APEEL 2 - Redwood City	Artificial fill/Holocene Bay mud (9.5 m)	106	123
Foster City Redwood Shores (APEEL 1)	Artificial fill/Holocene Bay mud (9.5 m)	106	124
Foster City - Menhaden Court	Artificial fill/Holocene Bay mud (15 m)	106	152
San Francisco Intern'l. Airpt.	Artificial fill/Holocene Bay mud (6 m)	106	153
Alameda Naval Air Station	Artificial fill/Holocene Bay mud (17 m)	108	154
Oakland Outer Harbor Wharf	Artificial fill/Holocene Bay mud (7 m)	108	155
Emeryville	Artificial fill/Holocene Bay mud (4 m)	108	156
Treasure Island	Artificial fill/Holocene Bay mud (13 m)	42	157
Larkspur ferry terminal	Artificial fill/Holocene Bay mud (18 m)	110	158

Station	Geologic Map page	Velocity Profile page		Station	Geologic Map page	Velocity Profile page
Agnew	64	148		Berkeley - 2-story hospital	70	144
Alameda Naval Air Station	108	154		Big Sur	74	146
Anderson Dam downstream	58,66	142		Bitterwater	100	147
APEEL 2 - Redwood City	106	123		Calaveras Reservoir South	64,82	149
APEEL 2E - John Muir School	70	118		Capitola	76	147
APEEL #7 - Pulgas Water Temple	24	114		Cherry Flat Reservoir	16	130
APEEL #9 - Crystal Springs	24	113		Corralitos	2	125
APEEL # 10 - Skyline Blvd.	24	115		Coyote Lake Dam dwnstrm.	60	143
Bear Valley 5 - Callens	88	147		Dublin Fire Station	68	148
Bear Valley #7 - Pinnacles	34	136		Emeryville	108	156
Bear Valley 10 - Webb	90	161		Foster City - Menhaden Court	106	152
Bear Valley 12 - Williams	86	147		Foster City - Redwood Shores (APEEL 1)	106	124
Belmont 2 - story office bldg.	24	126		Fremont - Emerson Court	64	144
Berkeley - Lawrence Berkeley Lab.	46	139		Fremont - Mission San Jose	64	144
Berkeley - Memorial Stadium	46	138		Gilroy-Gavilan College	6,62	117
Berkeley Strawberry Canyon	46	137		Gilroy #1	6	111

Station	Geologic Map page	Velocity Profile page		Station	Geologic Map page	Velocity Profile page
Gilroy 2 - Highway 101 Motel	62	119		Lexington Dam abutment	4	126
Gilroy 3 - Sewage Treatment Plant	62	120		Livermore - Fagundes Ranch	68,92	150
Gilroy 4 - San Ysidro School	62	121		LLNL East gate	28,68	142
Gilroy #6 - San Ysidro	12	112		LLNL NW corner	28,68	142
Gilroy #7 - Mantelli Ranch	62	160		LLNL Site 300	30	134
Gilroy Old Firehouse	62	149		Los Banos	94	147
Golden Gate Bridge	44	133		Mare Island	52	140
Greenfield	96	147		Milpitas 2-story bldg.	64	148
Halls Valley	58,84	142		Monterey City Hall	22	129
Hayward BART parking lot	70	142		Oakland Outer Harbor Wharf	108	155
Hayward City Hall FF-N	26	162		Oakland 2-story office bldg.	70,72	145
Hayward City Hall FF-S	26	163		Olema	102	149
Hayward - CSUH stadium	26	116		Palo Alto 2-story office bldg.	104	151
Hollister Airport	78	122		Patterson Pass Road	28	134
Hollister City Hall	78	122		Pidmont Jr. High School	38	126
Hollister SAGO	14	129		Point Bonita	48	126
Hollister - South and Pine	78	122		Richmond City Hall Parking Lot	50	127
Larkspur ferry terminal	110	158		SAGO South	14	129

Station	Geologic Map page	Velocity Profile page		Station	Geologic Map page	Velocity Profile page
Salinas	80	147		Santa Cruz - UCSC	10	128
Sandia National Lab.	28,68	142		Saratoga - Aloha Ave.	8	127
San Francisco - Cliff House	56	126		Saratoga - West Valley College	8	141
San Francisco - Diamond Hts.	36	126		South San Francisco - Sierra Point	32	135
San Francisco Intern'l. Airport	106	153		Stanford Linear Accelerator	18	131
San Francisco - Pacific Hts.	40	126		Sunnyvale - Colton Avenue	64	148
San Francisco - Presidio	44	133		Sunol Fire Station	68	142
San Francisco - Rincon Hill	40	126		Tracy sewage treatment plant	98	147
San Francisco - 1295 Shafter	54	130		Treasure Island	42	157
San Francisco - Telegraph Hill	40	126		Woodside Fire Station	20	132
San Jose - Santa Teresa Hills	58	142		Yerba Buena Island	42	159

SURFICIAL SEDIMENTS

Qc — COLLUVIUM (HOLOCENE)--Unconsolidated rock and soil debris.

Qal — ALLUVIUM (HOLOCENE AND UPPER PLEISTOCENE)--Unconsolidated gravel, sand, and silt deposited by streams.

Qls — LANDSLIDE DEPOSITS (HOLOCENE AND PLEISTOCENE)--Debris consisting of a mixture of colluvium and intact masses of rock, displaced down slope by gravity.

Qof — OLDER FLOODPLAIN DEPOSITS (PLEISTOCENE?)--Unconsolidated fluvial gravel, sand, and silt, deposited on older floodplain surfaces, dissected and elevated above present base level.

Qoa — OLDER ALLUVIUM (PLEISTOCENE?)--Unconsolidated fluvial gravel, sand, and silt, dissected, and elevated as terraces above present base level, along mountainous streams having no well-defined floodplains.

UNITS SOUTHWEST OF SAN ANDREAS FAULT

Tp — PURISIMA FORMATION (PLIOCENE)--Yellowish-grey, tuffaceous and diatomaceous siltstone, and fine- to medium-grained thick-bedded to massive, weakly consolidated bluish-gray sandstone with abundant andesitic detritus. Locally contains foraminifera of Pliocene age.

SAN LORENZO FORMATION (OLIGOCENE AND UPPER EOCENE)--

Tsl — Shale and sandstone, undivided

Tsr — Rices Mudstone Member - nodular light-grey mudstone, grading downward into fine-grained arkosic and slightly glauconitic sandstone. Unit contains bathyal foraminifera and marine mollusks assignable to the Refugian and Zemorrian Stages of the late Eocene and Oligocene.

Tst — Twobar Shale Member - thin-bedded olive-gray clay shale, containing bathyal benthic foraminifera assignable to the Narizian Stage of the late Eocene.

BUTANO SANDSTONE (UPPER AND MIDDLE EOCENE)--

Tb — Yellowish-gray, medium-bedded to massive arkosic sandstone with thin interbeds of olive-gray siltstone, undivided. Formation rests nonconformably on granitic Salinian basement west of report area and south of the Zayante fault, in the Laurel quadrangle (Clark, 1981). Northeast of the Zayante fault the basement of the Butano Sandstone is unknown. In the map area, the Butano yields bathyal benthic and planktic foraminifera assignable to the Narizian Stage of the middle to late Eocene, whereas in the Felton quadrangle to the west, the Butano ranges downward into the Penutian Stage of the early Eocene (P8 zone) (Clark, 1981).

Tbm — Dark-gray, thin-bedded nodular mudstone with interbedded thin to thick, locally graded, arkosic sandstone, mapped locally.

Tbs — Thick-bedded to massive, fine- to coarse-grained arkosic sandstone exposed at base of Formation locally.

UNITS NORTHEAST OF SAN ANDREAS FAULT AND SOUTHWEST OF THE BERROCAL FAULT

Tm — MARINE SHALE AND SANDSTONE OF HIGHLAND WAY (LOWER MIOCENE TO LOWER EOCENE)--Hard, dark-brown to black, light-brown weathering, silty to micaceous, locally siliceous carbonaceous shale, and minor quartzo-feldspathic sandstone. Sandstone is rhythmically intercalated within the shale as fine- to medium-grained tabular beds less than 10 cm thick and also forms sporadic thick channel-form beds of medium- to coarse-grained sandstone up to 5 m thick.

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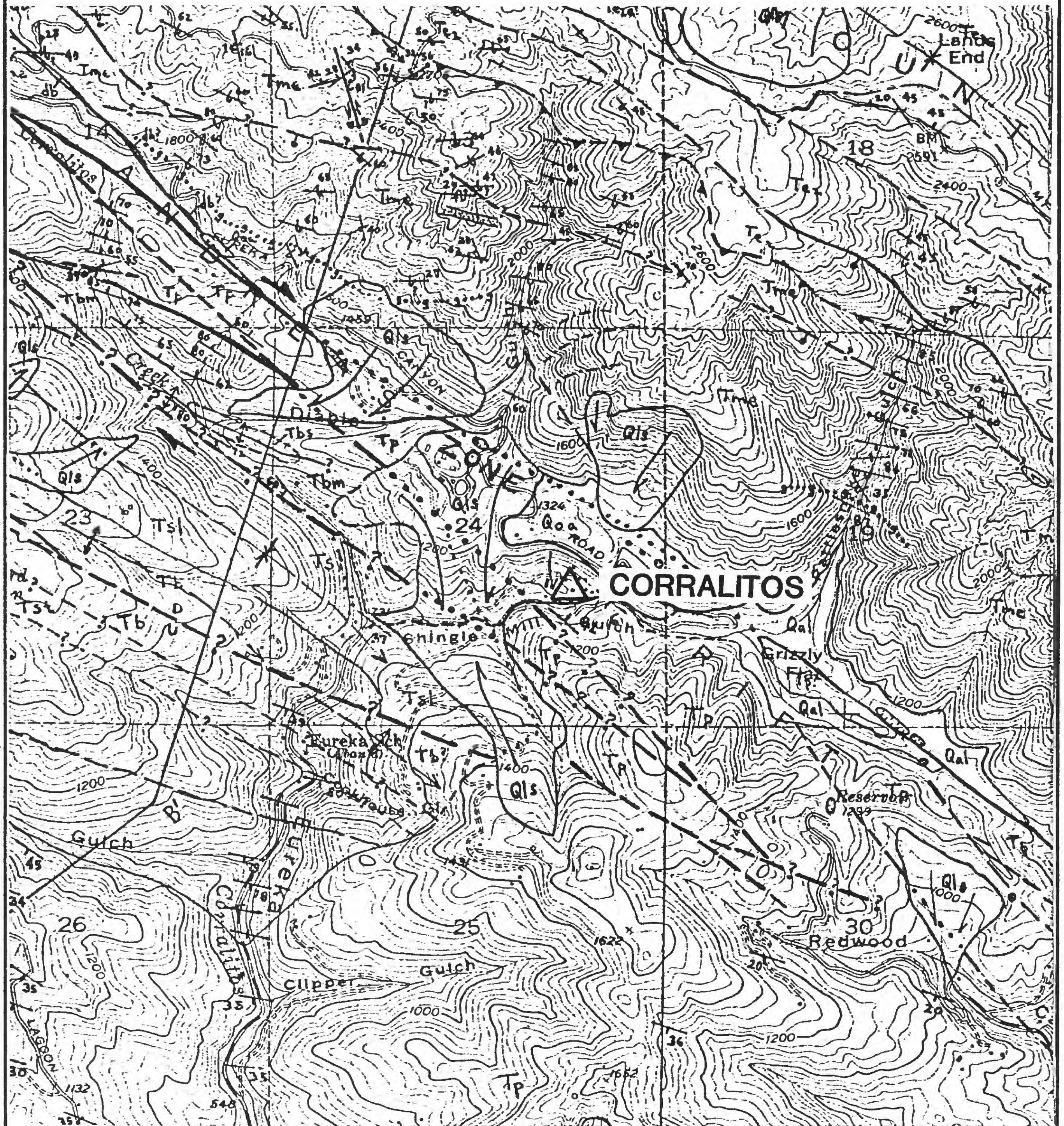
OPEN FILE MAP 88-752

SHEET 1 OF 2



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GEOLOGIC MAP AND STRUCTURE SECTIONS OF THE LOMA PRIETA 7 1/2' QUADRANGLE, SANTA CLARA AND SANTA CRUZ COUNTIES, CALIFORNIA

BY R. J. McLaughlin, J. C. Clark, and E. E. Brabb

1988

Figure 1

UNITS SOUTHWEST OF SAN ANDREAS FAULT

QUATERNARY

Qls — Landslide debris

TERTIARY

Tp — Purisima Formation
Marine sandstone

UNCONFORMITY

Tl — Lambert ? Shale
Marine semi-siliceous shale

Oligocene

Tvq — Vaqueros Sandstone
Marine arkosic sandstone

Tsl / Tsr / Tst — San Lorenzo Formation
Marine
Tsl, undivided siltstone and claystone
Tsr, Rices Mudstone Member
mudstone and siltstone; includes glauconitic sandstone at and near base; Zemarrian and Refugian Stages
Tst, Twobar Shale Member
bedded micaceous shale and claystone; Narizian Stage

Eocene

Tbs / Tb — Butano Sandstone
Marine arkosic sandstone and micaceous shale
Narizian Stage
Tbs, predominantly sandstone
Tb predominantly shale

UNITS NORTHEAST OF SAN ANDREAS FAULT

QUATERNARY

Holocene

Qal — Surficial deposits

Pleistocene

Qls — Landslide and mudflow deposits

Qoa — Older alluvium
Gravel, sand and clay

UNCONFORMITY

TERTIARY AND QUATERNARY

Pliocene and Pleistocene

QTs — Santa Clara Formation
Valley gravel, clay and sand

UNCONFORMITY

TERTIARY

Miocene

Tm — Monterey Shale
Marine siliceous shale

Tvd — ~~Dacite-rhyolite and dacite~~ breccia

Tt — Temblor (?) Formation
Marine arkosic sandstone

UNCONFORMITY

Eocene

Tss / Tls — Sedimentary rocks
Tss, sandstone and shale
Tls, limestone

TKsh / TKss — Marine sedimentary rocks
TKsh, micaceous shale, minor thin sandstone strata
TKss, arkosic sandstone

CRETACEOUS

Upper

Ksh / Kcg — Marine sedimentary rocks
Ksh, micaceous shale
Kcg, cobble conglomerate

JUR AND CRET

KJa — Argillite

JURASSIC AND/OR CRETACEOUS

vb / vd — Mafic igneous rocks, partly altered to greenstone
vb, basalt
vd, fine grained diorite

sp / sc — Ultramafic rocks
sp, serpentinite
sc, silica-carbonate rock, altered from serpentinite

fm / fg / fs / fc / fl / fsr — Franciscan rocks
Pervasively sheared weakly metamorphosed marine sedimentary and volcanic rocks
fm, metamorphic rocks, schist
fg, greenstone, after basalt
fs, graywocke sandstone
fc, varicolored chert
fl, limestone
fsr, shear zone or melange of above rocks

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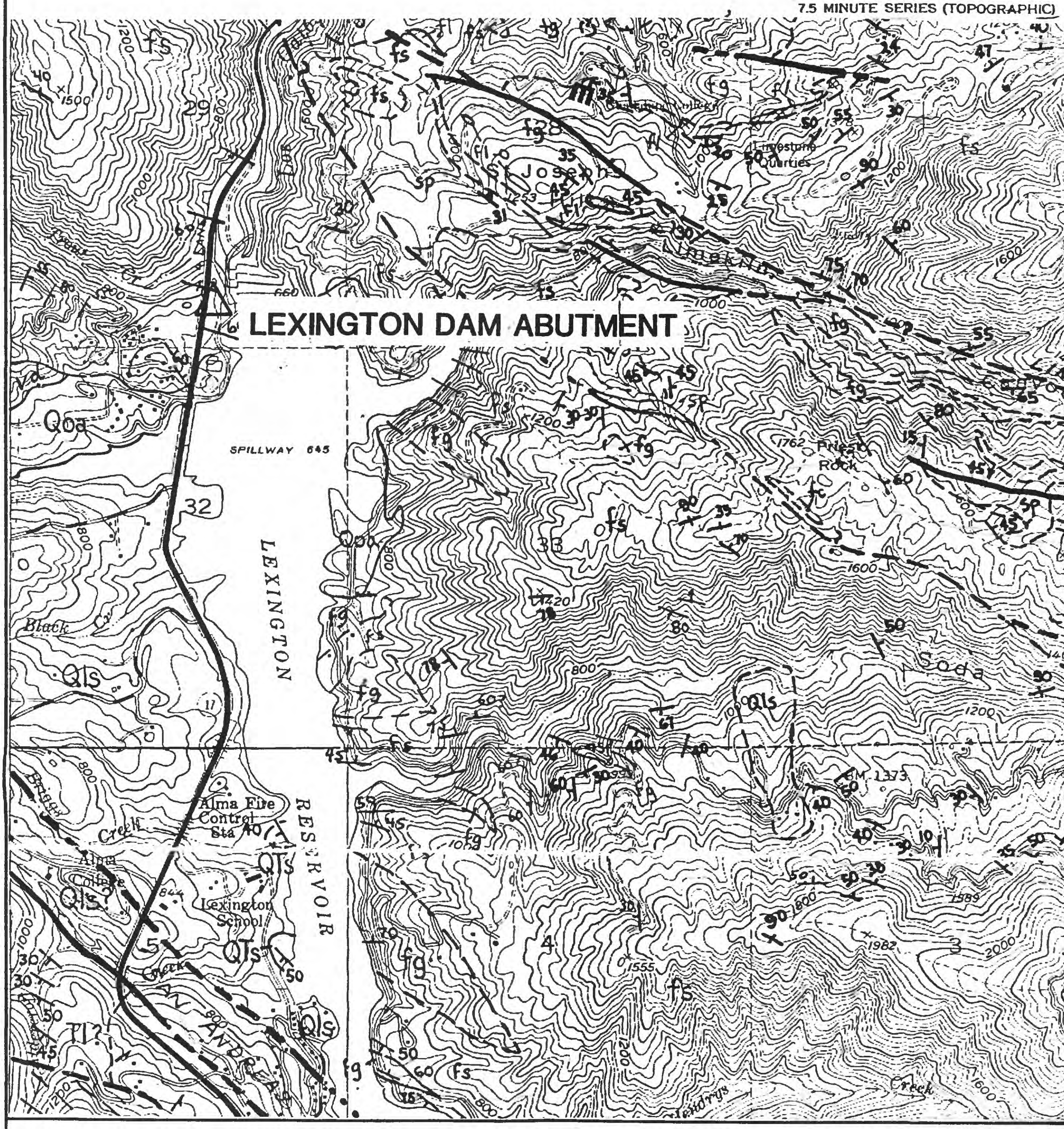
OPEN FILE REPORT 78-453

LOS GATOS QUADRANGLE
CALIFORNIA
7.5 MINUTE SERIES (TOPOGRAPHIC)



SCALE 1:24000

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PRELIMINARY
GEOLOGIC MAP OF THE LOS GATOS QUADRANGLE, SANTA CLARA & SANTA CRUZ COUNTIES, CALIFORNIA
BY
Thomas W. Dibblee, Jr and Earl E. Brabb
1978

Figure 2

UNITS SOUTHWEST OF SAN ANDREAS FAULT

Qal
Alluvium
(Holocene — QUATERNARY)

UNCONFORMITY

Qa
Aromas Sand
Eolian sand
(Pleistocene — QUATERNARY)

QTp
Paso Robles Formation
Nonmarine nodular clay, sand and pebble gravel; includes at the base fragments and boulders of Franciscan and granitic detritus and a small mass (labeled f) of Franciscan chert and greenstone, near Canyon Road
(Pliocene — TERTIARY)

UNCONFORMITY

qg
Hornblende quartz-gabbro
(MESOZOIC)

UNITS NORTHEAST OF SAN ANDREAS FAULT

Qls | Qal | Qc | Qg
Surficial deposits
Qg, sand and gravel of major streams
Qal, alluvium
Qls, landslide debris
Qc, clay and silt
(Holocene — QUATERNARY)

Qoa
Older alluvium
(Pleistocene — QUATERNARY)

UNCONFORMITY

Tuc | Tus
Nonmarine sedimentary deposits
Tuc, greenish claystone, sandstone and pebble conglomerate
Tus sandstone
(Pliocene — TERTIARY)

Te
Etchegoin Formation
Marine sandstone, siltstone and minor pebble conglomerate

Tcg
Nonmarine pebble conglomerate

UNCONFORMITY

Tm
Monterey Shale
Marine siliceous shale
(Miocene — TERTIARY)

Tts
Temblor Sandstone
Marine

UNCONFORMITY

Tmp
Shale of Mount Pajaro area
(Monterey Shale of Allen, 1946)
Marine siliceous and semi-siliceous shale
Saucesian and Zemorrian Stages
(Oligoc. & L. Mioc.)

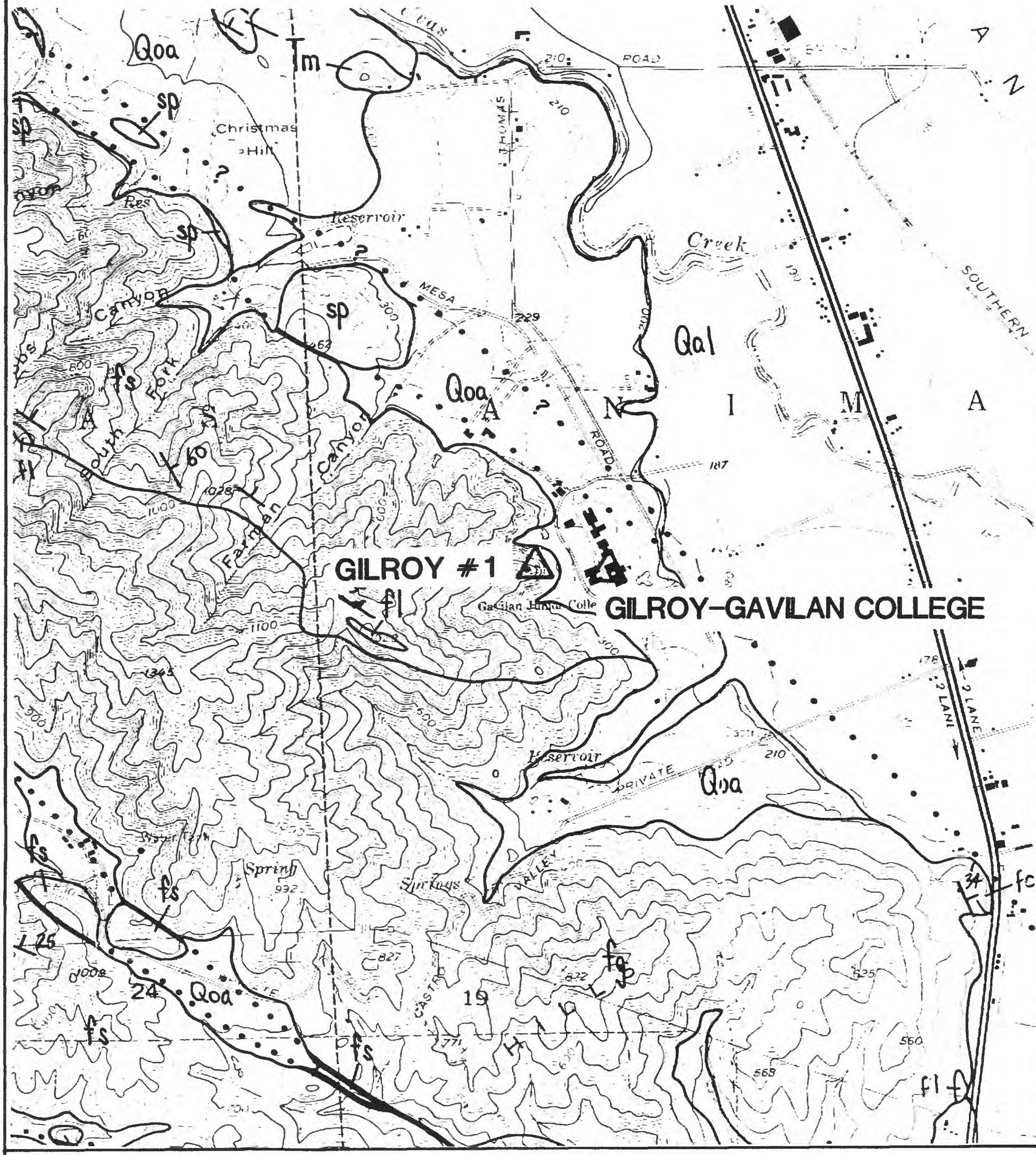
Tss
Marine arkosic sandstone
(Eocene?)

sp
Serpentinite
(JURASSIC OR CRETACEOUS)

fg | fs | fc | fl
Franciscan rocks
Pervasively sheared and weakly metamorphosed marine sedimentary and volcanic rocks
fg, greenstone, metam. from basalt
fs, graywacke sandstone and micaceous shale
fc, varicolored chert
fl, limestone
(JURASSIC OR CRETACEOUS)

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

OPEN FILE REPORT 78-453



SCALE 1:24 000

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1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 .5 0 1 KILOMETER

PRELIMINARY GEOLOGIC MAP OF THE CHITTENDEN QUADRANGLE, SANTA CLARA, SANTA CRUZ AND SAN BENITO COUNTIES, CALIFORNIA

BY

Thomas W. Dibblee, Jr. and Earl E. Brabb

1978

Figure 3

EXPLANATION

37°15'

Holocene

Qb Qyfo Qyf

Younger alluvial fan deposits

Qb, interfluvial basin deposits; mainly organic-rich clay and silty clay that locally contain modern fresh-water gastropods and pelecypods. Sunnyvale, Willows, and Bayshore Soil Series of U.S. Soil Conservation Service (1968) are developed on these deposits

Qyfo, fluvial deposits at the outer edge of young alluvial fans (Qyf); forms levees between basin deposits (Qb) and characterized by variable grain size. Mainly fine sand, silt, and silty clay. Clear Lake, Castro, and Campbell Soil Series of U.S. Soil Conservation Service (1968) are developed on these deposits

Qyf, young alluvial fan deposits grading headward to terrace and levee deposits of channels incised in Qof. Consists of moderately well sorted fine sand and silt with minor gravel beds becoming more abundant toward fan heads. Locally contains aboriginal artifacts and skeletal remains. The weakly developed Yolo, Garretson, and Cortina Soil Series of U.S. Soil Conservation Service (1968) are developed on these deposits

Qobm

Older San Francisco Bay mud

Qobm, semi consolidated organic-rich clay deposits; underlies younger San Francisco Bay mud of Nichols and Wright (1971) and young alluvial fan deposits; extends landward to maximum elevation of 10 feet above mean sea level. The distinctive Alviao Soil Series of U.S. Soil Conservation Service (1968) is developed on these deposits

QUATERNARY

Pleistocene

Qof

Older alluvial fan deposits

Qof, older fan deposits bordering uplands; at fan heads incised by channels partly filled by Qyf; at outer margins overlapped by younger alluvial fan deposits, Qyf, Qyfo and Qb. Mainly coarse sand and gravel with local accumulations of middle and late Pleistocene vertebrate fossils. The strongly developed Zamora, Pleasanton, San Ysidro, Arbuckle, Cropley, and Rincon Series of U.S. Soil Conservation Service (1968) are developed on these deposits

$Qofd_1$ $Qofd_2$

Older dissected alluvial fan deposits

Isolated alluvial deposits forming moderately dissected fans ($Qofd_1$) and highly dissected fans ($Qofd_2$); consist of coarse to very coarse highly weathered gravels. Hillgate, Saratoga, and Positas Soil Series of U.S. Soil Conservation Service (1968) have very strongly developed soil profiles which are slightly eroded (ofd_1) or deeply eroded with stripped soil horizons (ofd_2)

Pliocene

QTs QTb

Sedimentary and volcanic rocks

QTs, poorly consolidated conglomerate, sandstone, siltstone, and claystone with minor lignite deposits. Folded and faulted in part; includes Santa Clara Formation, Packwood Gravels of Crittenden (1951), and small areas of Merced Formation in the Palo Alto 7-1/2-minute quadrangle

QTb, basalt and other volcanic rocks

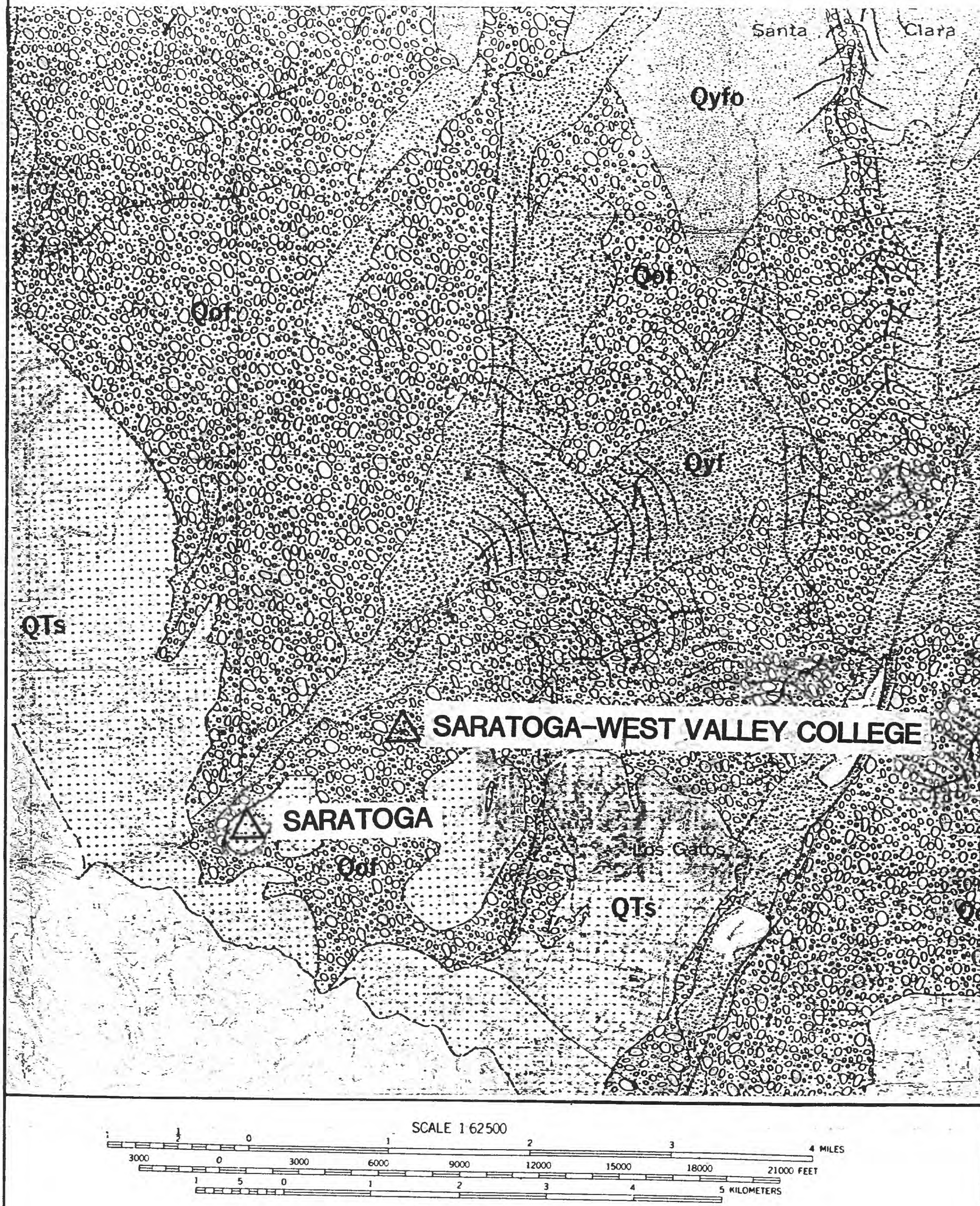
TERTIARY

Undifferentiated slope deposits and older bedrock

Areas underlain by older bedrock or colluvium derived from bedrock

DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

MISCELLANEOUS FIELD STUDIES
MAP MF - 335



GEOLOGIC MAP OF LATE CENOZOIC DEPOSITS, SANTA CLARA COUNTY, CALIFORNIA

by

E. J. Helley and E. E. Brabb

1971

Figure 4

DESCRIPTION OF MAP UNITS

SURFICIAL SEDIMENTS

Qal ALLUVIUM—Unconsolidated gravel, sand, and silt

Qls LANDSLIDE MATERIAL—Half arrows show direction of downslope movement

Qt RIVER TERRACE DEPOSITS—Unconsolidated sandy pebble and cobble gravel and dark-yellowish-orange fine to medium sand

Qm MARINE TERRACE DEPOSIT—Unconsolidated moderate-yellowish-brown fine sand and granular gravel

UPPER MIOCENE TO PLIOCENE SEDIMENTARY SEQUENCE

Tp PURISIMA FORMATION (upper Miocene and Pliocene)—Very thick bedded yellowish-gray tuffaceous and diatomaceous siltstone with thick interbeds of bluish-gray semifriable fine-grained andesitic sandstone. Includes Santa Cruz Mudstone east of Scotts Valley and north of Santa Cruz

Tsc SANTA CRUZ MUDSTONE (upper Miocene)—Medium- to thick-bedded and faintly laminated blocky-weathering pale-yellowish-brown siliceous organic mudstone. Includes Santa Margarita Sandstone along Glenwood syncline

Tsm SANTA MARGARITA SANDSTONE (upper Miocene)—Very thick bedded to massive thickly crossbedded yellowish-gray to white friable granular medium- to fine-grained arkosic sandstone; locally calcareous

MIDDLE MIOCENE SEDIMENTARY SEQUENCE

Tm MONTEREY FORMATION—Medium- to thick-bedded and laminated olive-gray to light-gray subsiliceous organic mudstone and sandy siltstone. Includes few thick dolomite interbeds

LOMPICO SANDSTONE—Thick-bedded to massive yellowish-gray medium- to fine-grained calcareous arkosic sandstone; locally friable

EOCENE TO LOWER MIOCENE SEDIMENTARY SEQUENCE

LAMBERT SHALE (lower Miocene)—Thin- to medium-bedded and faintly laminated olive-gray to dusky-yellowish-brown organic mudstone with phosphatic laminae and lenses in lower part

Tv VAQUEROS SANDSTONE (Oligocene and lower Miocene)—Thick-bedded to massive yellowish-gray arkosic sandstone

Basalt—Spheroidal-weathering pillow basalt flows in upper part

ZAYANTE SANDSTONE (Oligocene)—Thick- to very thick bedded yellowish-orange arkosic sandstone with thin interbeds of greenish and reddish siltstone and lenses and thick interbeds of pebble and cobble conglomerate

SAN LORENZO FORMATION

Tsr Rices Mudstone Member (Eocene and Oligocene)—Massive medium-light-gray fine- to very fine grained arkosic sandstone; thick bed of glauconitic sandstone at base

Tst Twobar Shale Member (Eocene)—Very thin bedded and laminated olive-gray shale

BUTANO SANDSTONE (Eocene)

Tbc Upper sandstone member—Thin- to very thick bedded medium-gray fine- to medium-grained arkosic sandstone with thin interbeds of medium-gray siltstone

Middle siltstone member—Thin- to medium-bedded nodular olive-gray pyritic siltstone

Lower sandstone member—Very thick bedded to massive yellowish-gray granular medium- to coarse-grained arkosic sandstone.

Conglomerate—Thick to very thick interbeds of sandy pebble conglomerate in lower part of lower sandstone member

PALEOCENE SEDIMENTARY SEQUENCE

Tl LOCATELLI FORMATION—Nodular olive-gray to pale-yellowish-brown micaceous siltstone

Sandstone—Massive medium-gray fine- to medium-grained arkosic sandstone locally at base

CRYSTALLINE PLUTONIC AND METAMORPHIC ROCKS

QUARTZ DIORITE—Grades to granodiorite south and east of Ben Lomond Mountain

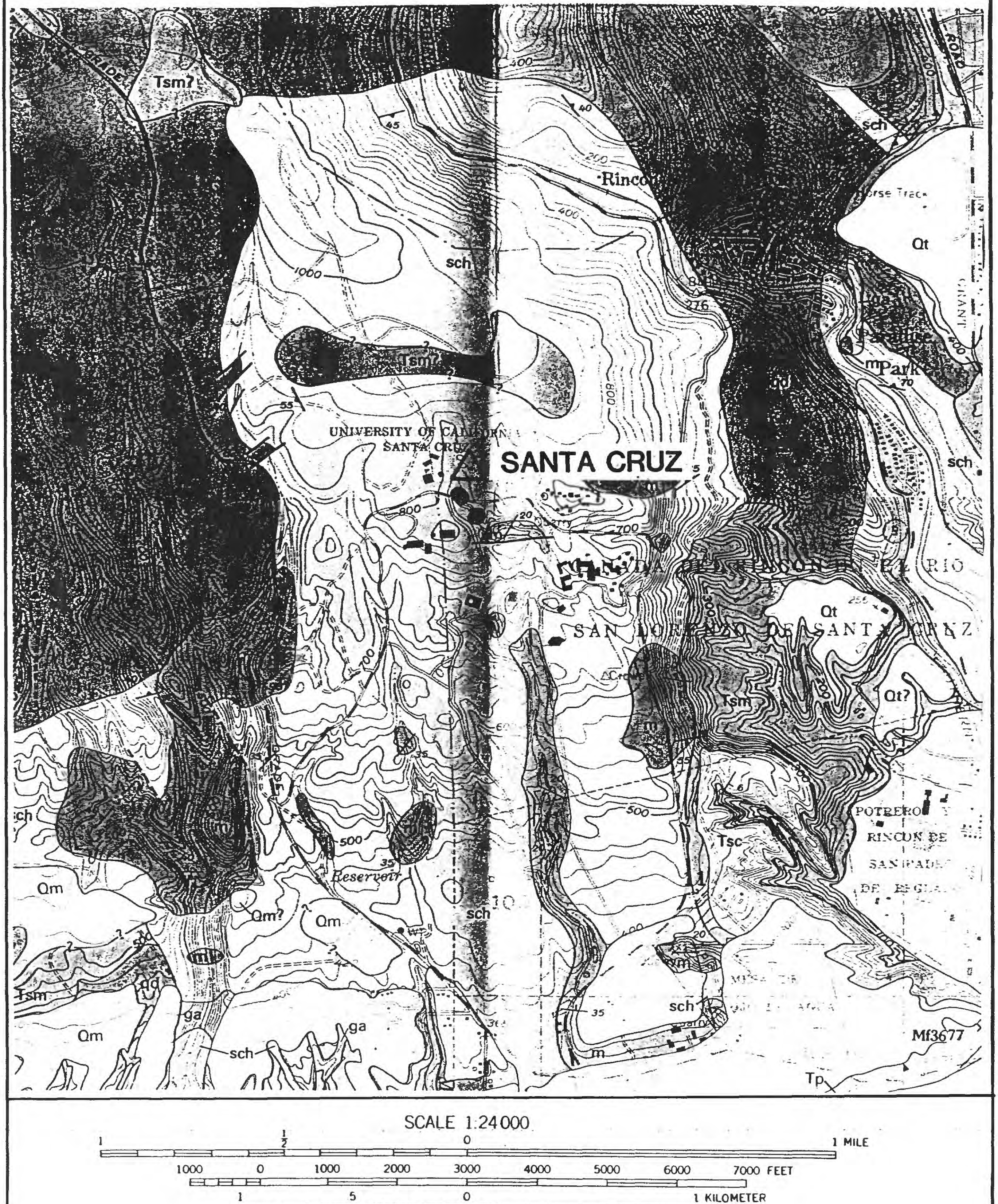
ga GRANITE AND ADAMELLITE

gd GNEISSIC GRANODIORITE

HORNBLENDE-CUMMINGTONITE GABBRO

sch METASEDIMENTARY ROCKS—Mainly pelitic schist and quartzite

MARBLE—Locally contains interbedded schist and calc-silicate rocks



GEOLOGIC MAP AND SECTIONS OF THE FELTON-SANTA CRUZ AREA, SANTA CRUZ COUNTY, CALIFORNIA

By JOSEPH C. CLARK

Figure 5

Holocene

Qg | Qa | Qls

Surficial deposits
Qg, gravel and sand of stream channels
Qa, alluvium-gravel, sand and clay
Qls, landslide debris

UNCONFORMITY

Pleistocene ?

Qsc

Santa Clara Formation (terrestrial)
gravel, sand and clay

Pliocene or Pleistocene ?

QTb

Unnamed basalt
(olivine basalt lava)

UNCONFORMITY

U. Cretac. and/or Paleo.-Eocene

KTsh

Unnamed marine sedimentary rocks
(age, early Eocene-, Paleocene and/or late Cretaceous)
No pattern = micaceous shale and siltstone
arkosic sandstone
conglomerate

Upper

Ksh

Berryessa Formation of Crittenden, 1951
Ksh, clay shale and siltstone
dotted units, arkosic sandst.

sp

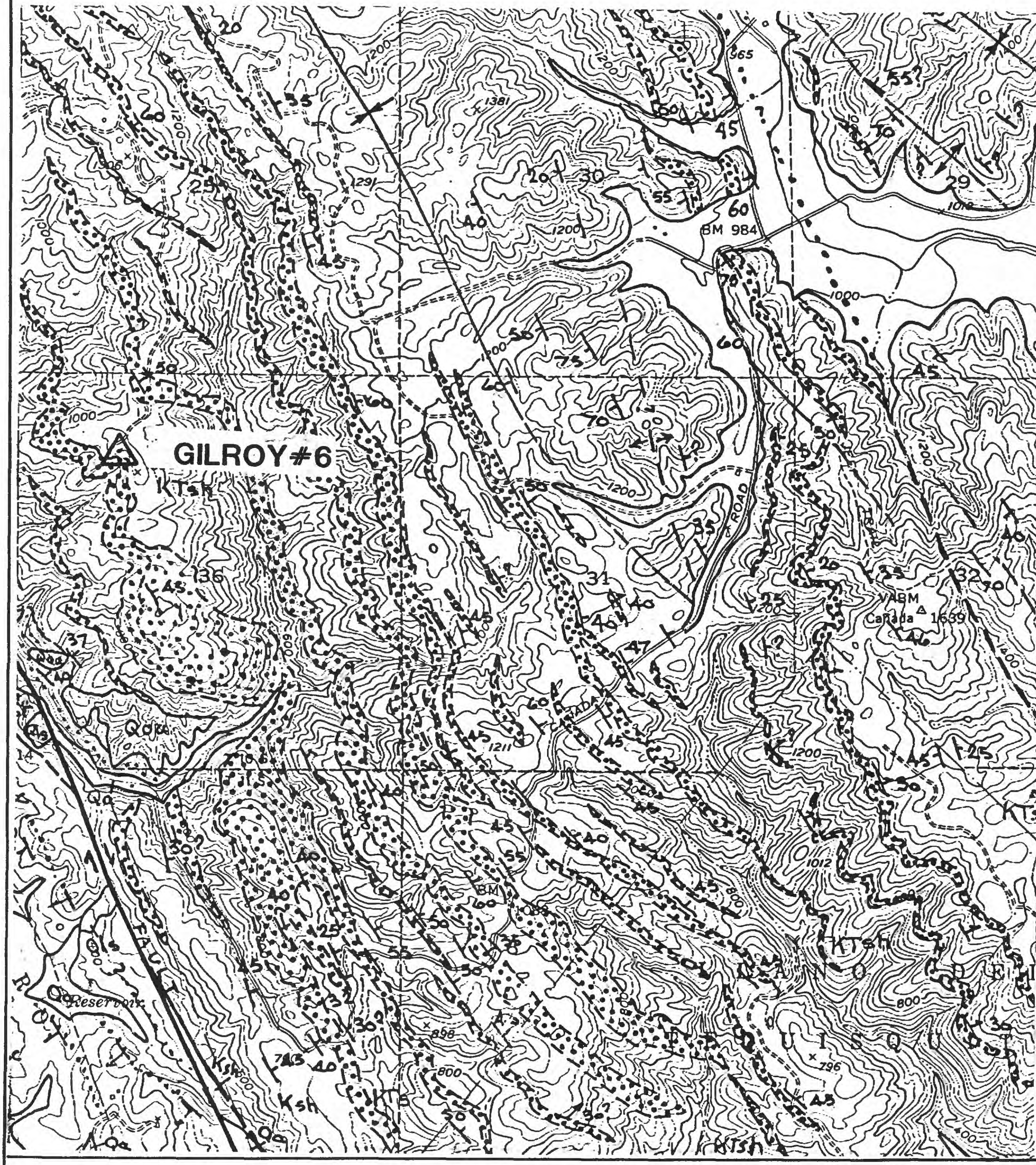
Serpentine and serpentinized ultramafic rocks

fs | fc | fg | fa | fsr

Franciscan rocks
(severely shattered eugeosynclinal marine rocks)
fs, graywacke sandstone, minor claystone
fc, varicolored chert
fg, greenstone
fa, glaucophane rock
fsr, pervasively sheared shale and graywacke containing tectonic fragments of graywacke, chert, greenstone and glaucophane rock

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

OPEN FILE MAP



SCALE 1:24000

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1 .5 0 1 KILOMETER

PRELIMINARY GEOLOGIC MAP OF THE GILROY HOT SPRINGS QUADRANGLE, SANTA CLARA COUNTY, CALIFORNIA

By Thomas W. Dibblee Jr., 1973

Figure 6

S.W. OF SAN ANDREAS FAULT

QUATERNARY

Holocene

Qa

Surficial sediments
Alluvium (includes some older dissected alluvium near fault)

?

Pleistocene

Qls

Landslide rubble of volcanic detritus

Qoa

Older alluvium of granitic detritus

UNCONFORMITY

TERTIARY

Oligocene or Miocene

Tvd

Unnamed volcanic rocks
(Dacite flows and flow breccia)

Tuc

Unnamed terrestrial sandstone siltstone and conglomerate

Tus

Unnamed marine sandstone and siltstone

Tug

Unnamed terrestrial conglomerate
(granitic and marble detritus)

UNCONFORMITY

MESOZOIC

qm | grd
qd

Granitic rocks
qm-mostly quartz monzonite
grd-granodiotite
qd-biotite quartz diorite

MESO. OR OLDER

ms | m | mq

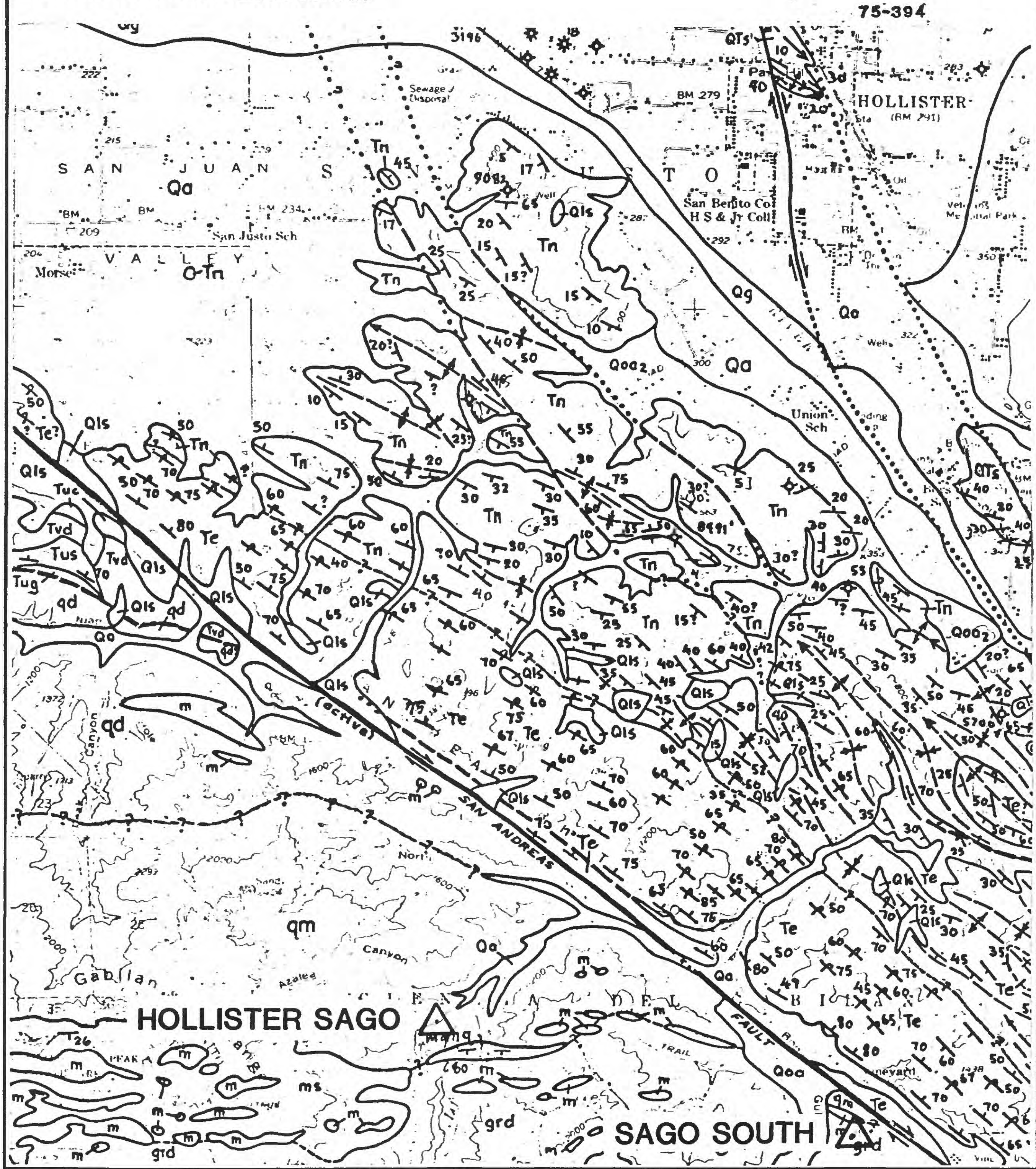
Metasedimentary rocks
(pendant remnants in granitic rocks)
ms-mica-schist-gneiss, includes admixtures of granitic rocks
m-marble (limestone & dolomite)
mq-quartzite

DEPARTMENT OF THE INTERIOR

UNITED STATES GEOLOGICAL SURVEY

OPEN FILE MAP

75-394



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1 .5 0 1 2 3 4 5 6 7 KILOMETERS

GEOLOGIC MAP OF THE HOLLISTER QUADRANGLE, CALIFORNIA

Geology by T.W. Dibblee Jr. & T.H. Rogers

Figure 7

QUATERNARY

Holocene

Qr, Qa, Qls

Surficial deposits
Qr, man made rock fill
Qa, alluvium, (gravel, sand & clay)
Qls, landslide debris

UNCONFORMITY

Pleistocene

Qoa

Older alluvium

UNCONFORMITY

Qsc

Santa Clara Formation
(non-marine, gravel, sand and clay)

UNCONFORMITY

TERTIARY

rh

Alum. Rock Rhyolite of Crittenden, 1951

Pliocene

Tor, Tb

Orinda Formation
non-marine conglomerate sandstone, red siltstone
Tb–basalt

Miocene

Tbr

Briones Sandstone
(marine sandstone and siltstone, upper Miocene)

Tm

Monterey Shale
Claremont Shale Member
(siliceous shale, mid. Miocene)

Tt

Temblor Sandstone
(marine middle Miocene)

UNCONFORMITY

CRETACEOUS

Ksh, Kss, Kcg

Marine sedimentary rocks
Ksh and Kss, Berryessa Form. of Crittenden, 1951
Ksh, micaceous shale
Kss, sandstone
Kcg, Oakland Conglomerate of Crittenden, 1951

JURASSIC AND/OR CRETACEOUS

sp, sc

Serpentine
sc, silica-carbonate rock

fs, fc, f, fg, gl

Franciscan rocks
fs, undiff. sandstone, (graywacke and micac. shale)
fc, chert
fg, greenstone
gl, glaucophane blue schist
f, mixed rocks, mostly micaceous shale or siltstone, pervasively sheared; contains fragments mostly of graywacke sandstone

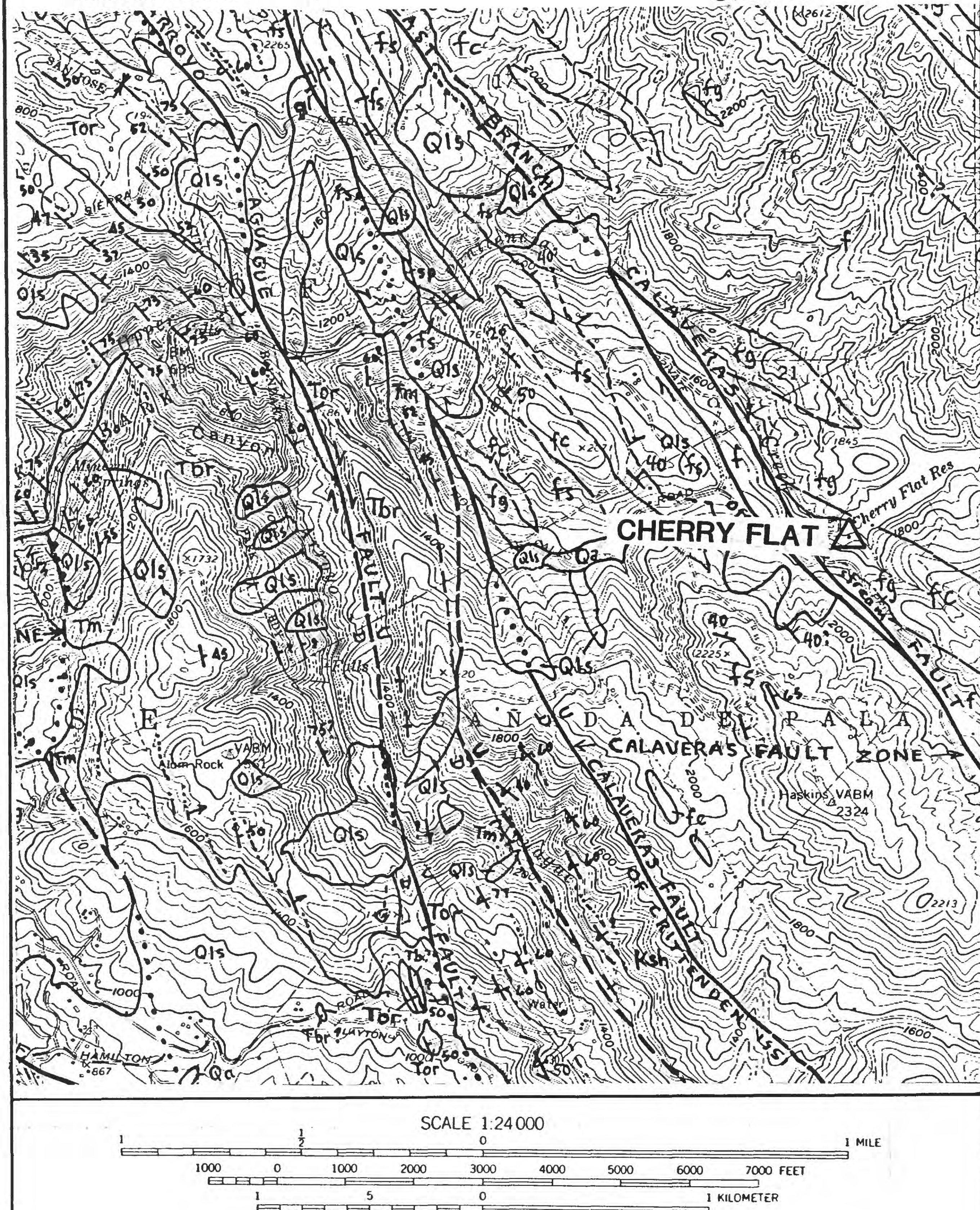
Contact
(dashed where gradational or approximately located)

U D

Fault
(dashed where inferred; dotted where concealed U-upthrown block, D-downthrown block, relatively; single arrow indicates observed dip of fault; double parallel arrows indi-

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

U.S. GEOLOGICAL SURVEY
OPEN FILE MAP



PRELIMINARY GEOLOGIC MAP OF THE CALAVERAS RESERVOIR QUADRANGLE, ALAMEDA AND SANTA CLARA COUNTIES, CALIFORNIA

By Thomas W. Dibblee Jr., 1973

Figure 8

Holocene

Qm

Bay mud

Soft water-saturated clay and silt; locally contains lenses of sand and shells, and layers of organic (peaty) matter on tidal flats. Thickness ranges from 0 to 60 feet

Qal

Alluvium

Gravel, sand, silt, and clay; unconsolidated and undissected. 0 to 10 feet thick

Ql

Landslide deposits

Active and(or) unstable; composition depends upon geologic setting. Active landslides may be present nearby in similar topographic and geologic settings

Qf (Ts)

Artificial fill

Gravel, sand, silt, and clay as well as manmade and organic debris. Source material, where known, shown in parentheses. Dikes bordering salt evaporating ponds almost wholly composed of materials dredged from adjacent tidal flats. Thickness indicated where known. Many small fills not shown; shielding fill (Ts) 25 feet thick over the Stanford Linear Accelerator not shown

Qoal

Older alluvium

Gravel, sand, silt, and clay in lenticular beds; moderately consolidated and deeply dissected. Stands in vertical cuts 20 feet high. Lenses of compressible clay are present throughout outcrop area. Deposits near Palo Alto are predominantly sandy gravel and gravelly sand and are an important source of groundwater; deposits near Redwood City are predominantly sand, silt, and clay. Includes interbedded marine and estuary deposits. 0 to 700 feet thick

Qol

Old landslide deposits

Apparently inactive and(or) stabilized; composition depends upon geologic setting. Inactive landslides may be present nearby in similar topographic and geologic settings. No evidence of recent movement observed

Qt

Terrace deposits

Flat-lying, poorly-sorted, unconsolidated stream terrace deposits of clay- to cobble-size material. Contains well-rounded small boulders of very well indurated exotic conglomerate of Cretaceous(?) age (cf. Cummings, 1968). Locally as much as 40 feet thick

QUATERNARY

EAST SIDE OF
SAN ANDREAS FAULT

Qs

Unnamed siltstone

Poorly consolidated clayey siltstone exposed locally in stream channels and construction sites. Maximum thickness greater than 10 feet

UNCONFORMITY

Qsc

Santa Clara Formation

Moderately well consolidated subaerial deposits of gravel, sand, silt, and clay in lenticular beds. Almost wholly composed of Franciscan rock debris. Marine conglomeratic sand, as much as 5 feet thick, locally present at base that may represent upper part of the Merced Formation or marine tongues in the subaerial deposits. Weathers to reddish-brown to black moderately expansive soil 1 to 2 feet thick. Maximum thickness about 600 feet. Equivalent to the Searsville and Arastradero facies of Cummings (1968)

Upper Pliocene

Tme

Merced Formation

Poorly consolidated marine sandstone, conglomeratic sandstone, and silty sandstone. Natural exposures rare. Abundantly fossiliferous locally. Maximum thickness probably less than 160 feet

Td

Dike

Altered rhyolitic(?) dike composed almost wholly of buddingtonite (ammonium feldspar) and quartz. Surrounded by halo of ammonium alteration

UNCONFORMITY

Middle and upper(?) Miocene

Tm

Monterey(?) Shale

Highly fractured, soft to hard semisiliceous shale, diatomaceous shale, and diatomaceous vitric tuff. Southeast of Felt Lake a diatomaceous vitric tuff bed, near top of section, contains ammonium-rich glass shards. Maximum thickness about 1200 feet

Ts / Tsb

Unnamed sandstone

Ts; clean, well-sorted, medium- to fine-grained friable marine sandstone. Includes some thin beds of yellow-brown dolomitic claystone and white to light-gray porcelaneous shale. Sandstone is about 1500 feet thick; dolomitic claystone and porcelaneous shale total less than 100 feet.

Tsb; hard, well-cemented barnacle shell sandstone. Includes some chert granule barnacle shell sandstone beds. Cement is calcium carbonate. Interfingers with overlying sandstone. Thickness ranges from 0 to 150 feet

Tpb / Tq

Page Mill Basalt

Tpb; interbedded columnar jointed flows, agglomerate, and tuffaceous beds, all moderately fractured and weathered. Pyritiferous in part; hydrothermally altered in southernmost Page Mill Road quarry, near presumed vent. Includes interbeds of silty to clayey sandstone in and near Page Mill Road quarries. Thickness ranges from 0 to about 200 feet.

Tq; fossiliferous chert granule quartzite as lenticular beds in and under volcanic rocks

UNCONFORMITY

Lower(?), middle, and upper Eocene

Tbu / Tbuc

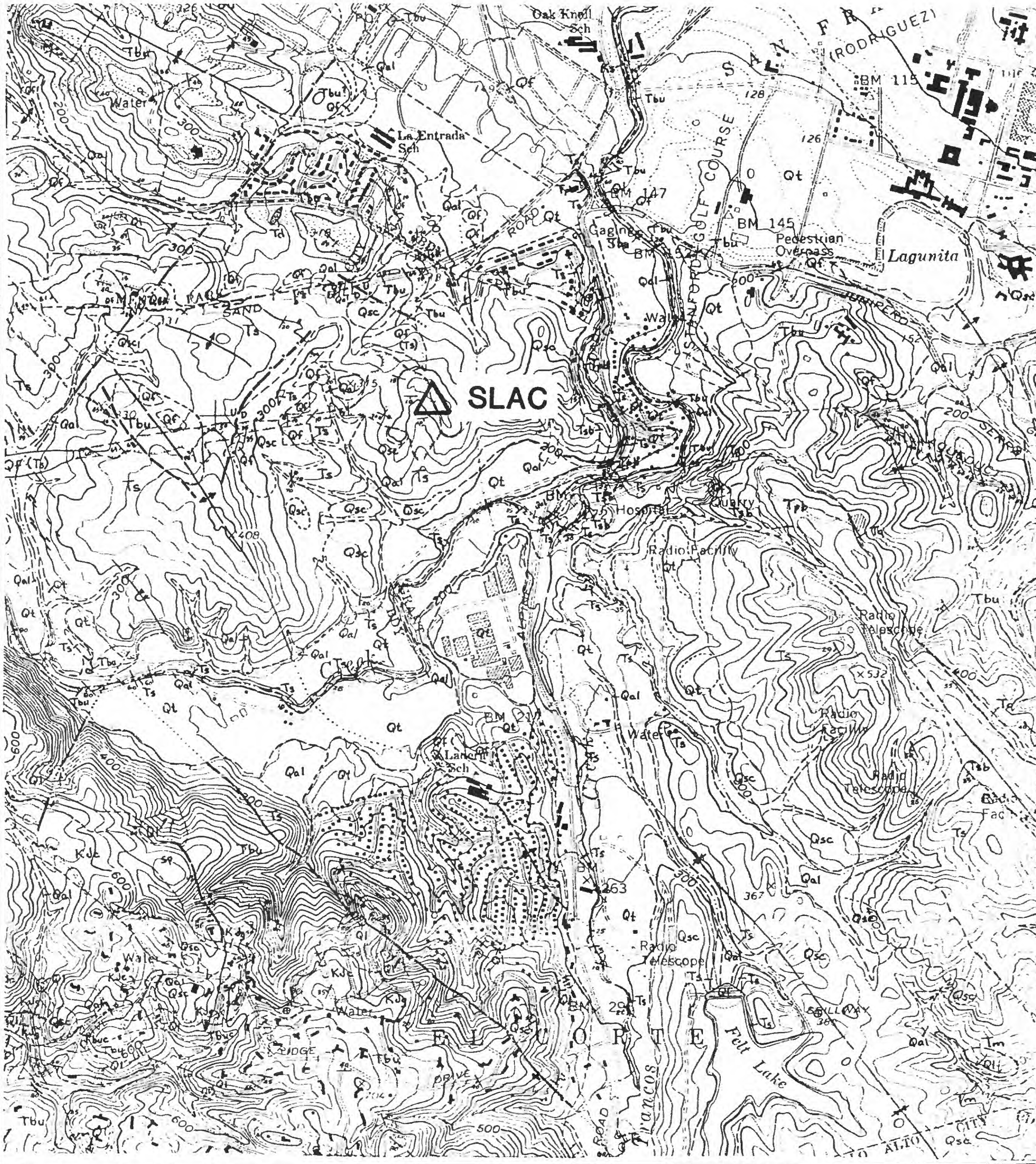
Butano(?) Sandstone

Tbu; poorly to very well cemented poorly sorted, coarse-grained, thick-bedded, feldspathic marine sandstone and interbedded silty claystone, glauconitic sandstone, calcareous claystone, and tuffaceous siltstone. Claystone-sandstone ratio about 3:1. Expansive (montmorillonite) clay common in claystones and sandstones of east-central outcrop area; probably common in yet undeveloped areas underlain by this unit. Chaotic mixture of sandstone blocks enclosed in sheared claystone near west end of the Stanford Linear Accelerator. Hard, tough, spherical and lenticular masses of sandstone cemented with calcium carbonate present locally in unoxidized zone. Greenstone-pebble conglomerate at apparent base of section on north side of Jasper Ridge. Total thickness exceeds 3200 feet; greenstone conglomerate is 10 to 30 feet thick.

Tbuc; coarse cobble conglomerate interbedded in base of section on south side of Jasper Ridge. Matrix is argillaceous-cemented feldspathic sandstone; Clasts are well rounded siliceous volcanic rocks and Franciscan rocks. Thickness ranges from 3 to 200 feet.

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

U.S. GEOLOGICAL SURVEY
OPEN FILE MAP



SCALE 1:24000

1 ½ 0 1 MILE

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1 .5 0 1 KILOMETER

GEOLOGIC MAP OF THE PALO ALTO 7 1/2' QUADRANGLE
SAN MATEO AND SANTA CLARA COUNTIES, CALIFORNIA
By
E H PAMPEYAN
1970

Figure 9

IN ORDER TO EMPHASIZE THE DISTRIBUTION OF BEDROCK, NO LANDSLIDE DEPOSITS ARE SHOWN ON THIS MAP. LANDSLIDES AND AN ANALYSIS OF SLOPE STABILITY WILL BE SHOWN ON SEPARATE MAPS.

QUATERNARY

Pleistocene and Holocene

Qu | Qal | Qsr | Qm | Qd | Qb | Qaf

Surficial deposits

Qu, surficial deposits, undivided
Qal, alluvium; gravel, sand, silt, and clay
Qsr, slope wash and ravine fill or colluvium; gravel, sand, silt, and clay
Qm, San Francisco Bay mud; soft clay and silt with some lenses of sand, shell, and plant material
Qd, windblown sand
Qb, beach deposits; sand and minor amounts of gravel
Qaf, artificial fill

Qt₁

Terrace deposits

Predominantly sand; some silt, clay, and gravel. Subscripts refer to different levels in local areas. Many small areas not shown

Pleistocene

Qc

Colma Formation

Predominantly sand; some silt, clay, and gravel

UNCONFORMITY

TERTIARY AND QUATERNARY

Pliocene and Pleistocene

QTs

Santa Clara Formation

Conglomerate, sandstone, siltstone, and claystone, some lignite locally

UNCONFORMITY

EAST OF SAN ANDREAS FAULT

QTm

Merced Formation

Sandstone, siltstone, and claystone, minor conglomerate and volcanic ash

UNCONFORMITY

TERTIARY

WEST OF SAN ANDREAS FAULT

Pliocene

Tp: Tptu | Tpl | Tpsg | Tpp | Tpt

Purisima Formation

Tp, Purisima Formation, undivided; siltstone, mudstone, sandstone, and conglomerate
Tptu, Tunitas Member of Cummings and others (1962); sandstone
Tpl, Lobitos Member of Cummings and others (1962); mudstone
Tpsg, San Gregorio Member of Cummings and others (1962); sandstone
Tpp, Pomponio Member of Cummings and others (1962); siltstone
Tpt, Tahana Member of Cummings and others (1962); sandstone and siltstone

Miocene

Tsc

Santa Cruz Mudstone of Clark (1966)

Tsm

Santa Margarita Sandstone

UNCONFORMITY

Tm

Monterey Shale

Tlo

Lompico Sandstone of Clark (1966)

Tus

Unnamed sandstone

Tpm

Page Mill Basalt

UNCONFORMITY

UNCONFORMITY

Oligocene

Eocene

Tla | Tvq | Tmb | Tsr | Tsl | Tst | Tls

Sandstone, shale, and volcanic rocks

Tla, Lambert Shale
Tvq, Vaqueros Sandstone
Tmb, Mindego Basalt and other volcanic rock
Tsl, San Lorenzo Formation, undivided; mudstone and shale
Tsr, Rices Mudstone Member of Lorenzo Formation of Brabb (1964)
Tst, Twobar Shale Member of San Lorenzo Formation of Brabb (1964)
Tls, Lambert and San Lorenzo Formations, undivided; mudstone and shale

Tb | Tbs

Butano Sandstone

Tb, Butano Sandstone, undivided; predominantly sandstone, minor shale and conglomerate
Tbs, shale

Tb?

Butano(?) Sandstone

Predominantly massive sandstone and claystone with some siltstone, and pebbly sandstone interbeds

UNCONFORMITY

Paleocene

Tss

Sandstone, shale, and conglomerate

UNCONFORMITY

WEST OF SAN GREGORIO FAULT

Upper Cretaceous

Kpp

Pigeon Point Formation

KJv

Unnamed volcanic rocks

Spatial relations uncertain but seem to underlie Pigeon Point Formation. Age may possibly be Cretaceous

BETWEEN SAN GREGORIO AND PILARCITOS-SAN ANDREAS FAULTS

Kgr

Granitic rocks

Mainly quartz diorite but includes some potash feldspar-rich varieties. Pegmatite and aplite dikes common

m

Marble

Includes hornfels and schist

PALEOZOIC (?)

EAST OF SAN ANDREAS-PILARCITOS FAULTS

JURASSIC AND CRETACEOUS

CRETACEOUS

Ksh

Shale near Palo Alto

JURASSIC OR CRETACEOUS

KJs

Sandstone at San Bruno Mountain

sp

Serpentine

Sheared and foliated serpentine and hard blocky serpentine in a sheared matrix. Includes small areas of other mafic rock and silica-carbonate rock

KJf | fs | fg | fc | fcg | fl | fm | fsr

Franciscan assemblage of Bailey, Jones, and Irwin (1964)

KJf, undivided Franciscan assemblage; mostly sandstone and shale, some greenstone, limestone, and chert
fs, predominantly sandstone (graywacke), minor shale
fg, greenstone (altered basalt, diabase and other volcanic rocks)
fc, chert
fcg, pebble or cobble conglomerate
fl, limestone
fm, metamorphic rocks of blueschist facies
fsr, sheared rocks; hard rounded masses or "knockers" of sedimentary, metamorphic, and volcanic rocks in a softer matrix of clay minerals

DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

MISCELLANEOUS FIELD STUDIES
MAP MF-328

SCALE 1:62 500

1 ½ 0 1 2 3 4 5 MILES

1 .5 0 1 2 3 4 5 6 7 KILOMETERS

PRELIMINARY GEOLOGIC MAP OF
SAN MATEO COUNTY, CALIFORNIA
Compiled by
Earl E Brabb and Earl H Pampeyan
1972

Figure 10

DESCRIPTION OF MAP UNITS

SURFICIAL SEDIMENTS

Qbs Beach sand; near Carmel Beach includes (near-shore) sands just offshore

Qg River sand and gravel

Qd Dune sand

Qa Alluvium

Qls LANDSLIDE DEBRIS Some or parts of some may be very young and possibly actively moving. Half arrows show direction of downslope movement

OLDER SURFICIAL SEDIMENTS (DISSECTED)

Qod Older dune sand

Qoa Older alluvium and terrace gravel and sand; at Monterey contains Pholas-bored pebbles at base and into underlying Monterey Shale

Qm Marine terrace sand and gravel

Qar AROMAS SAND (Pleistocene) Aromas Red Sands of Allen (1946) and Bowen (1965). Nonmarine; yellowish-brown to grayish-orange fine sand

QTp PASO ROBLES FORMATION (Pliocene(?) and Pleistocene) Old alluvium deposited in a valley. Light-gray gravel, sand, and clay

QTs *SEDIMENTARY DEPOSITS Seismic characteristics suggest poorly bedded sands and gravels; stratigraphic position unknown

Ts *SEDIMENTARY ROCKS Mudstone and coarse-grained, arkosic sandstone; marine; middle or late Tertiary

Tsm SANTA MARGARITA(?) SANDSTONE (Miocene) Marine and brackish-marine, white, friable, fine- to coarse-grained, arkosic sandstone; upper Miocene, possibly lower Pliocene

MONTEREY SHALE (Miocene) Siliceous marine deposits

Tmd Diatomite (Canyon del Rey Diatomite Member of Bowen, 1965), white, soft, punky, commonly silty; Delmontian Stage[1/] (type) of Kleinpell (1938), upper Miocene

Tm Siliceous shale (Aquajito Shale Member of Bowen, 1965), light-brown to white, hard, brittle, platy; Mohnian Stage, upper Miocene

Tml Semi-siliceous shale, thin-bedded, yellowish-brown, foraminiferal; includes interbedded yellowish-brown siltstone; Luisian Stage, middle Miocene

Tss MARINE SANDSTONE Buff to light-gray, friable arkosic sandstone; locally pebbly; in San Jose Canyon area contains interbedded conglomerate; middle Miocene; possibly in part upper and lower Miocene

Tus Sandstone as above, upper part (mapped as Los Laureles Sandstone Member of Monterey Formation by Bowen, 1965)

Tvb Volcanic rocks. Flows and flow-breccias of basalt and basaltic andesite (carmeloite of Lawson, 1893)

Tls Sandstone as above, lower part (mapped as Los Tularcitos Member of Chamisal Formation by Bowen, 1965)

Trc RED BEDS OF ROBINSON CANYON Robinson Canyon Member of Chamisal Formation of Bowen (1965). Terrestrial; red to gray arkosic sandstone, siltstone, and conglomerate; middle and possibly lower Miocene

Tc CARMELO FORMATION OF BOWEN (1965) (Paleocene) Carmelo Series of Lawson (1893); marine; interbedded sandstone, siltstone, mudstone, and cobble-pebble conglomerate

Tcg Cobble and boulder conglomerate, mostly of granitic detritus

GRANITIC ROCKS Light-gray crystalline rocks composed of about 2/3 feldspars, 1/3 quartz, and small amounts of biotite and hornblende; age, Cretaceous(?)

gdp granodiorite, porphyritic

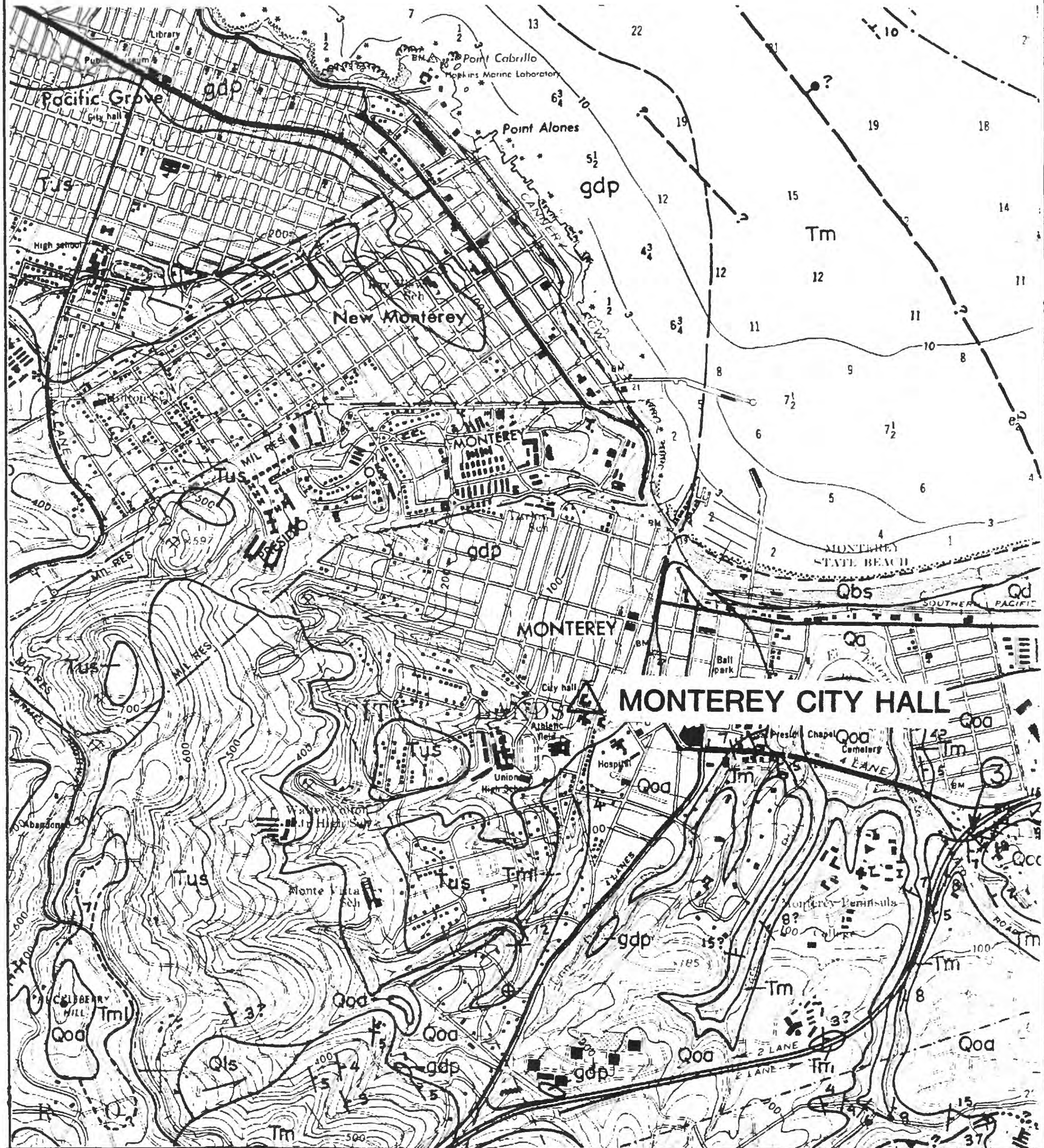
gd Granodiorite

***qd** Quartz diorite

ms METAMORPHIC ROCKS Biotite schist-gneiss and mixtures of granitic rocks

DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

MISCELLANEOUS FIELD STUDIES
MAP MF-577



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1 .5 0 1 KILOMETER

PRELIMINARY GEOLOGIC MAP OF THE MONTEREY AND SEASIDE 7.5-MINUTE QUADRANGLES, MONTEREY COUNTY, CALIFORNIA WITH EMPHASIS ON ACTIVE FAULTS

By

J.C. Clark, T.W. Dibblee Jr., H.G. Greene, and O.E. Bowen, Jr.

1974

Figure 11

AP 9

QUATERNARY

Pleistocene and Holocene

Qu | Qal | Qsr | Qm | Qd | Qb | Qaf

Surficial deposits

Qu, surficial deposits, undivided
Qal, alluvium; gravel, sand, silt, and clay
Qsr, slope wash and ravine fill or colluvium; gravel, sand, silt, and clay
Qm, San Francisco Bay mud; soft clay and silt with some lenses of sand, shell, and plant material
Qd, windblown sand
Qb, beach deposits; sand and minor amounts of gravel
Qaf, artificial fill

Qt₁

Terrace deposits

Predominantly sand; some silt, clay, and gravel. Subscripts refer to different levels in local areas. Many small areas not shown

IN ORDER TO EMPHASIZE THE DISTRIBUTION OF BEDROCK, NO LANDSLIDE DEPOSITS ARE SHOWN ON THIS MAP. LANDSLIDES AND AN ANALYSIS OF SLOPE STABILITY WILL BE SHOWN ON SEPARATE MAPS.

Pleistocene

Qc

Colma Formation

Predominantly sand; some silt, clay, and gravel

UNCONFORMITY

TERTIARY AND QUATERNARY

Pliocene and Pleistocene

QTs

Santa Clara Formation

Conglomerate, sandstone, siltstone, and claystone, some lignite locally

UNCONFORMITY

EAST OF SAN ANDREAS FAULT

QTm

Merced Formation

Sandstone, siltstone, and claystone, minor conglomerate and volcanic ash

UNCONFORMITY

TERTIARY

WEST OF SAN ANDREAS FAULT

Pliocene

Tp: Tptu, Tpl, Tpsg, Tpp, Tpt

Purisima Formation

Tp, Purisima Formation, undivided; siltstone, mudstone, sandstone, and conglomerate
Tptu, Tunitas Member of Cummings and others (1962); sandstone
Tpl, Lobitos Member of Cummings and others (1962); mudstone
Tpsg, San Gregorio Member of Cummings and others (1962); sandstone
Tpp, Pomponio Member of Cummings and others (1962); siltstone
Tpt, Tahana Member of Cummings and others (1962); sandstone and siltstone

Tsc

Santa Cruz Mudstone of Clark (1966)

Miocene

Tsm

Santa Margarita Sandstone

UNCONFORMITY

Tm

Monterey Shale

Tla

Lampico Sandstone of Clark (1966)

Tus

Unnamed sandstone

Tpm

Page Mill Basalt

UNCONFORMITY

UNCONFORMITY

Oligocene

Tla, Tvq, Tmb, Tsr, Tsl, Tst, Tls

Sandstone, shale, and volcanic rocks

Tla, Lambert Shale
Tvq, Vaqueros Sandstone
Tmb, Mindego Basalt and other volcanic rock
Tsl, San Lorenzo Formation, undivided; mudstone and shale
Tsr, Rices Mudstone Member of Lorenzo Formation of Brabb (1964)
Tst, Twobar Shale Member of San Lorenzo Formation of Brabb (1964)
Tls, Lambert and San Lorenzo Formations, undivided; mudstone and shale

Eocene

Tb, Tbs

AP 10

Butano Sandstone

Tb, Butano Sandstone, undivided; predominantly sandstone, minor shale and conglomerate
Tbs, shale

Tb?

AP 7

Butano(?) Sandstone

Predominantly massive sandstone and claystone with some siltstone, and pebbly sandstone interbeds

UNCONFORMITY

Paleocene

Tss

Sandstone, shale, and conglomerate

UNCONFORMITY

JURASSIC AND CRETACEOUS

Upper Cretaceous

WEST OF SAN GREGORIO FAULT

Kpp

Pigeon Point Formation

KJv

Unnamed volcanic rocks

Spatial relations uncertain but seem to underlie Pigeon Point Formation. Age may possibly be Cretaceous

BETWEEN SAN GREGORIO AND PILARCITOS-SAN ANDREAS FAULTS

Kgr

Granitic rocks

Mainly quartz diorite but includes some potash feldspar-rich varieties. Pegmatite and aplite dikes common

EAST OF SAN ANDREAS-PILARCITOS FAULTS

CRETACEOUS

Ksh

Shale near Palo Alto

JURASSIC OR CRETACEOUS

KJs

Sandstone at San Bruno Mountain

sp

Serpentine

Sheared and foliated serpentine and hard blocky serpentine in a sheared matrix. Includes small areas of other mafic rock and silica-carbonate rock

BEL

KJf | fs | fg | fc | fcg | fl | fm | fsr

Franciscan assemblage of Bailey, Jones, and Irwin (1964)

KJf, undivided Franciscan assemblage; mostly sandstone and shale, some greenstone, limestone, and chert
fs, predominantly sandstone (graywacke), minor shale
fg, greenstone (altered basalt, diabase and other volcanic rocks)
fc, chert
fcg, pebble or cobble conglomerate
fl, limestone
fm, metamorphic rocks of blueschist facies
fsr, sheared rocks; hard rounded masses or "knockers" of sedimentary, metamorphic, and volcanic rocks in a softer matrix of clay minerals

PALEOZOIC(?)

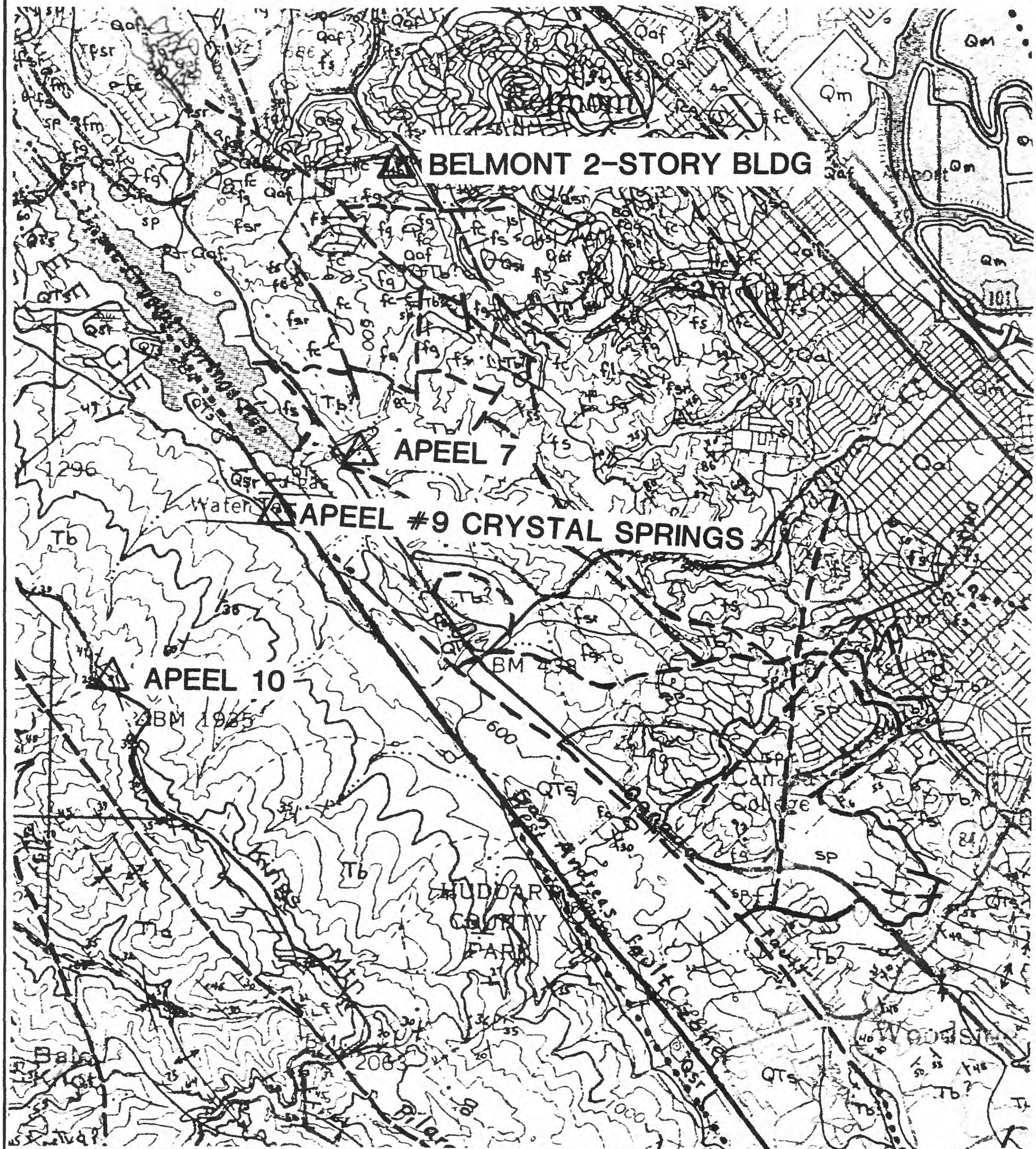
m

Marble

Includes hornfels and schist

DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

MISCELLANEOUS FIELD STUDIES
MAP MF-328



SCALE 1:62 500

1 ½ 0 1 2 3 4 5 MILES

1 .5 0 1 2 3 4 5 6 7 KILOMETERS

PRELIMINARY GEOLOGIC MAP OF
SAN MATEO COUNTY, CALIFORNIA
Compiled by
Earl E Brabb and Earl H Pampeyan
1972

Figure 12

QUATERNARY

Holocene

Qa | Qls

Surficial deposits

Qa; alluvium *
Qls; landslide debris

Unconformity

Pleistocene

Qoa

Older alluvium

Unconformity

TERTIARY

Pliocene

rh

HCH-N,CSUH ●

Rhyolite

Tan rhyolitic to dacitic felsite, highly fractured, (intrusive and extrusive)

Tps

Nonmarine sedimentary rocks

Weakly indurated, greenish-gray clay, few thin hard calcareous lenses, and gray to tan sandstone and pebble conglomerate containing debris from Franciscan rocks

Local Unconformity ?

Miocene

Tmss / Tmsl / Tmsh / Tso

Marine sedimentary rocks

Tmss; light gray arkosic sandstone; some beds hard, calcareous, pebbly, with abundant clam shells; minor gray siltstone

Tmsl; light gray to brown siltstone, massive to indistinctly bedded, argillaceous to sandy

Tmsh; siliceous shale, gray-white brittle, thin-bedded,

Tso; Sobrante Sandstone, tan, massive, fine-grained, arkosic, locally pebbly at base

Unconformity

CRETACEOUS

Upper Cretaceous

Kp / Kps / Kpc

Panoche Formation (marine)

Kp; clay shale, gray, micaceous, argillaceous to silty, minor thin sandstone beds,

Kps; sandstone, tan, hard, arkosic, locally contain large concretions, some interbedded clay shale

Kpc; conglomerate composed of cobbles of granitic and dioritic rocks porphyritic rocks, quartzite and black chert in matrix of brown sandstone

UPPER JURASSIC OR LOWER CRETACEOUS

JKk / JKc

Knoxville Formation

JKk; dark, micaceous shale, minor thin sandstone

JKc; conglomerate and dark sandstone, minor shale

JURASSIC AND/OR CRETACEOUS

sp | gb

Mafic and Ultramafic rocks

HCH-S ●

sp; serpentine
gb; gabbro-diabase, partly serpentinized

fg | fc | fs | gl

Franciscan assemblage

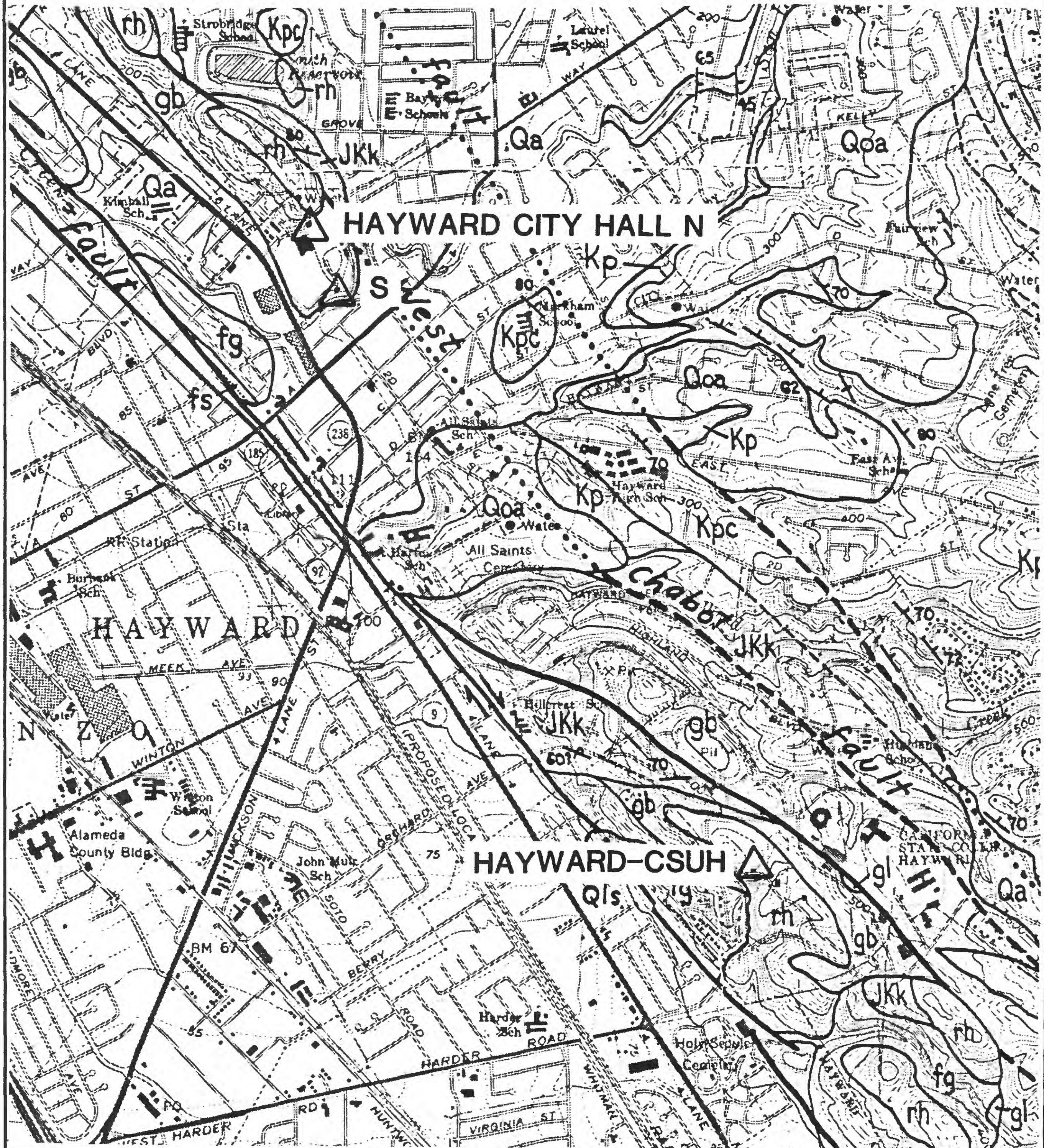
(Pervasively sheared and slightly metamorphosed; locally highly metamorphosed)

fg; greenstone
fc; chert
fs; sandstone (graywacke), and shale, sheared
gl; glaucophane schist

UNITED STATES GEOLOGICAL SURVEY

DEPARTMENT OF THE INTERIOR

OPEN FILE REPORT 80- 540



SCALE 1:24 000

1 ½ 0 1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 .5 0 1 KILOMETER

PRELIMINARY GEOLOGIC MAP OF THE HAYWARD QUADRANGLE, ALAMEDA AND CONTRA COSTA COUNTIES, CALIFORNIA

by

Thomas W. Dibblee, Jr.

1980

Figure 13

Qsg RECENT STREAM GRAVEL

Qfa RECENT FLOOD PLAIN ALLUVIUM

OLDER ALLUVIUM, divided into:

Qoa_1 Unit 1

Qoa_2 Unit 2

Qoa_3 Unit 3

Qoa_4 Unit 4

QTl LIVERMORE GRAVELS OF CLARK (1930) (Pliocene and Pleistocene)--Brown to and greenish-blue silty clay or claystone. Contains scattered vertebrate fossils

QTgt GREEN VALLEY AND TASSAJARA FORMATIONS, UNDIVIDED, OF CLARK (1943) (Pliocene and Pleistocene)--Red and maroon conglomerate, brown sandstone, blue, gray, brown, and red siltstone and claystone with minor gray limestone, lignite, and tuff

Tn NEROLY SANDSTONE (Miocene)--Blue sandstone, brown shale, and minor brown siltstone, andesitic tuff, and conglomerate

Tc CIERBO SANDSTONE (Miocene)--Gray, brown, and white sandstone with minor conglomerate, brown tuff, and carbonaceous brown shale. *Ostrea* and *Modiolus* shells common near base

Tb BRIONES SANDSTONE (Miocene)--Gray, calcareous sandstone with pebbly shelly conglomerate near middle and minor yellow limestone. Abundant *Ostrea* shells in conglomerates

Tor OURSAN(?) SANDSTONE (Miocene)--Brown sandstone with minor shelly and pebbly conglomerates

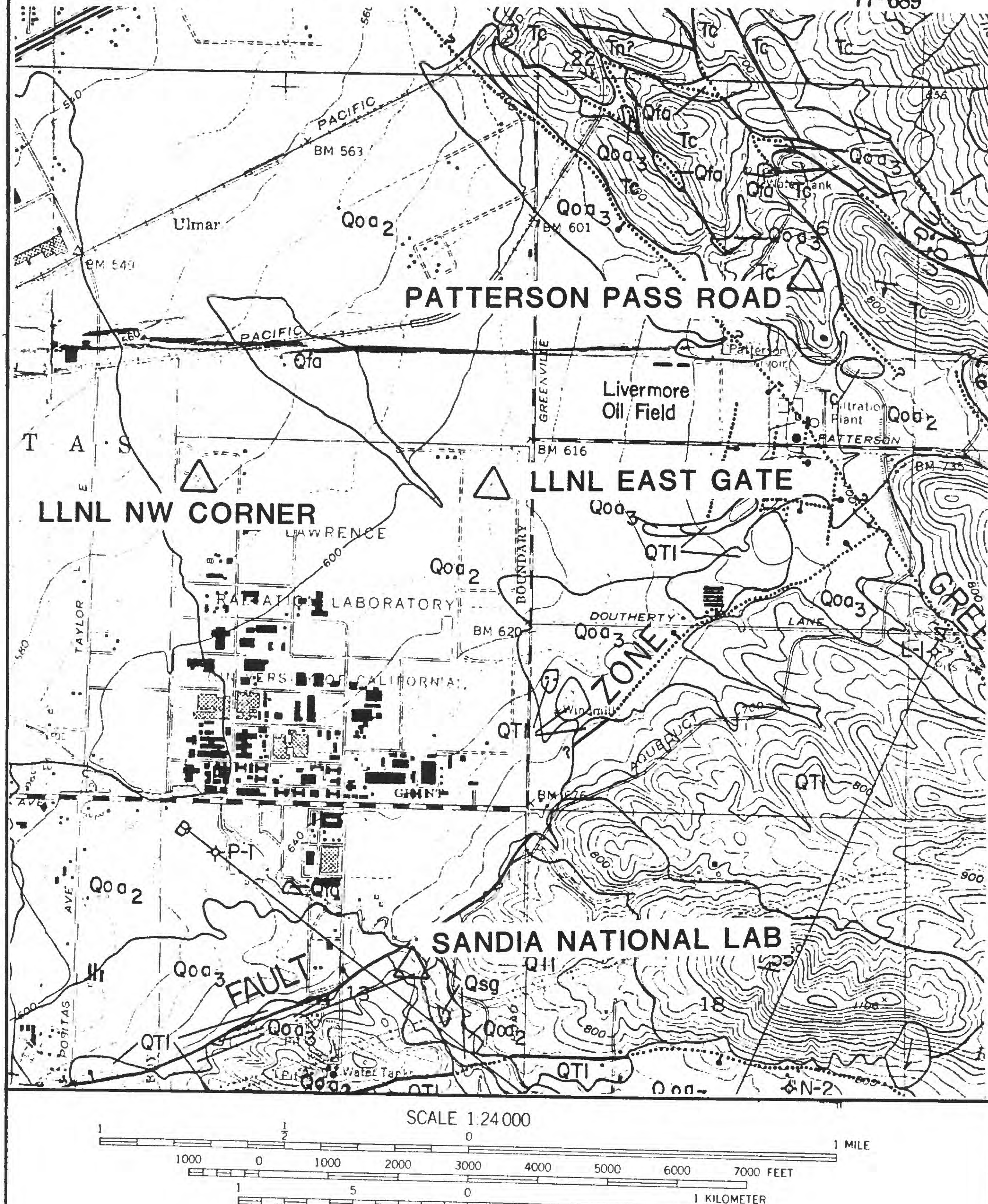
Tt TESLA FORMATION (Paleocene and Eocene)--White and buff sandstone and carbonaceous shale with minor lignite and white to light-blue clay

KJg GREAT VALLEY SEQUENCE (Jurassic and Cretaceous)--Brown, massive, places concretionary sandstone, brown thinly bedded siltstone and shale with scattered conglomerate lenses, grayish-brown carbonaceous shale, and dark-gray to black concretionary shale with minor fossiliferous sandstone

KJf FRANCISCAN ASSEMBLAGE (Jurassic and Cretaceous)--Gray-green sandstone and shale and red and green chert with minor greenstone, conglomerate, diabase, serpentinite, limestone, and blueschist

DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

OPEN FILE MAP
77-689



GEOLOGIC MAP OF THE LAS POSITAS, GREENVILLE, AND VERONA FAULTS, EASTERN ALAMEDA COUNTY, CALIFORNIA

BY

DARRELL G. HERD

1977

Figure 14

Map unit	Description	Epoch	Period
Qa, Qls	Surficial deposits Qa; alluvium Qls; landslide debris	Holocene	QUATERNARY
	Unconformity	?	
Qot, Qoa	Older alluvium Qot; younger terrace alluvium Qoa; older alluvium, dissected, locally deformed	Pleistocene	QUATERNARY
	Unconformity		
Tps, Tpc	Nonmarine sedimentary rocks Tps; weakly consolidated light gray pebble conglomerate, sandstone and greenish clay Tpc; mostly greenish clay	Pliocene	TERTIARY
		?	
Tn	Neroly Formation Brackish-marine(?) and nonmarine pebbly blue and gray sandstone	Miocene	TERTIARY
Tmss	Nonmarine sedimentary rocks Light gray, pebbly sandstone and clay	Miocene	TERTIARY
	Unconformity		
Km	Moreno Shale Marine clay shale	Upper Cretaceous	CRETACEOUS
Kps	Panoche Formation Marine, light gray, arkosic sandstone, with concretions, and some interbedded micaceous shale	Upper Cretaceous	CRETACEOUS

DEPARTMENT OF THE INTERIOR

UNITED STATES GEOLOGICAL SURVEY

OPEN-FILE REPORT 81-464

PRELIMINARY GEOLOGIC MAP OF THE TRACY QUADRANGLE, SAN JOAQUIN COUNTY, CALIFORNIA

by

Thomas W. Dibblee, Jr.

1981

Figure 15

EXPLANATION

QUATERNARY

Recent

Qafs / Qaf — Artificial fill
Clay, silt, sand, rock fragments, organic matter, and man-made debris.
Qafs, Indian shellmound

Ql — Landslide deposits
Composition and structure depend on geologic formation involved and type of landslide. Query indicates probable landslide deposit

Qal — Alluvium
Mostly sand and silt but locally contains clay, gravel, or boulders; generally gray to brown

Qb — Beach deposits
Predominantly well sorted medium-grained loose gray sand; locally consists of sandy gravel and cobbles

Qm — Bay mud
Soft gray clay and silt; locally contains shell fragments, plant remains, and thin beds of sand

Qd — Dune sand
Well sorted fine-grained gray sand, loose in most places

Pleistocene

Qt — Marine terrace deposits
Predominantly friable well sorted fine-grained yellowish-orange to gray sand; includes some alluvial gravel and colluvial clay

Qsr — Slope debris and ravine fill
Stony silty to sandy clay; locally silty to clayey sand or gravel; yellowish orange to medium gray, unstratified or poorly stratified

Qc — Colma Formation
In northeast and central parts of area, friable well sorted fine to medium sand containing a few beds of sandy silt, clay, and gravel; in southeast part of area, mostly sandy clay and silty sand; yellowish orange to gray

Qu — Sedimentary deposits, undifferentiated

TERTIARY AND QUATERNARY

Pliocene and Pleistocene

QTm — Merced Formation
Friable to firm sand, silt, and clay; minor amounts of gravel, lignite, and volcanic ash; medium gray to yellowish orange

JURASSIC AND CRETACEOUS

Franciscan Formation

KJs / KJst — Sandstone and shale
Interbedded sandstone and shale, hard where fresh and intact, soft where weathered or sheared. Commonly medium dark gray where fresh, olive gray to yellowish brown where moderately weathered, and yellowish orange to yellowish gray where highly weathered.
KJSh, sandstone generally containing more than two percent potassium-feldspar

KJc — Chert
Hard chert interbedded with firm shale; chert layers generally two or three inches thick, shale layers less than one inch thick, generally grayish red

KJg — Greenstone
Altered volcanic rocks, fine-grained, mostly basalt; hard where fresh, but weathered and firm to soft in most exposures; commonly grayish olive to moderate olive gray where moderately weathered, dark yellowish orange to light brown where highly weathered

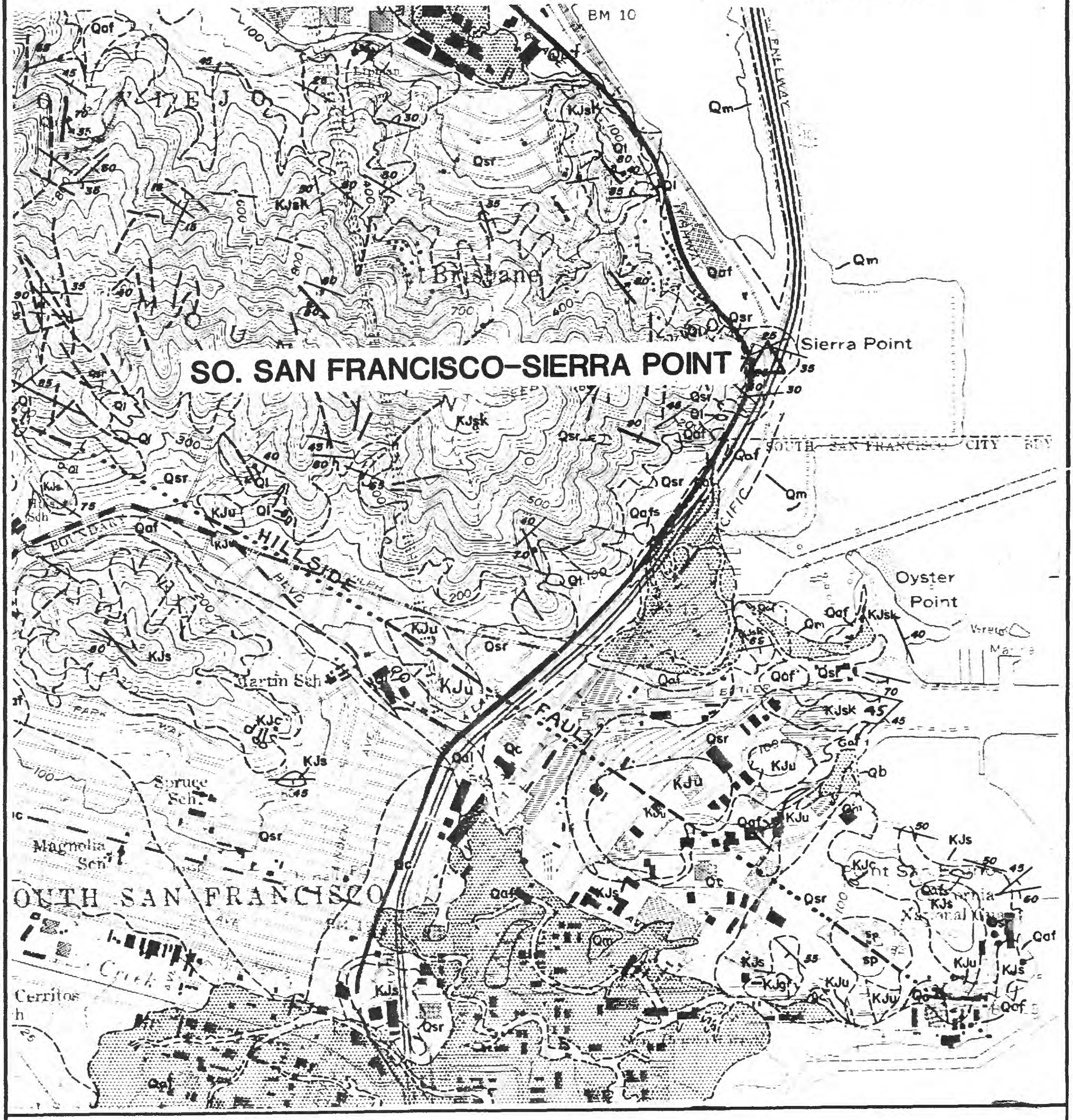
KJm — Metamorphic rocks
Hard to firm, fine- to coarse-grained schistose, gneissose, or granulose metamorphic rocks; dark gray, dark greenish gray, or dark bluish gray

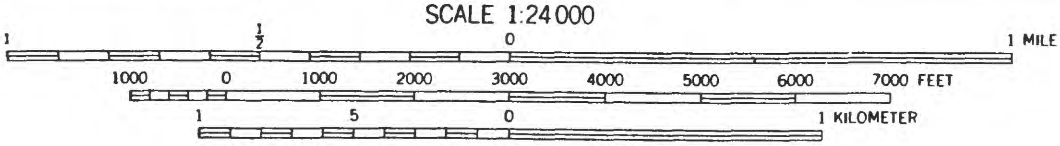
sp — Serpentine
Hard to soft, generally greenish gray; contains small bodies of gabbro and diabase. Intrusive into Franciscan Formation

KJu — Sheared rocks
Small to large fragments of hard rock in matrix of sheared rock. Matrix generally coherent and firm, but soft in places, especially where weathered. Dark gray where fresh, yellowish brown where weathered. Derived mostly from shale and sandstone of Franciscan Formation and serpentine

DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

MISCELLANEOUS FIELD STUDIES
MAP MF-311





PRELIMINARY GEOLOGIC MAP OF THE SAN FRANCISCO SOUTH QUADRANGLE AND PART OF THE HUNTERS POINT QUADRANGLE, CALIFORNIA

by

M. G. Bonilla

1971

Figure 16

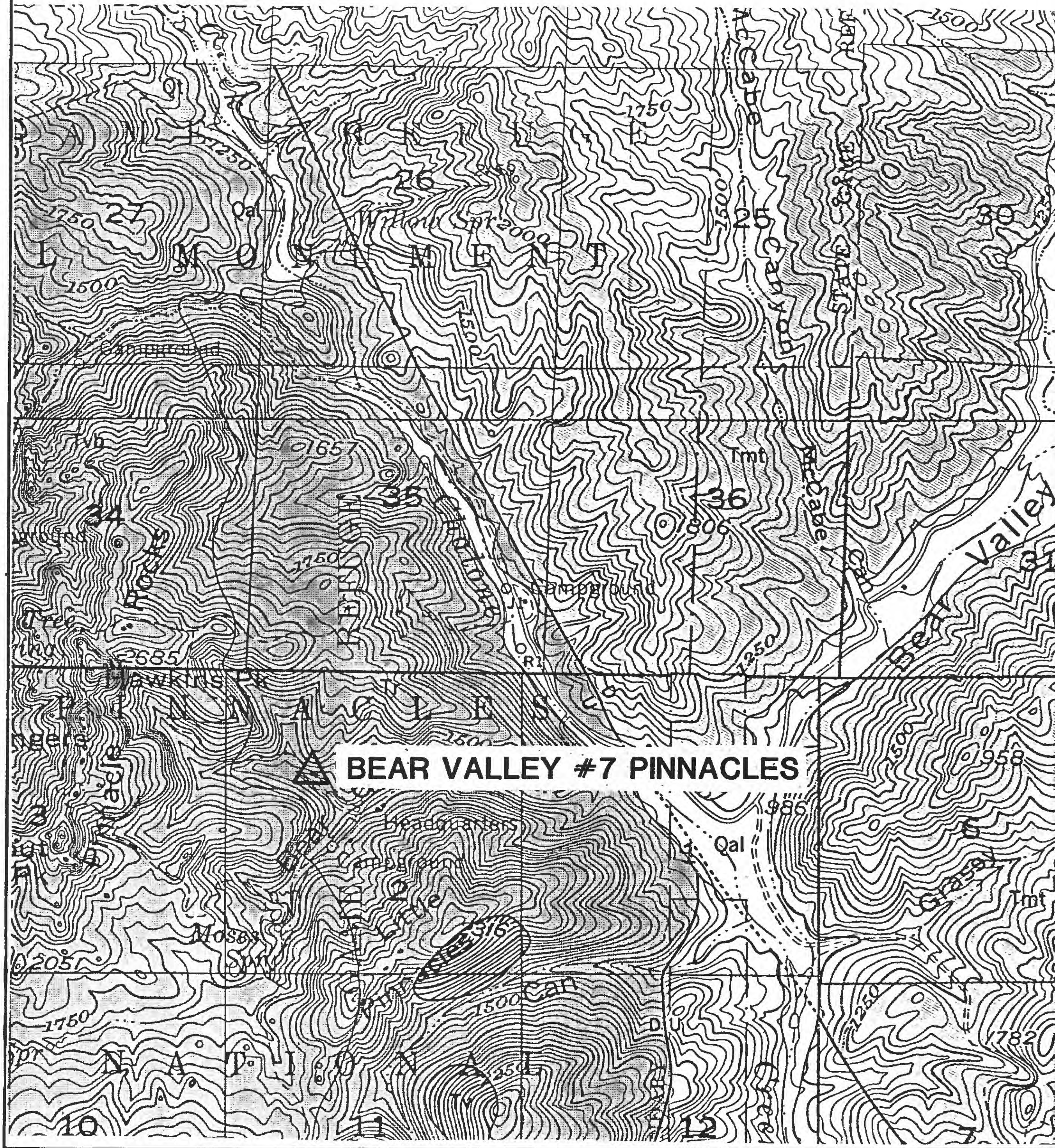
EXPLANATION

SEDIMENTARY ROCKS

Recent	Qal	Alluvium *Sand and gravel*	QUATERNARY
Pleistocene	Qt	Terrace deposits *Predominantly gravel*	QUATERNARY
Miocene	Tmt	Temblor formation *Fanglomerate grading upward into gravel and diatomaceous shale*	TERTIARY

IGNEOUS AND METAMORPHIC ROCKS

Miocene	Tvb	Volcanic breccias and tuffs *Predominantly rhyolitic*	TERTIARY
Miocene	● Tr	Rhyolite *Massive and laminated flows; also some andesite and basalt*	TERTIARY
Miocene	Tv	Vent tuffs and breccias *Rhyolitic; mark ancient volcanic vents*	TERTIARY
	g	Granodiorite, some granite, and gneiss *Locally intruded by rhyolite porphyry dikes and sills*	PRE-CRETACEOUS
	ls	Gabilan limestone *Marble, with some quartzite and schists*	PRE-JURASSIC



SCALE 1:31 680

1 ½ 0 1 MILE

CONTOUR INTERVAL 50 FEET
DATUM IS MEAN SEA LEVEL

GEOLOGIC MAP OF PINNACLES NATIONAL MONUMENT SHOWING LOCATIONS OF WELLS, CALIFORNIA

Geology modified by R. E. Evenson, 1959, after Philip Andrews, 1936

Figure 17

EXPLANATION

QUATERNARY

Recent

Qafs / Qaf — Artificial fill

Clay, silt, sand, rock fragments, organic matter, and man-made debris.
Qafs, Indian shellmound

Ql — Landslide deposits

Composition and structure depend on geologic formation involved and type of landslide. Query indicates probable landslide deposit

Qal — Alluvium

Mostly sand and silt but locally contains clay, gravel, or boulders; generally gray to brown

Qb — Beach deposits

Predominantly well sorted medium-grained loose gray sand; locally consists of sandy gravel and cobbles

Qm — Bay mud

Soft gray clay and silt; locally contains shell fragments, plant remains, and thin beds of sand

Qd — Dune sand

Well sorted fine-grained gray sand, loose in most places

Pleistocene

Qt — Marine terrace deposits

Predominantly friable well sorted fine-grained yellowish-orange to gray sand; includes some alluvial gravel and colluvial clay

Qsr — Slope debris and ravine fill

Stony silty to sandy clay; locally silty to clayey sand or gravel; yellowish orange to medium gray, unstratified or poorly stratified

Qc — Colma Formation

In northwest and central parts of area, friable well sorted fine to medium sand containing a few beds of sandy silt, clay, and gravel; in southeast part of area, mostly sandy clay and silty sand; yellowish orange to gray

Qu — Sedimentary deposits, undifferentiated

TERTIARY AND QUATERNARY

Pliocene and Pleistocene

QTm — Merced Formation

Friable to firm sand, silt, and clay; minor amounts of gravel, lignite, and volcanic ash; medium gray to yellowish orange

JURASSIC AND CRETACEOUS

Franciscan Formation

sp — Serpentine

Hard to soft, generally greenish gray; contains small bodies of gabbro and diabase. Intrusive into Franciscan Formation

KJs / KJsk — Sandstone and shale

Interbedded sandstone and shale, hard where fresh and intact, soft where weathered or sheared. Commonly medium dark gray where fresh, olive gray to yellowish brown where moderately weathered, and yellowish orange to yellowish gray where highly weathered.
KJSk, sandstone generally containing more than two percent potassium-feldspar

KJc — Chert

Hard chert interbedded with firm shale; chert layers generally two or three inches thick, shale layers less than one inch thick; generally grayish red

KJg — Greenstone

Altered volcanic rocks, fine-grained, mostly basalt; hard where fresh, but weathered and firm to soft in most exposures; commonly grayish olive to moderate olive gray where moderately weathered, dark yellowish orange to light brown where highly weathered

KJm — Metamorphic rocks

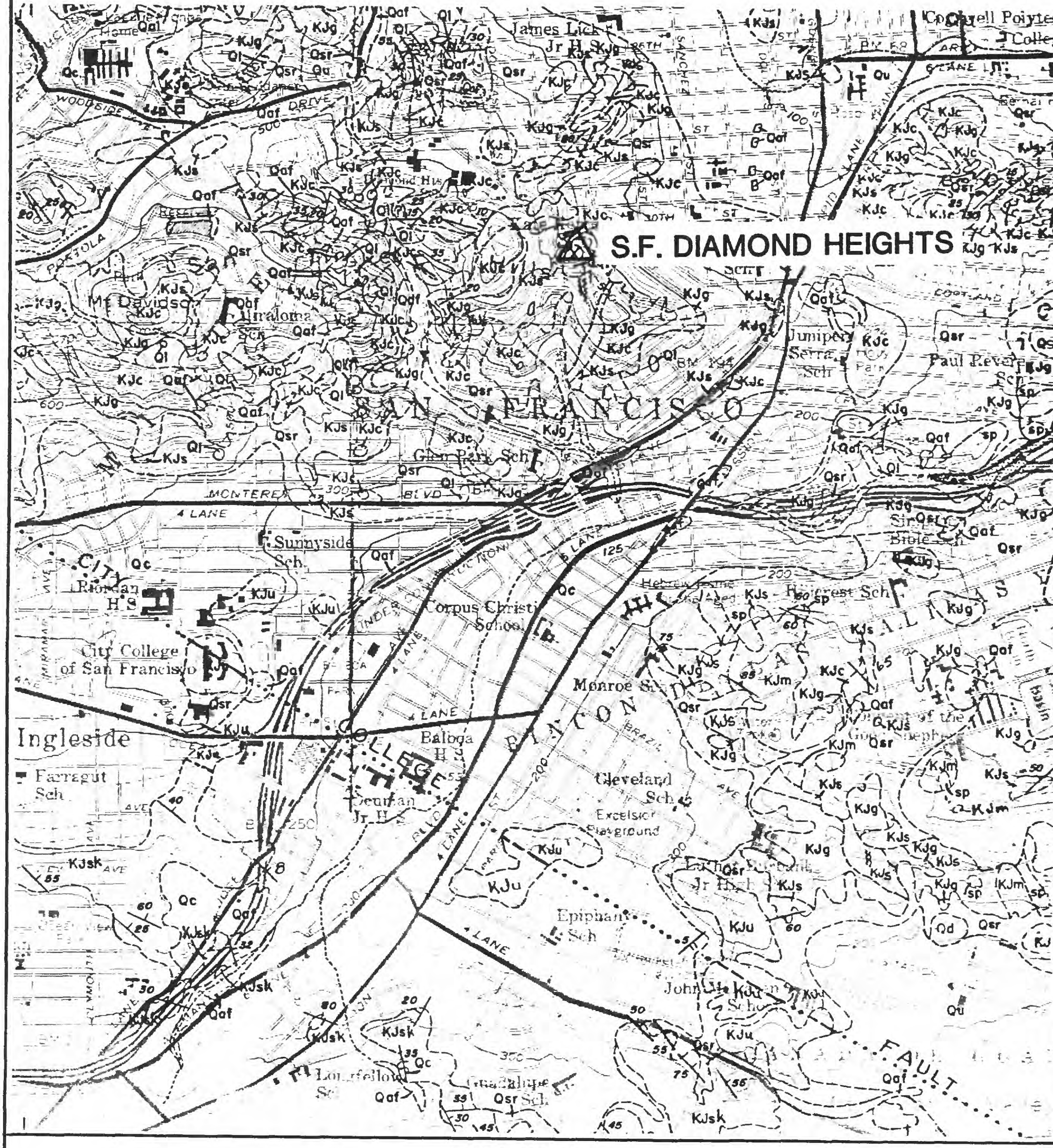
Hard to firm, fine- to coarse-grained schistose, gneissose, or granulose metamorphic rocks; dark gray, dark greenish gray, or dark bluish gray

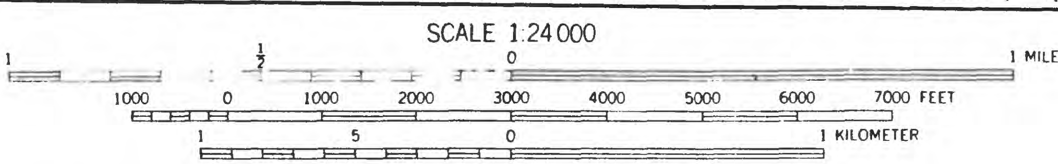
KJu — Sheared rocks

Small to large fragments of hard rock in matrix of sheared rock. Matrix generally coherent and firm, but soft in places, especially where weathered. Dark gray where fresh, yellowish brown where weathered. Derived mostly from shale and sandstone of Franciscan Formation and serpentine

MISCELLANEOUS FIELD STUDIES
MAP MF-311

DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY





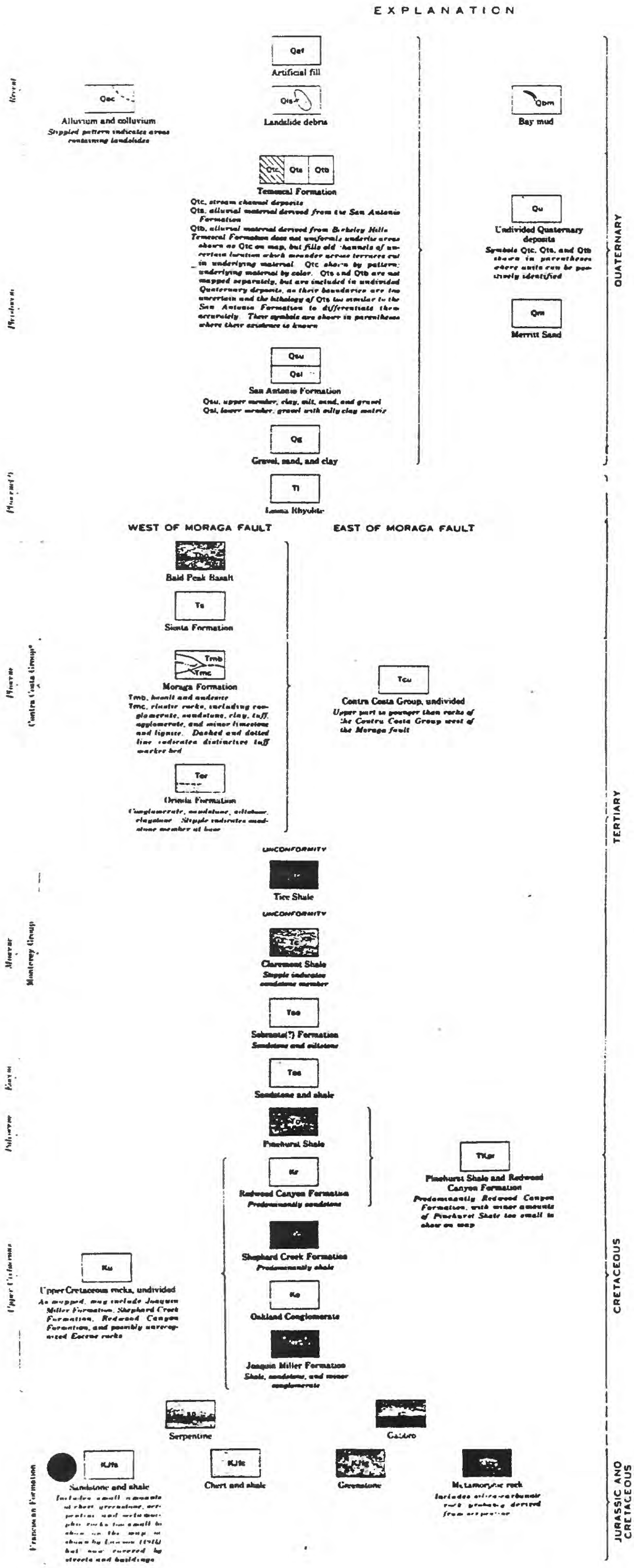
PRELIMINARY GEOLOGIC MAP OF THE SAN FRANCISCO SOUTH QUADRANGLE AND PART OF THE HUNTERS POINT QUADRANGLE, CALIFORNIA

by

M. G. Bonilla

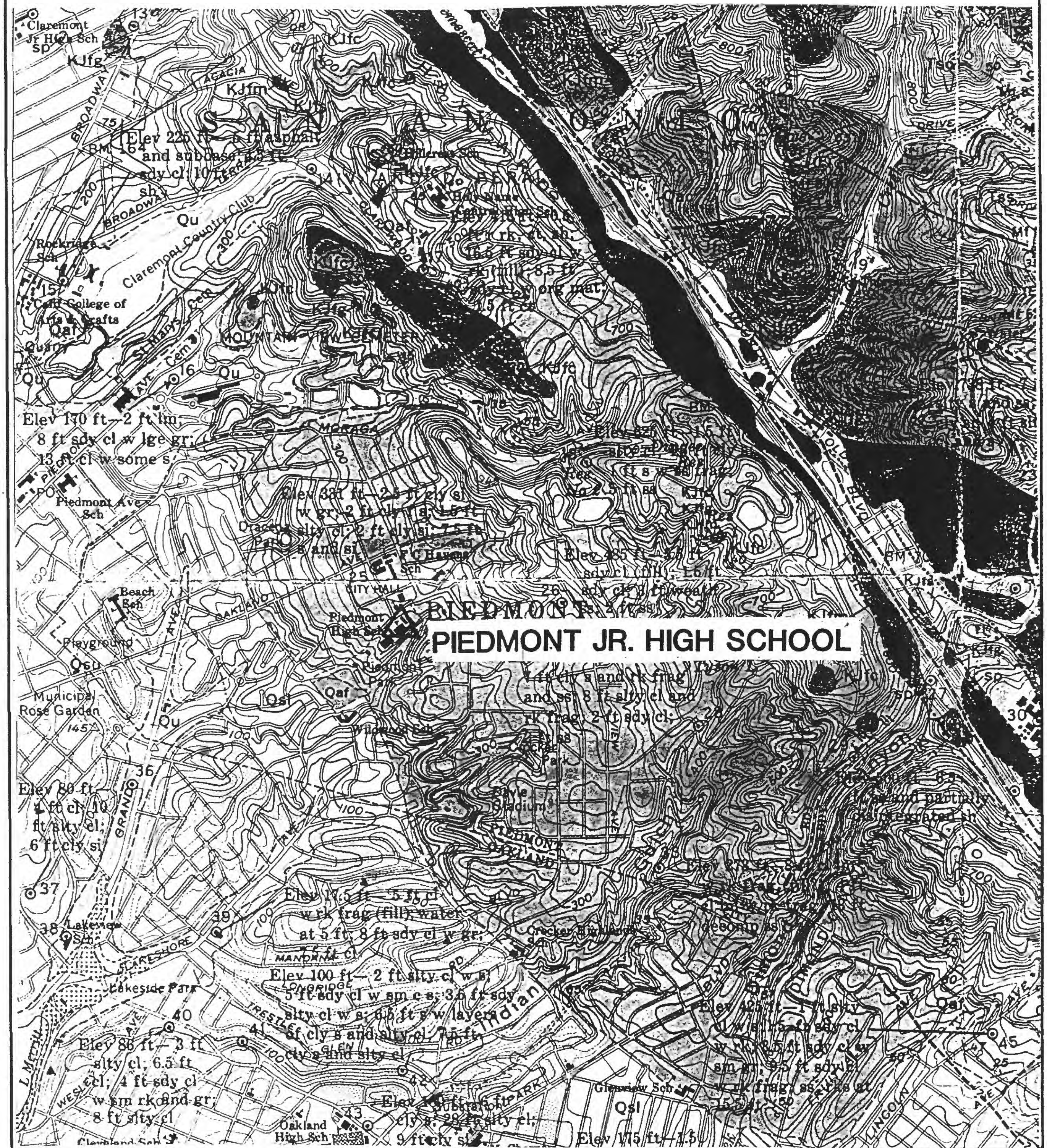
1971

Figure 18


EXPLANATION
Qaf
Artificial fill
Qac
Alluvium and colluvium
Stippled pattern indicates areas containing landslides
Qls
Landslide debris
Qbm
Bay mud
Qtc Qta Qtb
Temescal Formation
Qtc, stream channel deposits
Qta, alluvial material derived from the San Antonio Formation
Qtb, alluvial material derived from Berkeley Hills
Temescal Formation does not uniformly underlie areas shown as Qtc on map, but fills old channels of uncertain location which meander across terraces cut in underlying material. Qtc shown by pattern; underlying material by color. Qta and Qtb are not mapped separately, but are included in undivided Quaternary deposits, as their boundaries are too uncertain and the lithology of Qta too similar to the San Antonio Formation to differentiate them accurately. Their symbols are shown in parentheses where their existence is known
Qu
Undivided Quaternary deposits
Symbols Qtc, Qta, and Qtb shown in parentheses where units can be positively identified
Qm
Merritt Sand
Qsu
Qsl
San Antonio Formation
Qsu, upper member, clay, silt, sand, and gravel
Qsl, lower member, gravel with silty clay matrix
Qg
Gravel, sand, and clay
QUATERNARY
Tl
WEST OF MORAGA FAULT
EAST OF MORAGA FAULT
Bald Peak Basalt
Ts
Siesta Formation
Tmb
Tmc
Moraga Formation
Tmb, basalt and andesite
Tmc, clastic rocks, including conglomerate, sandstone, clay, tuff, agglomerate, and minor limestone and lignite. Dashed and dotted line indicates distinctive tuff marker bed
Tor
Orinda Formation
Tcu
Contra Costa Group, undivided
Upper part is younger than rocks of the Contra Costa Group west of the Moraga fault
UNCONFORMITY
Tice Shale
UNCONFORMITY
Tc
Claremont Shale
Stipple indicates sandstone member
Too
Sobrante(?) Formation
Sandstone and siltstone
Tes
Sandstone and shale
TERTIARY
Pinehurst Shale
Kr
Redwood Canyon Formation
Predominantly sandstone
TKpr
Pinehurst Shale and Redwood Canyon Formation
Predominantly Redwood Canyon Formation, with minor amounts of Pinehurst Shale too small to show on map
Shephard Creek Formation
Predominantly shale
Ku
Upper Cretaceous rocks, undivided
As mapped, may include Joaquin Miller Formation, Shephard Creek Formation, Redwood Canyon Formation, and possibly unrecognized Eocene rocks
Ko
Oakland Conglomerate
Joaquin Miller Formation
Shale, sandstone, and minor conglomerate
CRETACEOUS
Serpentine
Gabbro
Franciscan Formation
KJfs
Sandstone and shale
KJfc
Chert and shale
KJfg
Greenstone
Metamorphic rock
JURASSIC AND CRETACEOUS

DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

AREAL AND ENGINEERING GEOLOGY OF THE
OAKLAND EAST QUADRANGLE, CALIFORNIA
GQ-769



SCALE 1:24 000

1 ½ 0 1 MILE

1 .5 0 1 KILOMETER

AREAL AND ENGINEERING GEOLOGY OF THE OAKLAND EAST QUADRANGLE, CALIFORNIA

By

Dorothy H. Radbruch

1969

Figure 19

EXPLANATION

SURFICIAL DEPOSITS

QUATERNARY

Holocene

Qaf

Artificial fill

Predominantly dune sand but includes silt, clay, rock waste from excavations, manmade debris, and organic waste. Probable fill material indicated in parentheses. Maximum thickness approximately 80 feet

Qb

Modern beach deposits

Predominantly well sorted medium to coarse gray sand; coarse gravel and large cobbles in some places. Maximum thickness approximately 10 feet

Pleistocene(?)

Ql, Qly, Qlo

Landslide deposits

Generally unstratified mixtures of bedrock, sand, silt, and clay in varying proportions.
Qly, younger landslide deposits
Qlo, older landslide deposits

Pleistocene

Older beach deposits

Predominantly well sorted medium to coarse grey sand. Maximum thickness approximately 30 feet

Qal

Alluvium

Predominantly clayey silty sand and clayey silt, some pebbles; locally clean medium sand, generally gray to brown. Maximum thickness approximately 25 feet; observed thickness 15 feet

Slope debris and ravine fill

Angular rock fragments in sand, silt, and clay matrix; generally light yellow to reddish brown. Maximum thickness approximately 50 feet

Qd

Dune sand

Clean well-sorted fine to medium sand; yellowish brown to light gray. Maximum thickness approximately 150 feet

Colma Formation

Unconsolidated fine to medium sand with small to moderate amounts of silt and clay; in places includes clay beds, 6 inches to 5 ft thick; cobble-size rubble rare; commonly light brown to gray. Observed thickness 75 feet; probably maximum thickness approximately 300 feet

Bay mud and clay

Plastic gray silty clay; some lenses of sand, peat, and shell fragments; fluid to soft upper layers; moderately stiff clay at depth. Concealed except for exposures north of Corinthian Island and north of Sausalito Point. Maximum thickness approximately 140 feet

Qu

Surficial deposits, undivided

BEDROCK

CRETACEOUS

Upper Cretaceous

Ks

Sheared rocks, undifferentiated

Coherent blocks and pieces of hard rock as much as several hundred feet in diameter, in a matrix of intensely sheared shale and serpentine. Clasts predominantly sandstone, shale, and serpentine, but also include all other rock types known in Franciscan Formation. Matrix gray to greenish gray, moderately firm to soft and clayey; generally expansive and plastic when wet

JURASSIC(?) AND CRETACEOUS

Intrusive into Franciscan Formation

Serpentine

Mostly soft sheared rock containing hard knobs of unsheared serpentine, rodingite, and rocks of the Franciscan Formation. Derived from peridotites (mostly harzburgite, some dunite).
sph, hard serpentine, slightly sheared. Shown separately on Potrero Hill only. Variously colored, but generally greenish gray, blue, or brown. Includes sheared rocks (Ks) where that unit is mostly serpentine

gb

Gabbro

Fine- to coarse-grained gabbro; includes diabase where texture is subophitic. Occurs as inclusions or segregations in serpentine

Franciscan Formation

Jurassic(?) and Lower and Upper Cretaceous

KJss

Clastic sedimentary rocks

KJss, sandstone, thick-bedded and massive graywacke sandstone interbedded with thin layers of shale and fine-grained sandstone; some thick conglomerate lenses
KJsh, shale and thin-bedded sandstone, predominantly interbedded and laminated shale and fine-grained graywacke sandstone; beds generally 2 to 3 inches thick
KJs, sandstone and shale, undifferentiated; consists of units KJss or KJsh so poorly exposed that predominant lithology could not be determined
Sandstone and shale at Point Lobos and vicinity west of City College fault zone is probably Great Valley sequence of Bailey, Irwin, and Jones (1964, p. 123)

Radiolarian chert and shale

Reddish-brown; alternate beds of hard brittle chert, 1 to 5 inches thick, and firm brittle shale, ¼ to ½ inch thick. Locally includes bodies of massive chert

Greenstone

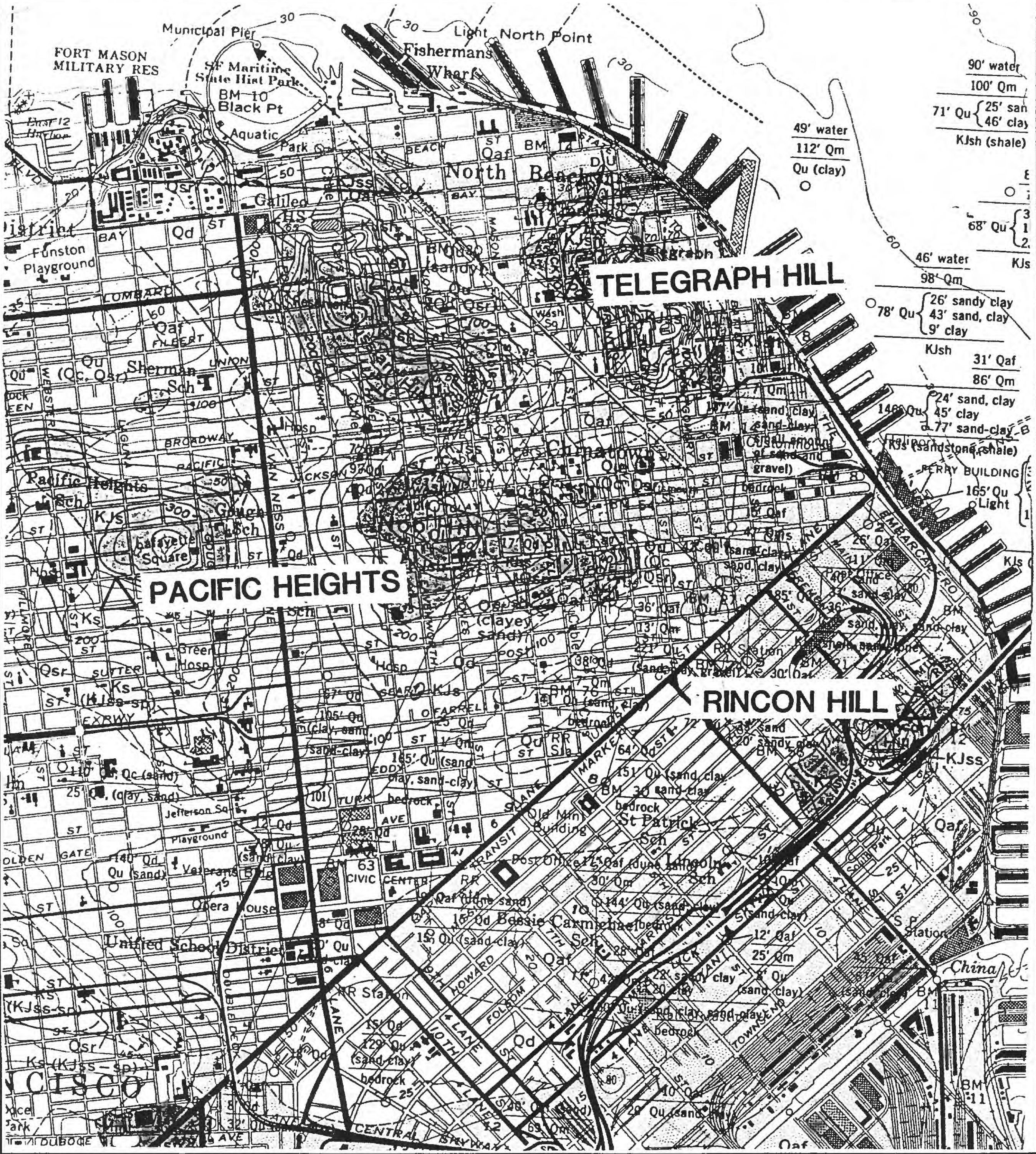
Greenish-gray aphanitic to medium-grained altered volcanic rocks; predominantly basalt. Includes flows, agglomerate, and tuff; pillow lavas common; less commonly massive; interbedded with radiolarian chert and sandstone

Metamorphic rocks

Fine- to coarse-grained slate, schist, and granofels of the blueschist facies

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

PROFESSIONAL PAPER 782
PLATE I



SCALE 1:24 000

1 ½ 0 1 MILE

1 .5 0 1 KILOMETER

GEOLOGIC MAP OF THE SAN FRANCISCO NORTH QUADRANGLE, SAN FRANCISCO AND MARIN COUNTIES, CALIFORNIA

Geology mapped in 1948–61 by Julius Schlocker, M. G. Bonilla, D. H. Radbruch, C. A. Kaye, and W. I. Konkoff

Figure 20

EXPLANATION

QUATERNARY

Recent

Qls

Landslide debris

Clayey, silty sand that has moved down steep slope on Yerba Buena Island.

Qaf

Artificial fill

Sand, clay, or miscellaneous refuse.

Qrc

Reworked colluvium

Silty, clayey sand derived from underlying sandstone of the Franciscan group; moved downslope by water and gravity; in places reworked by wind.

Qbm

Bay mud

Sandy, clayey silt with shells and other organic material. Underlies most artificial fill.

Pleistocene

Qm

Merritt sand

Beach or near-shore deposit of slightly clayey, silty sand.

Qtc

Temescal formation

Alluvial-fan deposit comprising interfingering lenses of clayey gravel, sandy silty clay, and sand-clay-silt mixtures.

Qa

Alameda formation

Upper exposed few feet composed of sandy, silty clay with few pebbles; lower part consists of continental and marine sand, clay, gravel. Maximum known thickness, 1,050 feet.

JURASSIC CRETACEOUS

Jk

Knoxville formation (Jurassic)

Shale with some beds of graywacke.

KJf

Franciscan group (Jurassic and Cretaceous)

Graywacke with small amounts of shale.

Contact

Indefinite contact

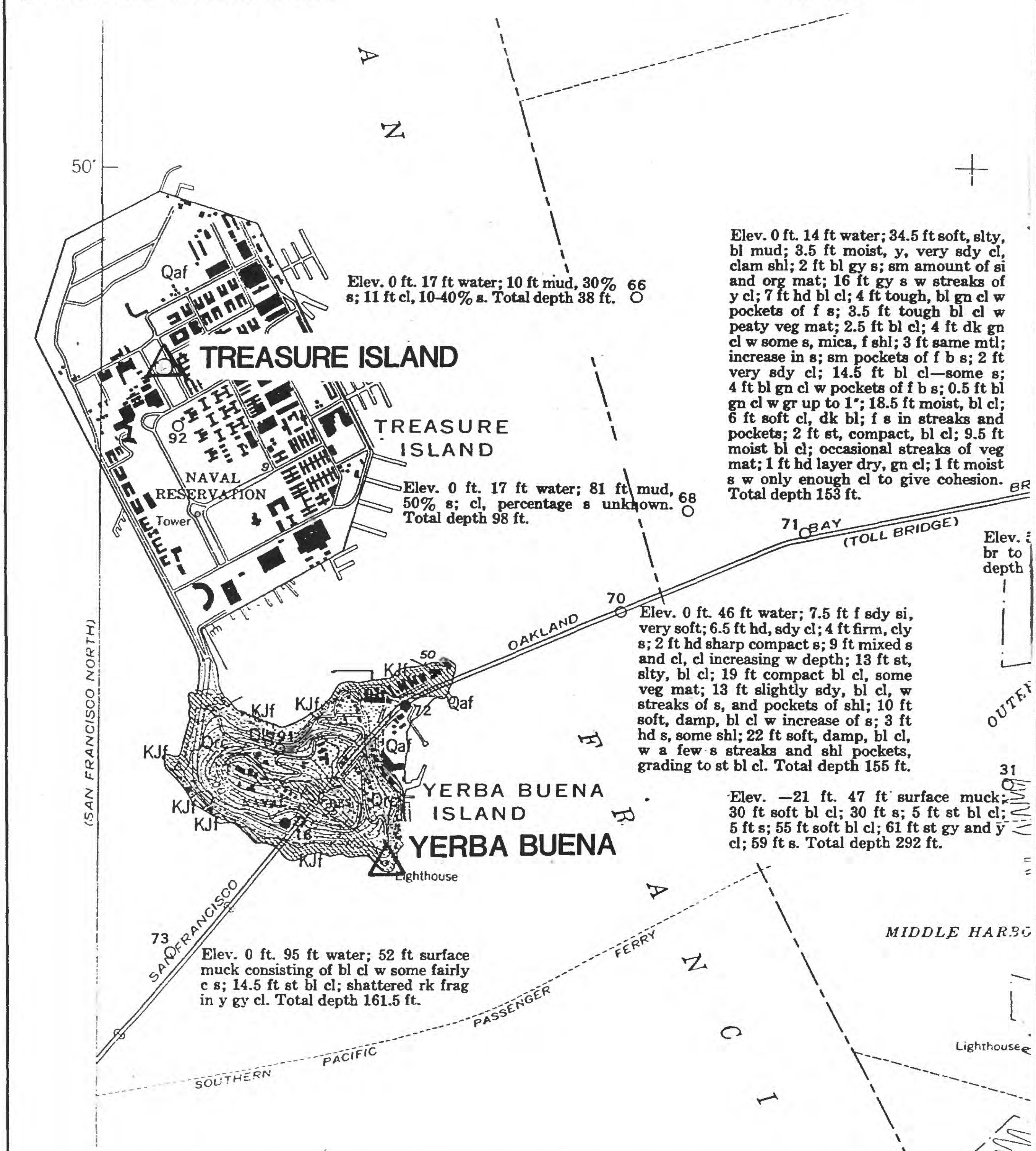
Includes gradational contacts, inferred contacts, and indefinite boundaries of surficial deposits.

Approximate boundaries of former shores, ponds, tidal flats, and streams now filled or concealed

After unpublished U. S. Coast and Geodetic Survey planetable sheets nos. XXIV and XXV, U. S. Coast Survey, San Francisco Bay, Calif., 1856.

DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

MISCELLANEOUS GEOLOGIC INVESTIGATIONS
MAP I-239



SCALE 1:24 000

1 ½ 0 1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 .5 0 1 KILOMETER

AREAL AND ENGINEERING GEOLOGY OF THE OAKLAND WEST QUADRANGLE, CALIFORNIA

By

Dorothy H. Radbruch

1957

Figure 21

EXPLANATION

SURFICIAL DEPOSITS

QUATERNARY

Holocene

(Qaf) **Artificial fill**

Predominantly dune sand but includes silt, clay, rock waste from excavations, manmade debris, and organic waste. Probable fill material indicated in parentheses. Maximum thickness approximately 60 feet

(Qb) **Modern beach deposits**

Predominantly well sorted medium to coarse gray sand; coarse gravel and large cobbles in some places. Maximum thickness approximately 40 feet

Holocene and Pleistocene(?)

(Ql, Qly, Qlo) **Landslide deposits**

Generally unstratified mixtures of bedrock, sand, silt, and clay in varying proportions.
Qly, younger landslide deposits
Qlo, older landslide deposits

(Qal) **Alluvium**

Predominantly clayey silty sand and clayey silt, some pebbles; locally clean medium sand, generally gray to brown. Maximum thickness approximately 98 feet; observed thickness 15 feet

(Qs) **Slope debris and ravine fill**

Angular rock fragments in sand, silt, and clay matrix; generally light yellow to reddish brown. Maximum thickness approximately 80 feet

(Qd) **Dune sand**

Clean well-sorted fine to medium sand; yellowish brown to light gray. Maximum thickness approximately 150 feet

(Qm) **Bay mud and clay**

Plastic gray silty clay; some lenses of sand, peat, and shell fragments; fluid to soft upper layers; moderately stiff clay at depth. Concealed except for exposures north of Corinthian Island and north of Sausalito Point. Maximum thickness approximately 140 feet

(Qu) **Surficial deposits, undivided**

Pleistocene

(Qob) **Older beach deposits**

Predominantly well sorted medium to coarse gray sand. Maximum thickness approximately 30 feet

(Qc) **Colma Formation**

Unconsolidated fine to medium sand with small to moderate amounts of silt and clay; in places includes clay beds, 9 inches to 5 ft thick; cobble-size rubble rare; commonly light brown to gray. Observed thickness 75 feet; probably maximum thickness approximately 300 feet

BEDROCK

CRETACEOUS

Upper Cretaceous

(Ks) **Sheared rocks, undifferentiated**

Coherent blocks and pieces of hard rock as much as several hundred feet in diameter, in a matrix of intensely sheared shale and serpentine. Clasts predominantly sandstone, shale, and serpentine, but also include all other rock types known in Franciscan Formation. Matrix gray to greenish gray, moderately firm to soft and clayey; generally expansive and plastic when wet

JURASSIC(?) AND CRETACEOUS

Intrusive into Franciscan Formation

(sp, sph) **Serpentine**

Mostly soft sheared rock containing hard knobs of unsheared serpentine, rodingite, and rocks of the Franciscan Formation. Derived from peridotites (mostly harzburgite, some dunite).
sph, hard serpentine, slightly sheared. Shown separately on Potrero Hill only. Variously colored, but generally greenish gray, blue, or brown. Includes sheared rocks (Ks) where that unit is mostly serpentine

(gb) **Gabbro**

Fine- to coarse-grained gabbro; includes diabase where texture is subophitic. Occurs as inclusions or segregations in serpentine

Jurassic(?) and Lower and Upper Cretaceous — Franciscan Formation

(KJss, KJsh, KJs) **Clastic sedimentary rocks**

KJss, sandstone; thick-bedded and massive graywacke sandstone interbedded with thin layers of shale and fine-grained sandstone; some thick conglomerate lenses
KJsh, shale and thin-bedded sandstone; predominantly interbedded and laminated shale and fine-grained graywacke sandstone; beds generally 2 to 3 inches thick
KJs, sandstone and shale, undifferentiated, consists of units KJss or KJsh so poorly exposed that predominant lithology could not be determined
Sandstone and shale at Point Lobos and vicinity west of City College fault zone is probably Great Valley sequence of Bailey, Irwin, and Jones (1964, p. 123)

(KJc) **Radiolarian chert and shale**

Reddish-brown; alternate beds of hard brittle chert, 1 to 5 inches thick, and firm brittle shale, ⅛ to ½ inch thick. Locally includes bodies of massive chert

(KJg) **Greenstone**

Greenish-gray aphanitic to medium-grained altered volcanic rocks; predominantly basalt. Includes flows, agglomerate, and tuff; pillow lavas common, less commonly massive; interbedded with radiolarian chert and sandstone

(KJm) **Metamorphic rocks**

Fine- to coarse-grained slate, schist, and granofels of the blueschist facies

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

PROFESSIONAL PAPER 782
PLATE 1

SCALE 1:24 000

1 ½ 0 1 MILE

1 .5 0 1 KILOMETER

GEOLOGIC MAP OF THE SAN FRANCISCO NORTH QUADRANGLE, SAN FRANCISCO AND MARIN COUNTIES, CALIFORNIA

Geology mapped in 1948–61 by Julius Schlocker, M. G. Bonilla, D. H. Radbruch, C. A. Kaye, and W. J. Kockoff

Figure 22

EXPLANATION

Recent

Qaf — Artificial fill

Qbm — Bay mud

Qac — Alluvium and colluvium

Qls — Landslide debris

Pleistocene and Recent

Qu — Undifferentiated Quaternary deposits
Qtc, Qts, and Qtb shown in parentheses where known; may also include Qaf, Qbm, Qac, Qls, Qsu, Qsl and Qg

Qtc (Qts, Qtb) — Qtc, Temescal Formation, dark alluvium; (Qts), alluvial material derived from the San Antonio Formation; (Qtb), material contemporaneous with Qtc and Qts deposited by streams flowing from Berkeley Hills

Qtc/Qsu indicates Temescal Formation overlying upper member of San Antonio Formation.

Qm — Merritt sand

Qsu / Qsl — San Antonio Formation
Qsu, upper member, clay, silt, and sand, and gravel; Qsl, lower member, gravel with silty clay matrix.

Pleistocene ?

Qg — Unnamed gravel, sand, and clay

Pliocene ?

Tl, Tn — Tl, Leona Rhyolite; Tn, Northbrae Rhyolite

Pliocene — Contra Costa Group

West of Moraga fault

Tbp — Bald Peak Formation
Predominantly basalt

Ts — Siesta Formation
Silty claystone and sandstone

Tm — Moraga Formation
Basalt, andesite, and intercalated clastic rocks

Tor — Orinda Formation
Conglomerate, sandstone, siltstone, claystone

East of Moraga fault

Tcc / Tcp — Contra Costa Group undifferentiated; sedimentary rocks younger than formations of the Contra Costa Group recognized west of the Moraga fault, and Pinole tuff, Tcp.

Miocene (TERTIARY)

Tsp — San Pablo Formation
Predominantly sandstone
UNCONFORMITY (Pease, 1953)

Tb / Thl — Briones Sandstone, Tb
Hercules Shale member, Thl

Monterey Group

Tr — Rodeo Shale

Th — Hambre Sandstone

Tt — Tice Shale

To — Oursan Sandstone

Tc — Claremont Shale

Tso — Sobrante Formation
Sandstone and siltstone

Oligocene–Miocene?

Tk — Kirker Tuff

Tsr — San Ramon Sandstone

Eocene

Tem — Markley Sandstone
In this area predominantly clay shale (see table)

Tes — Unnamed Eocene sandstone and shale

Paleocene

Tmz — Martinez Formation
Sandstone and siltstone

Tp — Siliceous Shale

Upper Cretaceous (CRETACEOUS)

Kr — Sandstone

TKu — Paleocene siliceous shale and Upper Cretaceous sandstone units, undifferentiated. Predominantly sandstone unit, with minor amounts of siliceous shale too small to show on the map.

Ku — Undifferentiated Upper Cretaceous rocks; may include unrecognized Eocene rocks.

Ks — Shale

Ko — Oakland Conglomerate

Kjm — Sandstone, shale, conglomerate

Upper Jurassic (JURASSIC)

Jk — Knoxville Formation
Shale, sandstone, and minor conglomerate

Jurassic and Cretaceous ? (JURASSIC ? AND CRETACEOUS ?)

sp — Serpentine

gb — Gabbro

Franciscan Group

KJfs — Sandstone and shale
(Includes small amounts of chert, greenstone, serpentine, and metamorphic rocks too small to show on the map, or shown by Lawson (1914) but now covered by streets and buildings.)

KJfc — Chert and shale

KJfg — Greenstone

KJfm — Metamorphic rocks undifferentiated
(Includes silica-carbonate rock probably derived from serpentine intrusive into rocks of the Franciscan group.)

U. S. DEPARTMENT OF INTERIOR

GEOLOGICAL SURVEY

OPEN FILE REPORT

PRELIMINARY GEOLOGIC MAP AND ENGINEERING GEOLOGIC INFORMATION, OAKLAND AND VICINITY, CALIF.

DORTHY RADBRUCH & J.E. CASE, 1967

Figure 23

QUATERNARY

Qaf — ARTIFICIAL FILL. Deposits of rock, soil, garbage and trash, or bay mud placed by man upon natural surfaces, mostly for engineering purposes. Highly variable from place to place as to composition, degree of compaction, etc. Not shown for most highway fills, for dikes on bay marshlands, or within many areas of dense urban development. Qaf/Qm indicates artificial fill placed on bay mud.

DEBRIS FLOW LANDSLIDES. Predominantly deposits of unconsolidated and unsorted soil and rock debris (colluvium) that have moved downslope en masse or in increments by flow or creep processes. Slip surfaces in the base materials of these landslides are roughly planar and approximately parallel to the slope surface. Includes some soil and rock debris avalanche deposits that have accumulated outward from the base of slopes by rapid flow. Estimated maximum thickness in feet is indicated where such estimates could be made with reasonable confidence from surface observations.

BLOCK SLUMP LANDSLIDES. Masses of relatively intact to highly disrupted bedrock that have moved downslope by rotational slip along deep concave slip planes, or rarely, by translational slip along planar surfaces. Commonly flanked by, and succeeded downslope by, debris flow deposits.

Qm — BAY MUD. Marshlands, former marshlands, and mudflats bordering San Francisco and San Pablo Bays. Mostly at or below mean sea level; these are thick deposits of unconsolidated, low-density, semi-fluid, highly compressible, highly impermeable silty clay. They are rich in disseminated peaty material, contain lenses of peat, and are likely to contain lenses of sand in many areas. Bay mud is plastic and swells when wet, but shrinks and becomes hard when dry. In places where dikes have excluded tide water for many decades, the surface consists of a partly dried, somewhat firm crust as much as a few feet thick, but such crusts are underlain by the soft, saturated mud described above.

Qa — ALLUVIUM. Unconsolidated deposits of clay, silt, sand, and gravel underlying the bottom lands of the main stream valleys, consisting of materials transported and deposited by the streams.

Qc — COLLUVIUM. Unconsolidated and unsorted soil material and weathered rock fragments accumulated on or at the base of slopes by natural gravitational or slope wash processes. Derived by weathering and decomposition of bedrock materials underlying the slopes. Covers most slopes, but mapped only where assumed to be more than about 5 feet thick. May include some unrecognized landslide deposits. Includes Colma Formation on Angel Island.

TERTIARY

Tv — VOLCANIC ROCKS, UNDIFFERENTIATED. Small exposures of andesite, dacite, and rhyolite, most of which are dikes, but some of which may be remnants of lava flows similar to those found near Novato on Burdell Mountain; all range in color from dark gray to purplish or pinkish.

CRETACEOUS

Ks — SANDSTONE AND SHALE, with very minor amounts of conglomerate. Occurrences of principal rock types and associations in this unit are indicated on the map by the following lithologic symbols.

ss — Sandstone, mainly thickly bedded, medium- to coarse-grained arkose composed predominantly of fairly well sorted, angular to subrounded grains of quartz and feldspar, with minor fine-grained matrix. Also includes arkosic-wacke, which differs from the arkose only in that it contains grains of rock fragments as well as quartz and feldspar. Both types of sandstone are light gray where fresh, but buff to almost white in typical weathered exposures. Individual beds are as much as 50 feet thick, so exposures commonly appear massive, with evidence of bedding obscure.

sh — Shale, generally well-bedded siltstone, dark gray where fresh, light gray, buff, or more or less stained brown by iron oxides along joints where weathered.

ssh — Sandstone and shale. Thin beds of light gray, fine-grained, quartz-rich sandstone that grade upward into and alternate rhythmically with, thin beds of gray to black shale, the thickness of individual graded sandstone-shale couplets typically ranging from 2 to about 6 inches.

cg — Conglomerate, composed of well-rounded pebbles in a sandy matrix.

It was not possible to follow and delineate contacts between these various lithologic varieties in the field. All of them typically yield light to medium brown, sandy or silty, moderately well-drained, non-swelling soils.

KJs — SANDSTONE AND SHALE. The sandstone (ss) is predominantly thickly bedded, medium- to coarse-grained graywacke composed of unsorted angular to subangular grains of quartz, feldspar, and dark rock fragments, with abundant fine-grained, clayey matrix. Typically gray or greenish gray where fresh, but brown where weathered. Some sandstones in this unit approach arkose in composition, with appropriately lighter colors. The shale (sh) is dark gray where fresh, brown where weathered. Relatively rare alternating thin beds of sandstone and shale (ssh), similar in composition and appearance to those within the unit Ks, are associated with this unit. In some places, these rocks are slightly to severely sheared or brecciated, and may grade gradually or abruptly into melange matrix. They all tend to yield brownish or buff, clay-rich, relatively poorly drained soils.

KJch — CHERT. Principally thinly bedded, hard, brittle, radiolarian chert; typical individual beds are one to a few inches thick and separated from each other by thin films or layers of shale. Mostly brown, but also greenish or light gray. Locally contains thick beds of brown chert or red or yellow jasper. Yields rocky, permeable soils.

JURASSIC

KJg — BASALTIC VOLCANIC ROCKS, all more or less altered. Predominantly greenstone, originally basalt erupted in a submarine environment, and exhibiting pillow structure in places where well exposed. Mostly dark gray green or dull green in fresh exposures, but dull greenish brown to reddish brown where weathered. Yields brown or reddish-brown, swelling, clay-rich soils.

mc mv KJsch — SEMI-SCHIST, PHYLLITE, AND SCHIST, with associated metachert and metavolcanic rocks. Predominantly slightly to well foliated or lineated metamorphosed sedimentary and volcanic rocks. The metasedimentary rocks, most of which were originally thinly bedded graywacke and shale are typically fine grained and are dark gray to bluish where freshly exposed in deep cuts, but pale gray to buff or brown in weathered exposures. In many places, these metasedimentary rocks appear superficially similar to unmetamorphosed graywacke. They are principally composed of quartz, with lesser amounts of mica, chlorite, glaucophane, jadeite, lawsonite, and pyrite that vary in proportion from place to place, and they commonly contain closely to widely spaced thin veins of white quartz. Metachert (mc), which occurs as sporadic small but prominent outcrops and elongated exposures, is white, pinkish, pale bluish, or reddish brown. In most places it exhibits the thin bedding characteristic of radiolarian chert, from which it was derived. The metavolcanic rocks (mv), are mostly dense, massive to schistose, fine-grained, metamorphosed basaltic rocks that are dull green, greenish gray, or bluish where fresh, but brown or greenish brown where weathered.

The metasedimentary rocks, except metachert, are deeply weathered in most places, and yield pale buff to brown, clay-rich soils that almost characteristically contain small angular fragments of white quartz derived from the thin veins in the bedrock. These soils contain swelling clay minerals, and are relatively unstable on slopes. The metavolcanic rocks weather to reddish brown, rocky, clay-rich soils.

fm — FRANCISCAN MELANGE. A tectonic mixture consisting of small to large masses of resistant rock types, principally of sandstone, greenstone, chert, and serpentine, but including various exotic metamorphic rock types, embedded in a matrix of pervasively sheared or pulverized rock material. The melange represents one or more immense, geologically ancient fault zones that resulted from the collision of two major plates of the earth's crust, the North American and the Pacific plates, during late Mesozoic and possibly early Cenozoic time. The various rock types along the interaction zone were differentially sheared or crushed, and mixed in such a way that the fragments or masses that resisted shearing, all of which are bounded by faulted surfaces, were brought into disoriented, commonly chaotic juxtaposition. It is these resistant masses or fragments that are seen in outcrop, the weak, finely sheared matrix in which they are embedded being easily weathered and eroded so that exposures of it are seldom apparent in natural terrain. Melange most commonly yields irregularly hummocky topography, the topographic irregularities often resulting both from differential erosion of the resistant masses embedded in the weak matrix and from abundant landsliding. Where they were seen at the surface, the resistant rock masses are indicated separately on the map, but many more of them are certain to be present than so indicated. These separate masses are outlined to scale, where possible, but boundaries of many are indeterminate from field observations alone. Masses too small to be delineated at this scale are indicated by the symbol X. Melange matrix tends to weather to brownish gray or black, clay-rich, swelling soils that are generally easily distinguished from those derived from other geologic units underlying upland portions of the mapped area. Unsheared rock masses enclosed within the matrix yield local zones of soils characteristic of these various source rocks, mostly soils similar in texture and appearance to those mentioned for similar rock types under Ks, KJg, and KJsch. Exposures of rock masses within the sheared melange matrix are identified separately by lithologic symbols as follows:

ss — Sandstone and shale. Mainly graywacke-type sandstone, with or without relatively minor amounts of shale; these are generally similar to the unit labelled KJs in very large masses. Includes dark-gray, tough metagraywacke and some masses of arkosic sandstone similar to that found in Ks.

ssh — Sandstone and shale. Alternating thin beds of sandstone and shale, similar to that so labelled within Ks.

cg — Conglomerate. Small isolated outcrops of hard, dark-colored rocks composed of well-rounded pebbles in a sandy matrix. The pebbles are chiefly of gray chert.

ch — Chert and allied siliceous rocks. Mainly isolated prominent outcrops of reddish-brown, greenish, or light-gray, thinly bedded radiolarian chert, but includes prominent exposures of massive, red, yellow, or mottled jasper.

gs — Greenstone. More or less altered or metamorphosed basaltic igneous rocks similar to KJg, except occurring in small, isolated masses.

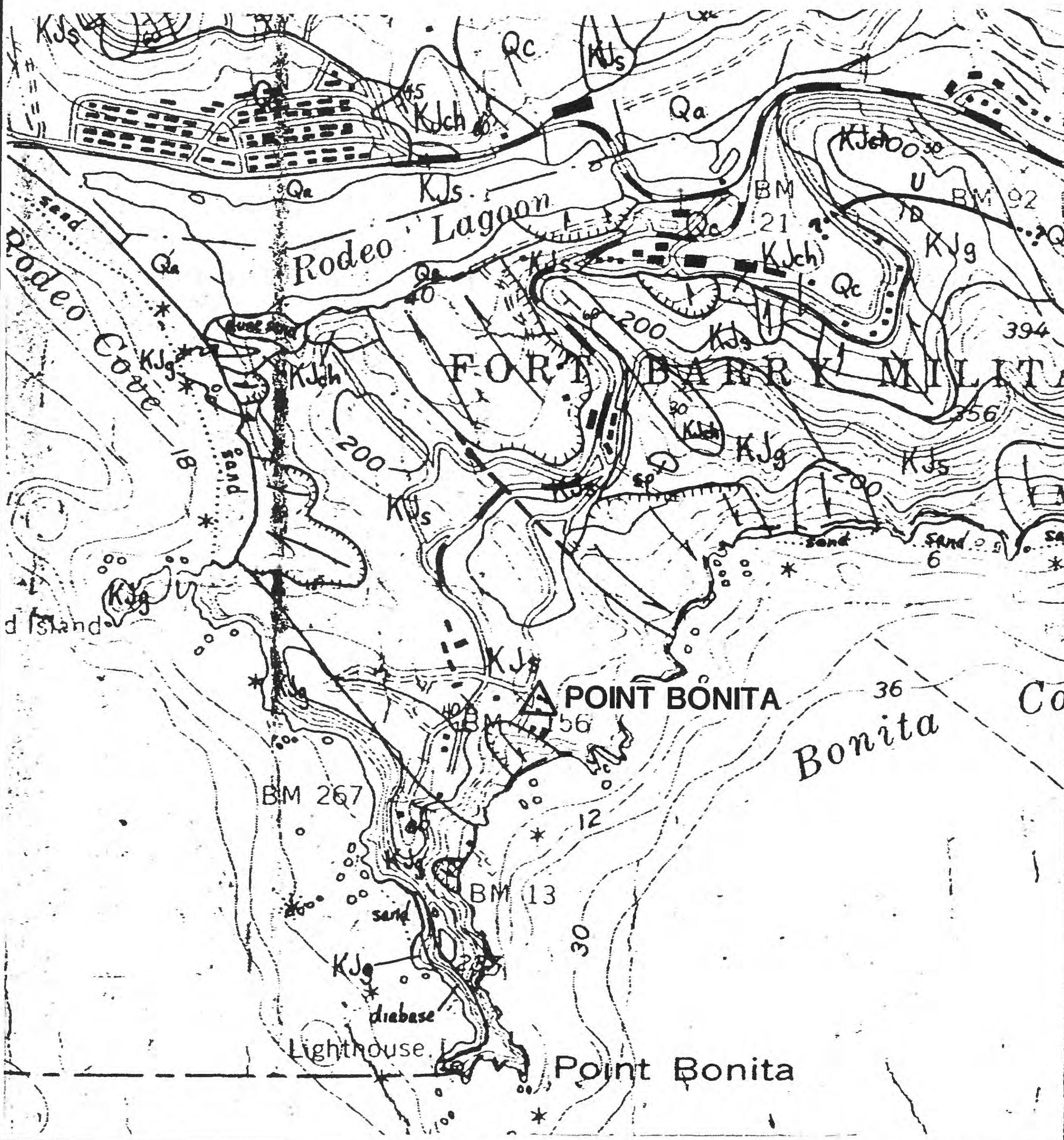
gl — Metamorphic rocks. Chiefly dense, coarsely crystalline, dark-bluish, glaucophane-bearing schists or gneisses and dark-green eclogite. These characteristically occur as small prominent outcrops, mostly less than a few tens of feet in maximum dimension. Includes masses of fine-grained semi-schist, phyllite, metachert, and metavolcanic rocks similar to KJsch, that are found within areas principally underlain by melange matrix.

am — Amphibolite. Dense, dark-colored rocks composed principally of black hornblende and white feldspar.

sp — Serpentine. Pale-green to dark-green, fine-grained, metamorphic rocks composed almost entirely of the magnesium silicate minerals lizardite and chrysotile, commonly with abundant, finely disseminated magnetite. Most or all derived by metamorphism of various kinds of peridotite, igneous rocks that originated in the mantle, below the earth's crust. In this area, the serpentine is closely sheared, so that most outcrops reveal abundant curved, polished surfaces. Occurs as tiny to very large lenses or irregular-shaped sheet-like masses that are mostly or entirely limited to melange or other fault zones. Because of its unique chemical characteristics, serpentine weathers very slowly, and it tends to crop out prominently, with thin, poor-quality soils sparsely distributed between more abundant rock exposures.

CALIFORNIA DIVISION OF MINES AND GEOLOGY
JAMES E. SLOSSON, STATE GEOLOGIST

GEOLOGY FOR PLANNING IN CENTRAL AND SOUTHEASTERN MARIN COUNTY, CALIFORNIA
OFR 76-2 S.F. PLATE 1D
SOUTH CENTRAL MARIN GEOLOGY



.5 0 1 KILOMETER

SCALE 1:12,000

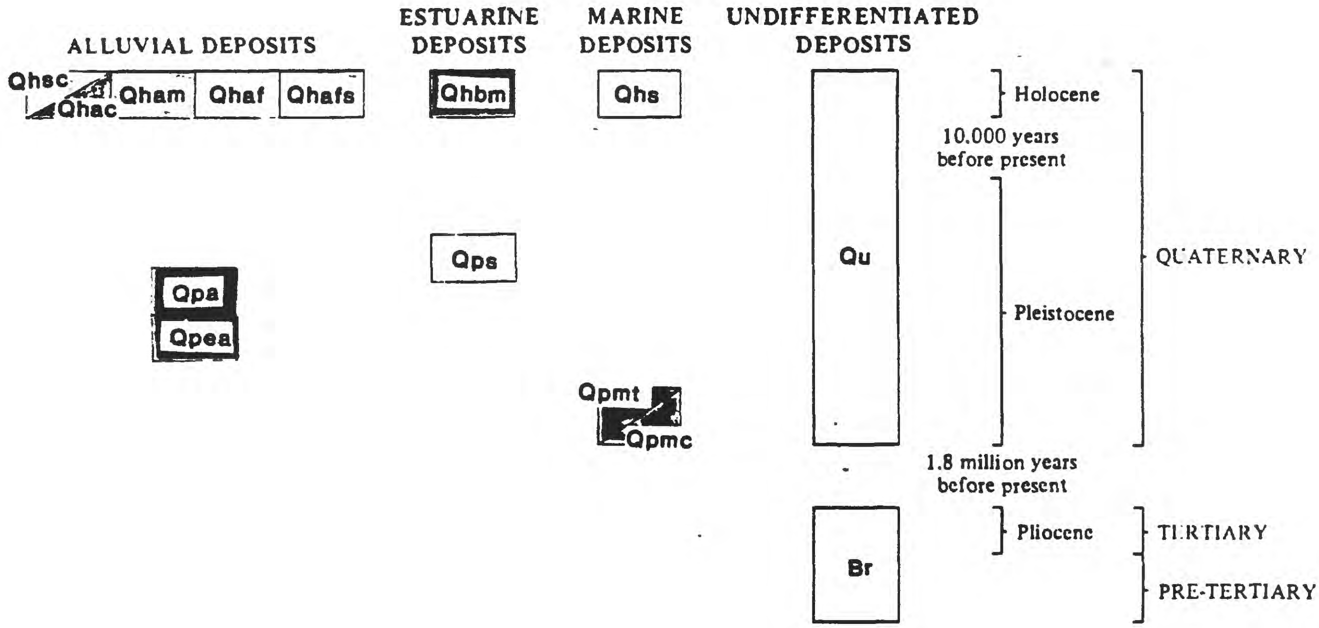
GEOLOGY OF THE LOWER ROSS VALLEY, CORTE MADERA
HOMESTEAD VALLEY, TAMALPAIS VALLEY, TENNESSEE VALLEY,
AND ADJACENT AREAS
MARIN COUNTY, CALIFORNIA

Compiled by Salem J. Rice and Theodore C. Smith

1976

Figure 24

CORRELATION OF MAP UNITS



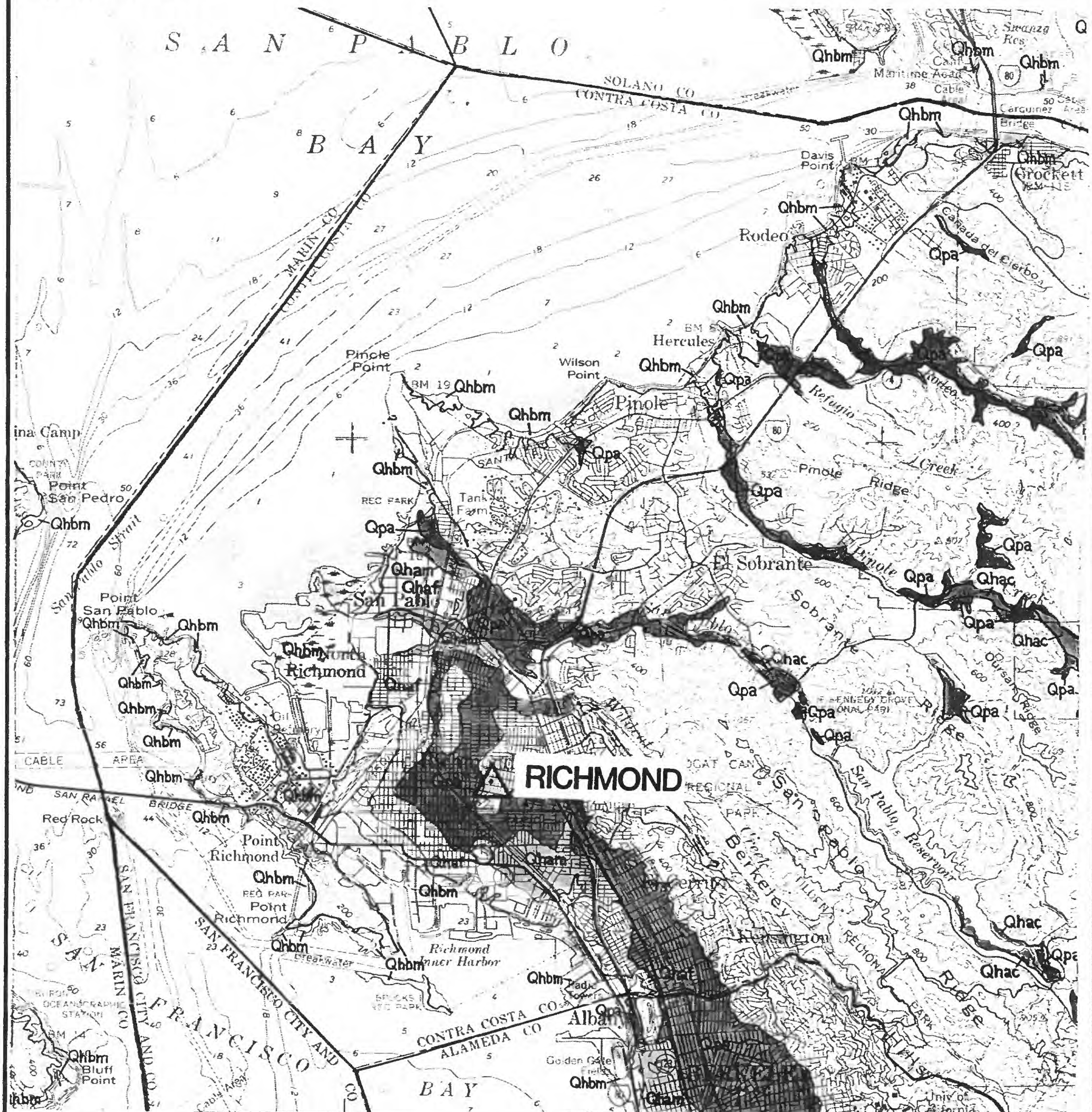
DESCRIPTION OF MAP UNITS

Qhsc	STREAM CHANNELS – Open alluvial channels with movable beds, mapped where scale permits
Qhac	COARSE-GRAINED ALLUVIUM – Unconsolidated, moderately sorted permeable sand and silt with coarse sand and gravel; more abundant toward fan heads
Qham	MEDIUM-GRAINED ALLUVIUM – Unconsolidated moderately sorted moderately sorted permeable fine sand, silt, and clayey silt with a few thin beds of coarse sand
Qhaf	FINE-GRAINED ALLUVIUM – Unconsolidated plastic moderately to poorly sorted carbonaceous silt and clay
Qhafs	FINE-GRAINED SALT - AFFECTED ALLUVIUM – Unconsolidated plastic moderately to poorly sorted carbonaceous silt and clay. Irregularly bedded with carbonate nodules
Qhbm	BAY MUD – Unconsolidated water-saturated dark plastic carbonaceous clay and silty clay
Qhs	BEACH AND DUNE SAND DEPOSITS – Loose well-sorted fine- to medium-grained sand
Qpa	LATE PLEISTOCENE ALLUVIUM – Weakly consolidated slightly weathered poorly sorted irregularly interbedded clay, silt, sand, and gravel
Qps	PLEISTOCENE BEACH AND DUNE SAND DEPOSITS (MERRIT SAND) – Loose well-sorted fine to medium sand
Qpea	EARLY PLEISTOCENE ALLUVIUM – Moderately consolidated deeply weathered poorly sorted irregularly interbedded clay, silt, sand, and gravel
Qpmt	MARINE TERRACE DEPOSITS – Weakly consolidated slightly weathered sand and gravel
Qpmc	COLMA FORMATION – Pale, loose or friable well-sorted fine- to medium-grained sandstone with subordinate gravel, sandstone, siltstone, and claystone
Qu	UNDIVIDED QUATERNARY DEPOSITS – Not recognizable as discrete map units because original form obliterated by urbanization
Br	UNDIVIDED BEDROCK – Older than Pleistocene

This site is on Plio–Pleistocene alluvium equivalent to the Santa Clara Formation (E.Helley,personal communication,1991)

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

PROFESSIONAL PAPER 943
PLATE 2



SCALE 1:125 000

2 1 0 2 4 6 8 10 MILES

2 1 0 2 4 6 8 10 KILOMETERS

GEOLOGIC MAP OF THE FLATLAND DEPOSITS OF THE NORTHEASTERN PART OF THE SAN FRANCISCO BAY REGION

Geology by D. B. Burke, E. J. Helley, K. R. LaJoie, J. C. Tinsley, and G. F. Weber, 1972 – 74

Figure 25

Qaf | Qbm | Qa

Surficial deposits

Qaf; man-made fill
Qbm; bay mud
Qa; alluvium

Holocene — QUATERNARY

?

Unconformity

Qoa

Older alluvium

Pleistocene

Unconformity ? ?

Tps
Tpt

Nonmarine sedimentary and volcanic rocks

Tps: Orinda Formation, claystone, sandstone, and pebble conglomerate
Tpt; Pinole Tuff, pumiceous tuff breccia

Pliocene

Unconformity

Tmsu
Tmss
Tmsh
Tmsl

Marine sedimentary rocks

Tmsu; sandstone, bluish-gray, massive, locally pebbly
Tmss; sandstone, buff, massive, arkosic, locally fossiliferous
Tmsl; siltstone and claystone, light gray, massive, locally sandy
Tmsh; shale or mudstone, gray-white, silty, siliceous or diatomaceous, massive to shaly

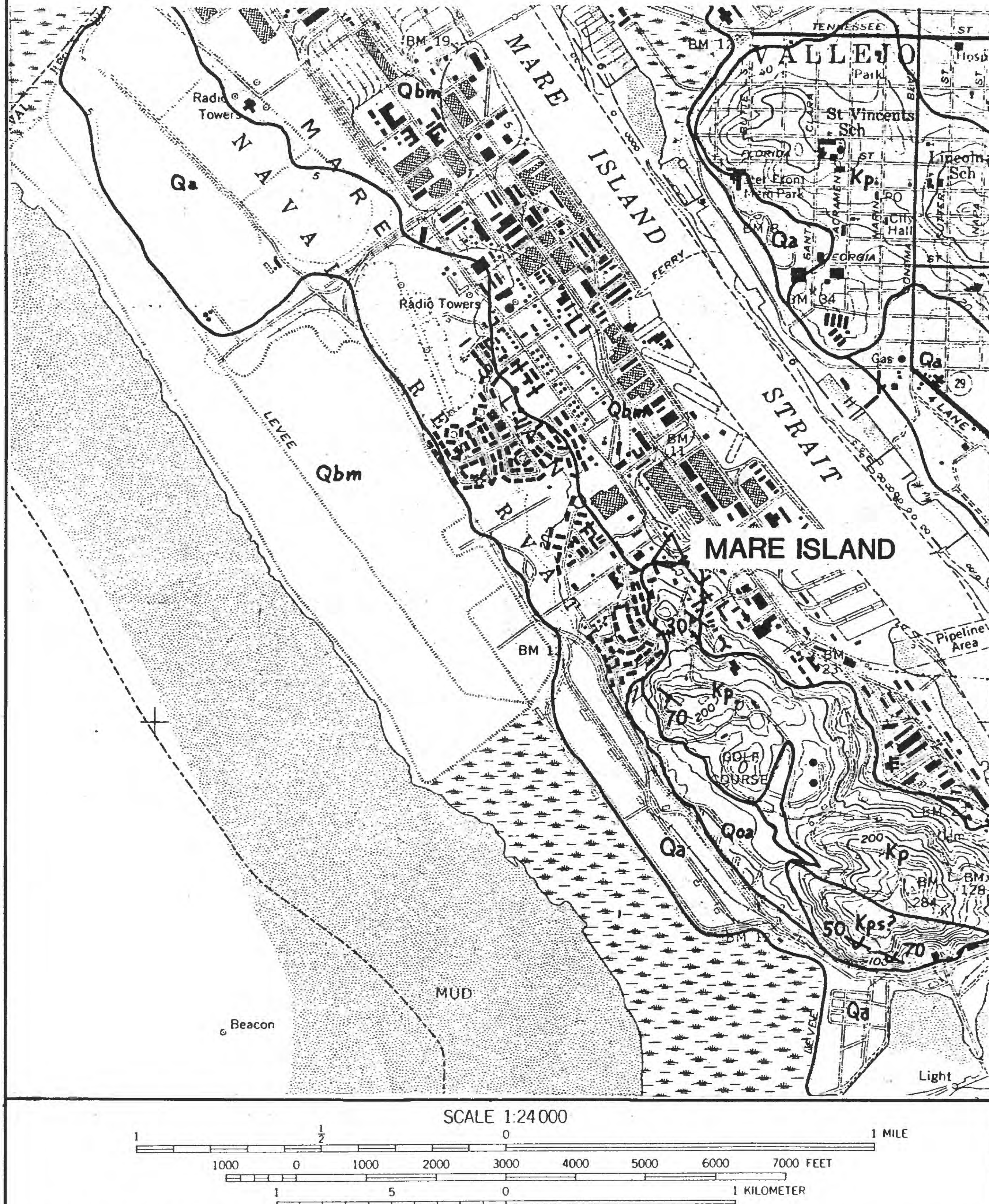
Miocene — TERTIARY

Kps
Kp

Panoche Formation

Kps; arkosic sandstone, buff, minor shale
Kp: micaceous shale, minor thin sandstone beds

Upper Cretaceous — CRETACEOUS



PRELIMINARY GEOLOGIC MAP OF THE MARE ISLAND QUADRANGLE, SOLANO AND CONTRA COSTA COUNTIES, CALIFORNIA

by

Thomas W. Dibblee, Jr.

1981

Figure 26

EXPLANATION

QUATERNARY

Recent

Qaf / Qaf? — **Artificial fill**
Clay, silt, sand, rock fragments, organic matter, and man-made debris.
Qafs, Indian shellmound

Qls — **Landslide deposits**
Composition and structure depend on geologic formation involved and type of landslide. Query indicates probable landslide deposit

Qal — **Alluvium**
Mostly sand and silt but locally contains clay, gravel, or boulders; generally gray to brown

Qb — **Beach deposits**
Predominantly well sorted medium-grained loose gray sand; locally consists of sandy gravel and cobbles

Qm — **Bay mud**
Soft gray clay and silt; locally contains shell fragments, plant remains, and thin beds of sand

Qd — **Dune sand**
Well sorted fine-grained gray sand, loose in most places

Qr — **Marine terrace deposits**
Predominantly friable well sorted fine-grained yellowish-orange to gray sand; includes some alluvial gravel and colluvial clay

Qsr — **Slope debris and ravine fill**
Stony silty to sandy clay; locally silty to clayey sand or gravel; yellowish orange to medium gray, unstratified or poorly stratified

Pleistocene

Qc — **Colma Formation**
In northeast and central parts of area, friable well sorted fine to medium sand containing a few beds of sandy silt, clay, and gravel; in southeast part of area, mostly sandy clay and silty sand; yellowish orange to gray

Qu — **Sedimentary deposits, undifferentiated**

TERTIARY AND QUATERNARY

Pliocene and Pleistocene

QTm — **Merced Formation**
Friable to firm sand, silt, and clay; minor amounts of gravel, lignite, and volcanic ash; medium gray to yellowish orange

JURASSIC AND CRETACEOUS

Franciscan Formation

KJs / KJss — **Sandstone and shale**
Interbedded sandstone and shale, hard where fresh and intact, soft where weathered or sheared. Commonly medium dark gray where fresh, olive gray to yellowish brown where moderately weathered, and yellowish orange to yellowish gray where highly weathered.
KJsh, sandstone generally containing more than two percent potassium-feldspar

KJc — **Chert**
Hard chert interbedded with firm shale, chert layers generally two or three inches thick, shale layers less than one inch thick, generally grayish red

KJg — **Greenstone**
Altered volcanic rocks, fine-grained, mostly basalt; hard where fresh, but weathered and firm to soft in most exposures, commonly grayish olive to moderate olive gray where moderately weathered, dark yellowish orange to light brown where highly weathered

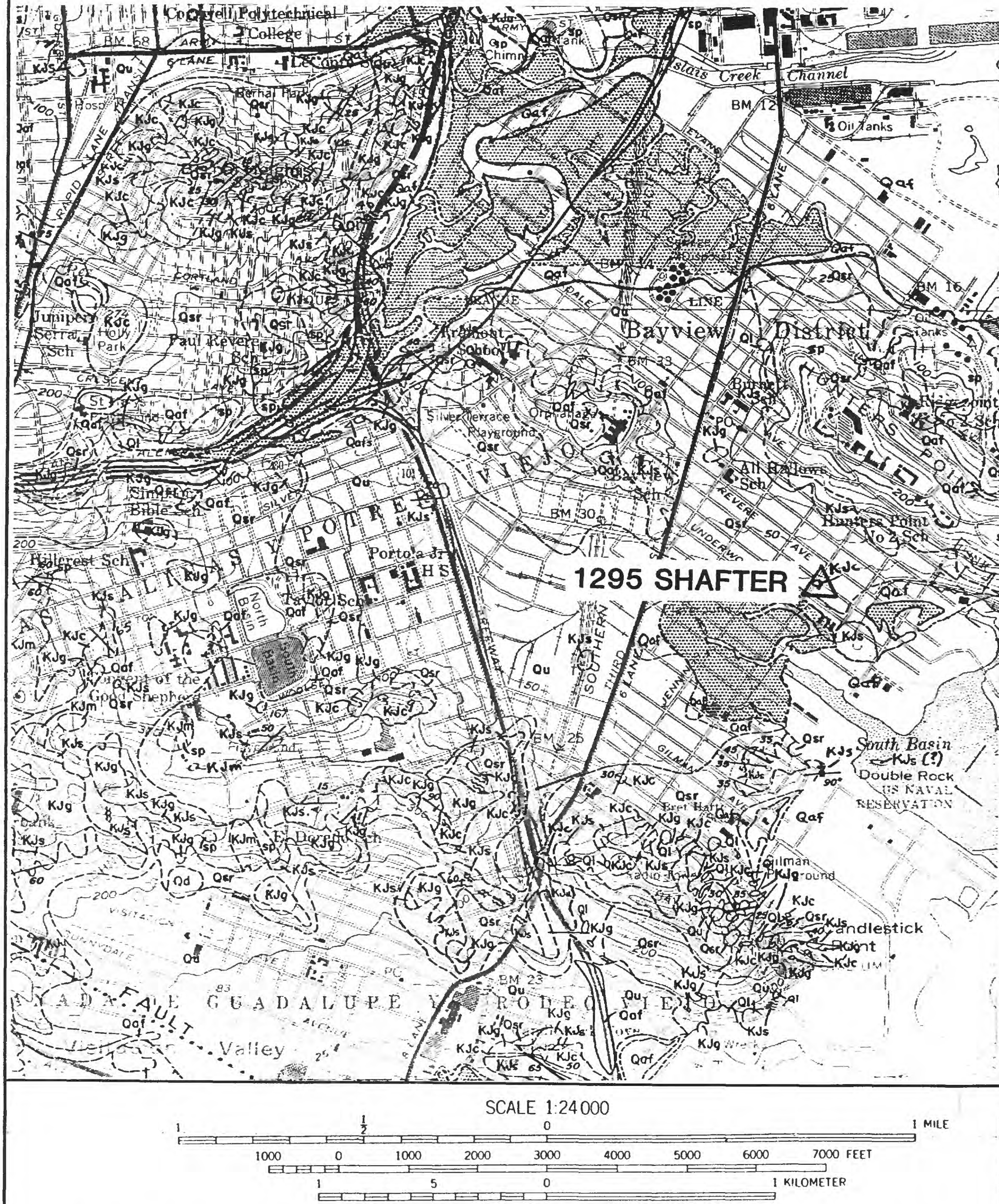
KJm — **Metamorphic rocks**
Hard to firm, fine- to coarse-grained schistose, gneissose, or granulose metamorphic rocks, dark gray, dark greenish gray, or dark bluish gray

sp — **Serpentine**
Hard to soft, generally greenish gray; contains small bodies of gabbro and diabase. Intrusive into Franciscan Formation

KJu — **Sheared rocks**
Small to large fragments of hard rock in matrix of sheared rock. Matrix generally coherent and firm, but soft in places, especially where weathered. Dark gray where fresh, yellowish brown where weathered. Derived mostly from shale and sandstone of Franciscan Formation and serpentine

DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

MISCELLANEOUS FIELD STUDIES
MAP MF-311



PRELIMINARY GEOLOGIC MAP OF THE SAN FRANCISCO SOUTH QUADRANGLE AND PART OF THE HUNTERS POINT QUADRANGLE, CALIFORNIA

by

M. G. Bonilla

1971

Figure 27

EXPLANATION

SURFICIAL DEPOSITS

QUATERNARY

Holocene

Qaf — Artificial fill

Predominantly dune sand but includes silt, clay, rock waste from excavations, manmade debris, and organic waste. Probable fill material indicated in parentheses. Maximum thickness approximately 80 feet

Qb — Modern beach deposits

Predominantly well sorted medium to coarse gray sand; coarse gravel and large cobbles in some places. Maximum thickness approximately 40 feet

Holocene and Pleistocene(?)

Ql, Qly, Qlo — Landslide deposits

Generally unstratified mixtures of bedrock, sand, silt, and clay in varying proportions.
Qly, younger landslide deposits
Qlo, older landslide deposits

Qal — Alluvium

Predominantly clayey silty sand and clayey silt, some pebbles; locally clean medium sand, generally gray to brown. Maximum thickness approximately 25 feet; observed thickness 15 feet

Qs — Slope debris and ravine fill

Angular rock fragments in sand, silt, and clay matrix; generally light yellow to reddish brown. Maximum thickness approximately 20 feet

Qd — Dune sand

Clean well-sorted fine to medium sand; yellowish brown to light gray. Maximum thickness approximately 150 feet

Qm — Bay mud and clay

Plastic gray silty clay; some lenses of sand, peat, and shell fragments; fluid to soft upper layers; moderately stiff clay at depth. Concealed except for exposures north of Corinthian Island and north of Sausalito Point. Maximum thickness approximately 140 feet

Qu — Surficial deposits, undivided

Pleistocene

Qob — Older beach deposits

Predominantly well sorted medium to coarse gray sand. Maximum thickness approximately 30 feet

Qc — Colma Formation

Unconsolidated fine to medium sand with small to moderate amounts of silt and clay; in places includes clay beds, 6 inches to 5 ft thick; cobble-size rubble rare; commonly light brown to gray. Observed thickness 75 feet; probably maximum thickness approximately 300 feet

BEDROCK

CRETACEOUS

Upper Cretaceous

Ks — Sheared rocks, undifferentiated

Coherent blocks and pieces of hard rock as much as several hundred feet in diameter, in a matrix of intensely sheared shale and serpentine. Clasts predominantly sandstone, shale, and serpentine, but also include all other rock types known in Franciscan Formation. Matrix gray to greenish gray, moderately firm to soft and clayey; generally expansive and plastic when wet

Intrusive into Franciscan Formation

sp — Serpentine

Mostly soft sheared rock containing hard knobs of unsheared serpentine, rodingite, and rocks of the Franciscan Formation. Derived from peridotites (mostly harzburgite, some dunite).
sph, hard serpentine, slightly sheared. Shown separately on Potrero Hill only. Variously colored, but generally greenish gray, blue, or brown. Includes sheared rocks (Ks) where that unit is mostly serpentine

gb — Gabbro

Fine- to coarse-grained gabbro; includes diabase where texture is subophitic. Occurs as inclusions or segregations in serpentine

JURASSIC(?) AND CRETACEOUS

Jurassic(?) and Lower and Upper Cretaceous — Franciscan Formation

KJss, KJsh, KJs — Clastic sedimentary rocks

KJss, sandstone; thick-bedded and massive graywacke sandstone interbedded with thin layers of shale and fine-grained sandstone; some thick conglomerate lenses.
KJsh, shale and thin-bedded sandstone; predominantly interbedded and laminated shale and fine-grained graywacke sandstone; beds generally 1 to 5 inches thick
KJs, sandstone and shale, undifferentiated, consists of units KJss or KJsh so poorly exposed that predominant lithology could not be determined
Sandstone and shale at Point Lobos and vicinity west of City College fault zone is probably Great Valley sequence of Bailey, Irwin, and Jones (1964, p. 123)

ch — Radiolarian chert and shale

Reddish-brown; alternate beds of hard brittle chert, 1 to 5 inches thick, and firm brittle shale, ½ to ¼ inch thick. Locally includes bodies of massive chert

gs — Greenstone

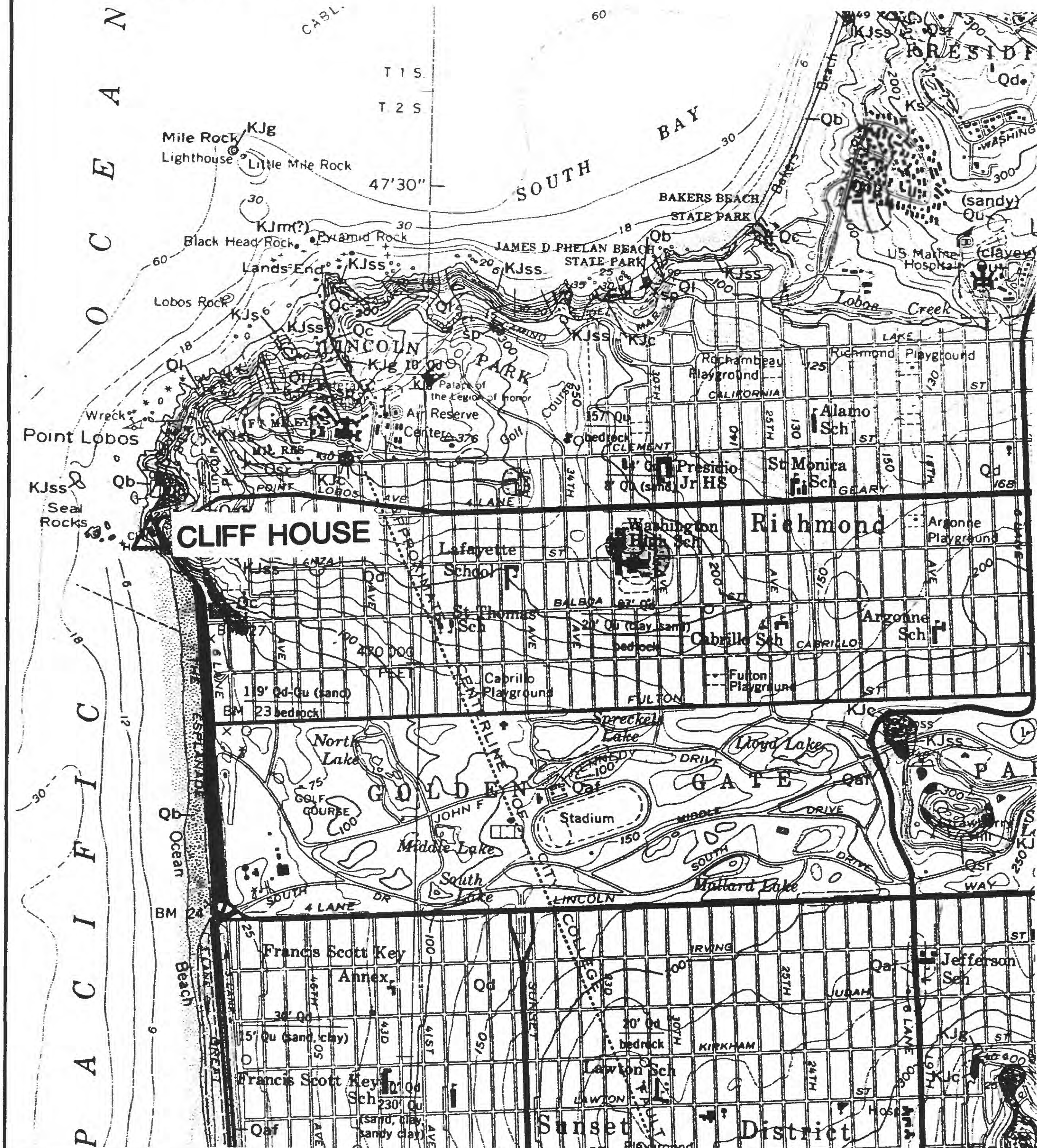
Greenish-gray aphanitic to medium-grained altered volcanic rocks; predominantly basalt. Includes flows, agglomerate, and tuff; pillow lavas common; less commonly massive; interbedded with radiolarian chert and sandstone

m — Metamorphic rocks

Fine- to coarse-grained slate, schist, and granofels of the blueschist facies

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

PROFESSIONAL PAPER 782
PLATE 1



SCALE 1:24 000

1 ½ 0 1 MILE

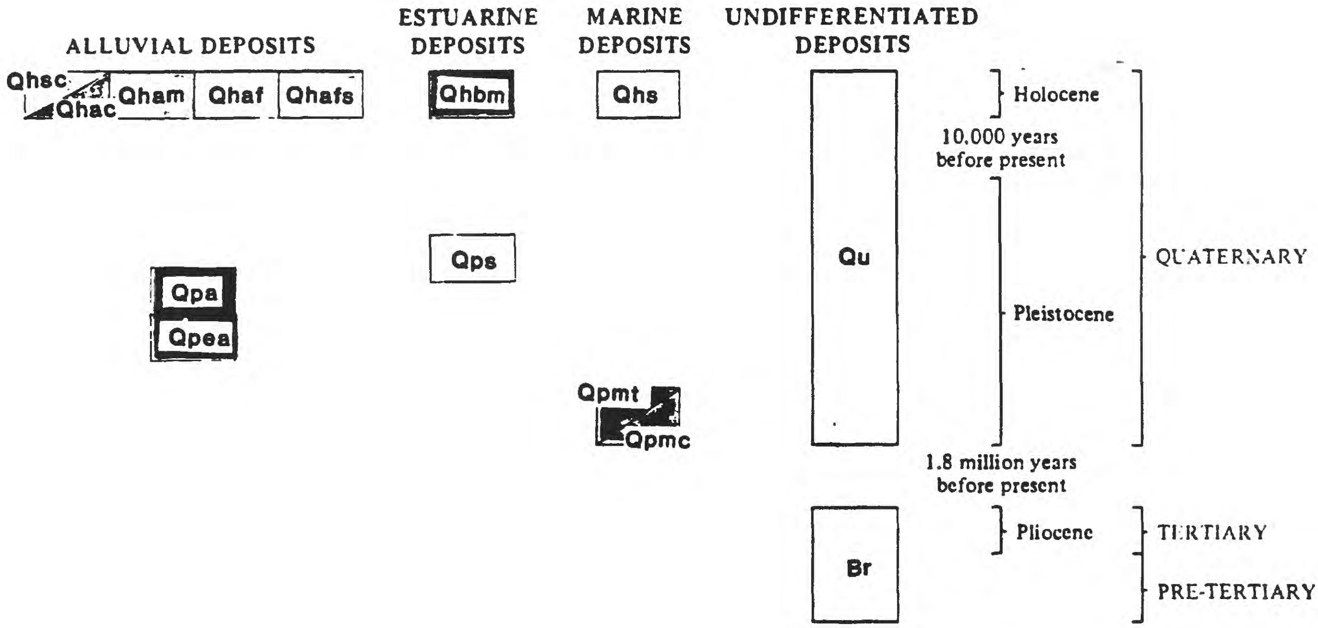
1 .5 0 1 KILOMETER

GEOLOGIC MAP OF THE SAN FRANCISCO NORTH QUADRANGLE, SAN FRANCISCO AND MARIN COUNTIES, CALIFORNIA

Geology mapped in 1948-61 by Julius Schlocker, M. G. Bonilla, D. H. Radbruch, C. A. Kaye, and W. I. Konkoff

Figure 28

CORRELATION OF MAP UNITS



DESCRIPTION OF MAP UNITS

Qhsc STREAM CHANNELS – Open alluvial channels with movable beds, mapped where scale permits

Qhac COARSE-GRAINED ALLUVIUM – Unconsolidated, moderately sorted permeable sand and silt with coarse sand and gravel; more abundant toward fan heads

Qham MEDIUM-GRAINED ALLUVIUM – Unconsolidated moderately sorted moderately sorted permeable fine sand, silt, and clayey silt with a few thin beds of coarse sand

Qhaf FINE-GRAINED ALLUVIUM – Unconsolidated plastic moderately to poorly sorted carbonaceous silt and clay

Qhafs FINE-GRAINED SALT - AFFECTED ALLUVIUM – Unconsolidated plastic moderately to poorly sorted carbonaceous silt and clay. Irregularly bedded with carbonate nodules

Qhbm BAY MUD – Unconsolidated water-saturated dark plastic carbonaceous clay and silty clay

Qhs BEACH AND DUNE SAND DEPOSITS – Loose well-sorted fine- to medium-grained sand

Qpa LATE PLEISTOCENE ALLUVIUM – Weakly consolidated slightly weathered poorly sorted irregularly interbedded clay, silt, sand, and gravel

Qps PLEISTOCENE BEACH AND DUNE SAND DEPOSITS (MERRIT SAND) – Loose well-sorted fine to medium sand

Qpea EARLY PLEISTOCENE ALLUVIUM – Moderately consolidated deeply weathered poorly sorted irregularly interbedded clay, silt, sand, and gravel

Qpmt MARINE TERRACE DEPOSITS – Weakly consolidated slightly weathered sand and gravel

Qpmc COLMA FORMATION – Pale, loose or friable well-sorted fine- to medium-grained sandstone with subordinate gravel, sandstone, siltstone, and claystone

Qu UNDIVIDED QUATERNARY DEPOSITS – Not recognizable as discrete map units because original form obliterated by urbanization

Br UNDIVIDED BEDROCK – Older than Pleistocene

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

PROFESSIONAL PAPER 943
PLATE 3

GEOLOGIC MAP OF THE FLATLAND DEPOSITS OF THE SOUTHERN PART OF THE SAN FRANCISCO BAY REGION

Geology by D. B. Burke, E. J. Helley, K. R. LaJoie, J. C. Tinsley, and G. E. Weber, 1972 – 74

Figure 29

Qr | Qg | Qls | Qa | Qlb

Surficial deposits

Qr, man-made rock fill
Qg, gravel and sand of stream channels
Qa, alluvium-gravel, sand, silt and clay
Qls, landslide debris
Qlb, landslide of basalt debris

} Holocene

UNCONFORMITY ?

Qoa

● Older alluvium (dissected)

UNCONFORMITY

Qsc | Qsb

Santa Clara Formation (terrestrial)
Qsc, gravel, sand & clay
Qsb, gravel with basalt detritus

} Pleistocene

?

QTb | bi

Unnamed basalt (olivine basalt lava 3.5 m.y. old*)
bi, intrusive

} Pliocene or Pleistocene

?

Tsc

Unnamed sandstone and conglomerate (terrestrial)

} - Pliocene ? -

UNCONFORMITY

Tus

Unnamed sandstone (marine)

Tm

Monterey (siliceous) Shale (marine, middle Mio)

Tms

Temblor ? Sandstone (marine)

} Miocene

UNCONFORMITY

KTsh

Unnamed marine sedimentary rocks
(age, early Eocene-Paleocene and/or late Cretaceous)
No pattern = micaceous shale and siltstone
arkosic sandstone
conglomerate
limestone

} U. Cretac. and/or Paleocene-Eocene

Ksh

Berryessa Formation ? of Crittenden, 1951 (marine shale)
dotted unit = sandstone

Kshl

Unnamed shale

} Upper

sp

Serpentine and serpentinized ultramafic rocks

fs | fc | fg

Franciscan rocks
(severely shattered eugeosynclinal marine rocks)
fs, graywacke, sandst and minor claystone
fc, varicolored chert
fg, greenstone (altered from basaltic rocks)

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

U.S. GEOLOGICAL SURVEY
OPEN FILE MAP

SCALE 1:24 000

1 ½ 0 1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

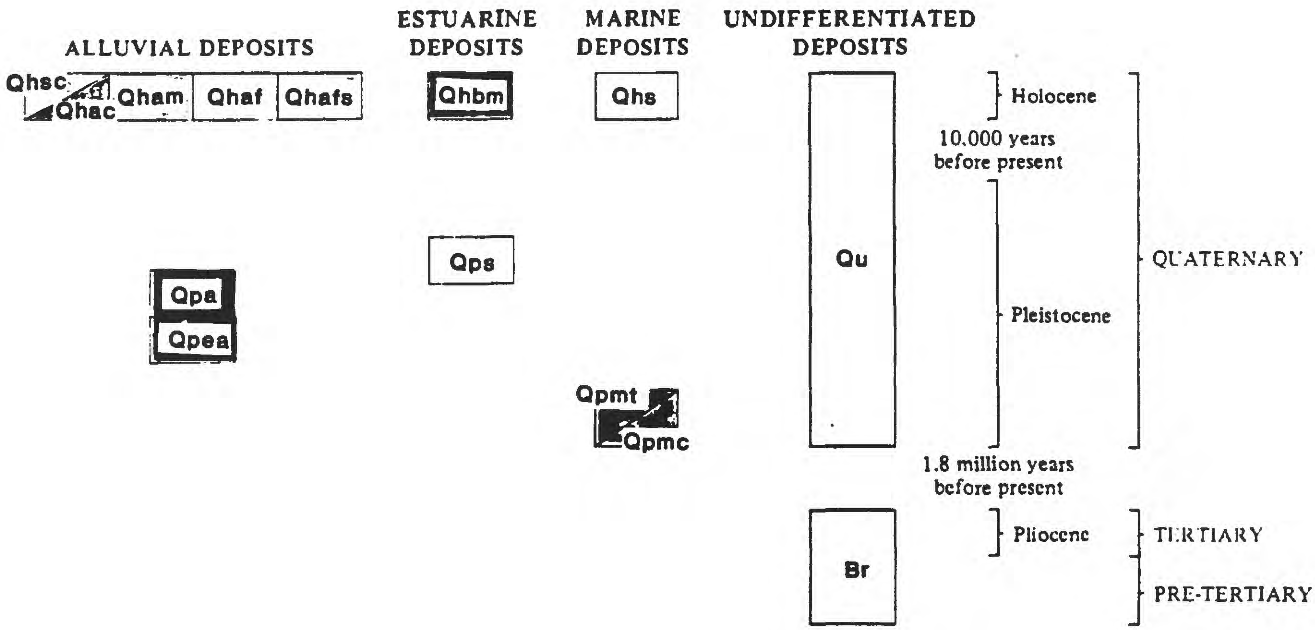
1 .5 0 1 KILOMETER

PRELIMINARY GEOLOGIC MAP OF THE GILROY QUADRANGLE, SANTA CLARA COUNTY, CALIFORNIA

By Thomas W. Dibblee Jr., 1973

Figure 30

CORRELATION OF MAP UNITS

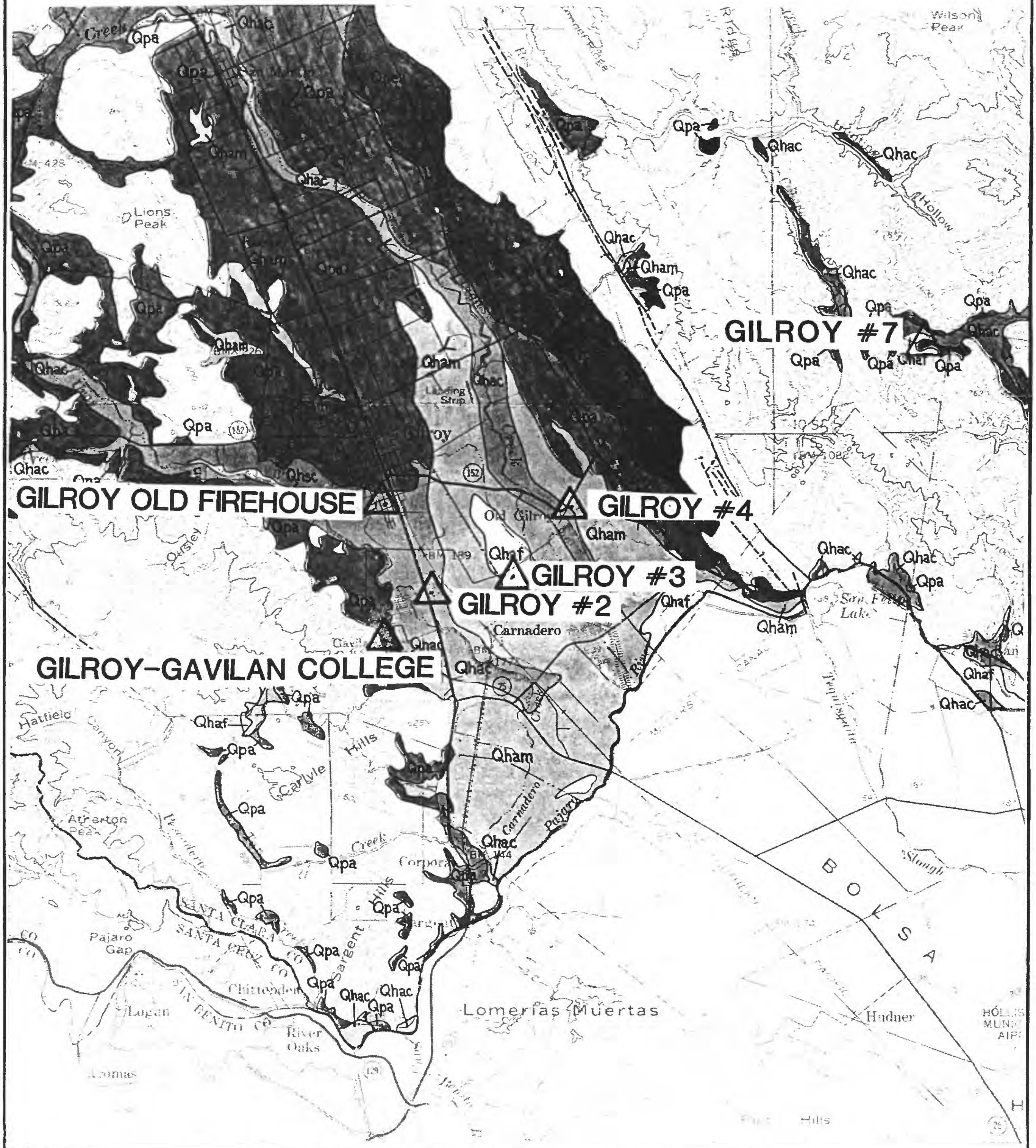


DESCRIPTION OF MAP UNITS

	Qhsc	STREAM CHANNELS – Open alluvial channels with movable beds, mapped where scale permits
G2,GOF ●	Qhac	COARSE-GRAINED ALLUVIUM – Unconsolidated, moderately sorted permeable sand and silt with coarse sand and gravel; more abundant toward fan heads
G4 ●	Qham	MEDIUM-GRAINED ALLUVIUM – Unconsolidated moderately sorted moderately sorted permeable fine sand, silt, and clayey silt with a few thin beds of coarse sand
G3 ●	Qhaf	FINE-GRAINED ALLUVIUM – Unconsolidated plastic moderately to poorly sorted carbonaceous silt and clay
	Qhafs	FINE-GRAINED SALT - AFFECTED ALLUVIUM – Unconsolidated plastic moderately to poorly sorted carbonaceous silt and clay. Irregularly bedded with carbonate nodules
	Qhbm	BAY MUD – Unconsolidated water-saturated dark plastic carbonaceous clay and silty clay
	Qhs	BEACH AND DUNE SAND DEPOSITS – Loose well-sorted fine- to medium-grained sand
G7,GGC ●	Qpa	LATE PLEISTOCENE ALLUVIUM – Weakly consolidated slightly weathered poorly sorted irregularly interbedded clay, silt, sand, and gravel
	Qps	PLEISTOCENE BEACH AND DUNE SAND DEPOSITS (MERRIT SAND) – Loose well-sorted fine to medium sand
	Qpea	EARLY PLEISTOCENE ALLUVIUM – Moderately consolidated deeply weathered poorly sorted irregularly interbedded clay, silt, sand, and gravel
	Qpmt	MARINE TERRACE DEPOSITS – Weakly consolidated slightly weathered sand and gravel
	Qpmc	COLMA FORMATION – Pale, loose or friable well-sorted fine- to medium-grained sandstone with subordinate gravel, sandstone, siltstone, and claystone
	Qu	UNDIVIDED QUATERNARY DEPOSITS – Not recognizable as discrete map units because original form obliterated by urbanization
	Br	UNDIVIDED BEDROCK – Older than Pleistocene

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

PROFESSIONAL PAPER 943
PLATE 3



SCALE 1:125 000

2 1 0 2 4 6 8 10 MILES

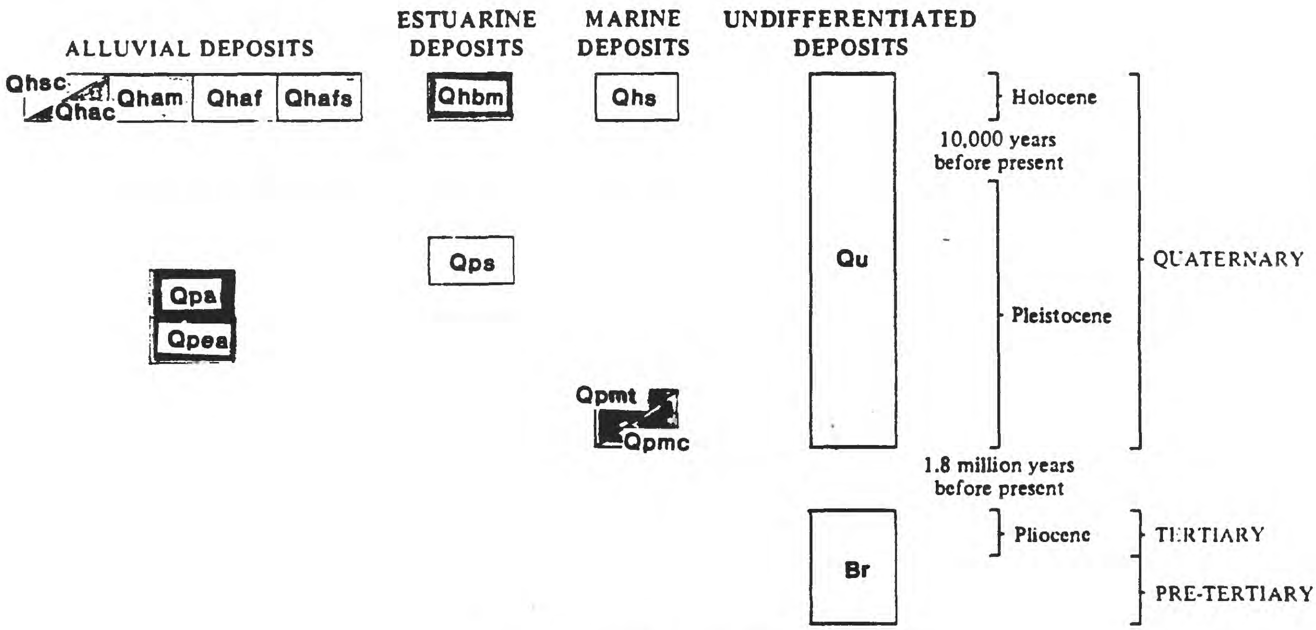
2 1 0 2 4 6 8 10 KILOMETERS

GEOLOGIC MAP OF THE FLATLAND DEPOSITS OF THE SOUTHERN PART OF THE SAN FRANCISCO BAY REGION

Geology by D. B. Burke, E. J. Helley, K. R. LaJoie, J. C. Tinsley, and G. E. Weber, 1972 – 74

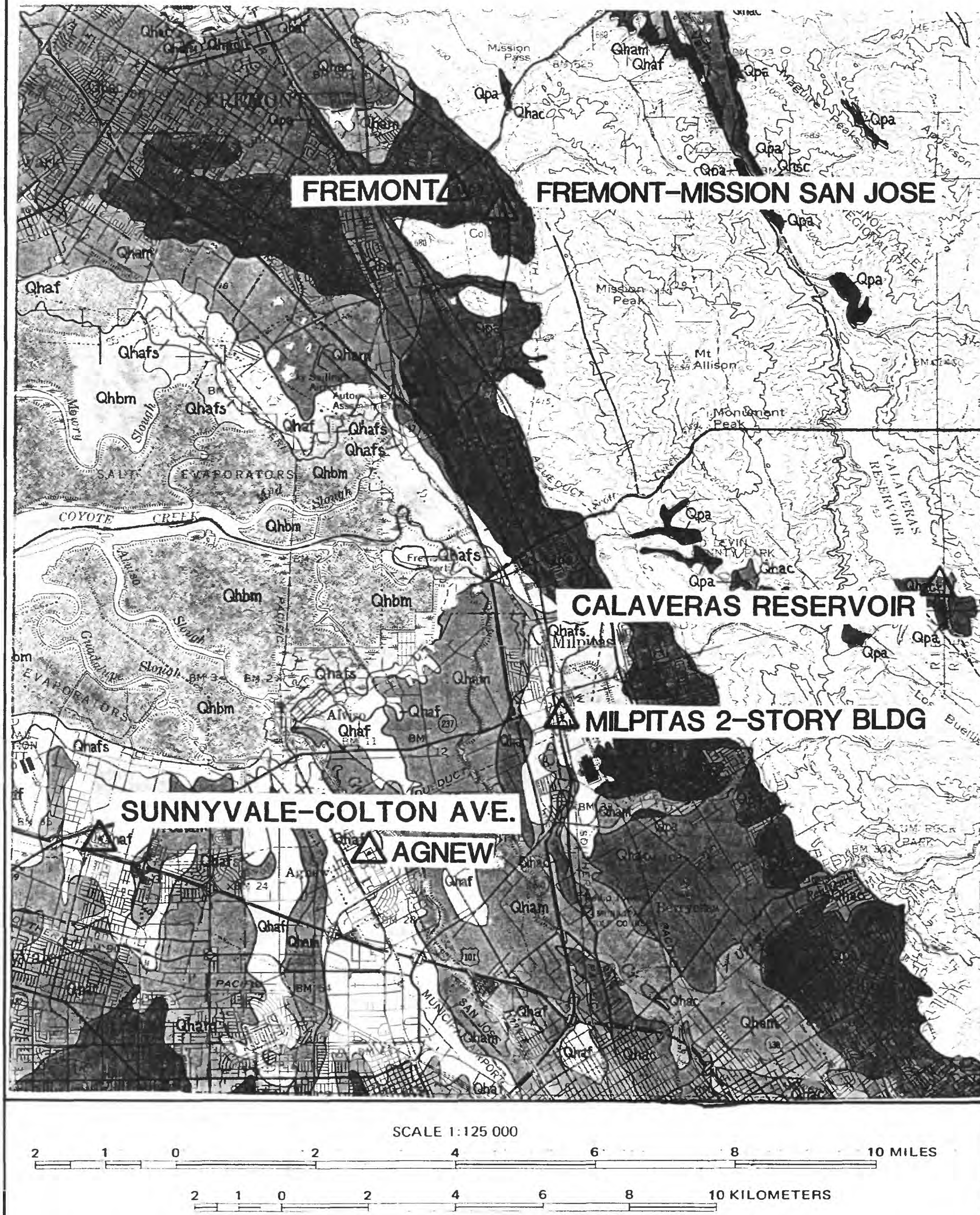
Figure 31

CORRELATION OF MAP UNITS



DESCRIPTION OF MAP UNITS

MIL,SUN	Qhsc	STREAM CHANNELS – Open alluvial channels with movable beds, mapped where scale permits
AGN ●	Qhac	COARSE-GRAINED ALLUVIUM – Unconsolidated, moderately sorted permeable sand and silt with coarse sand and gravel; more abundant toward fan heads
	Qham	MEDIUM-GRAINED ALLUVIUM – Unconsolidated moderately sorted moderately sorted permeable fine sand, silt, and clayey silt with a few thin beds of coarse sand
CAL ●	Qhaf	FINE-GRAINED ALLUVIUM – Unconsolidated plastic moderately to poorly sorted carbonaceous silt and clay
	Qhafs	FINE-GRAINED SALT - AFFECTED ALLUVIUM – Unconsolidated plastic moderately to poorly sorted carbonaceous silt and clay. Irregularly bedded with carbonate nodules
	Qhbm	BAY MUD – Unconsolidated water-saturated dark plastic carbonaceous clay and silty clay
	Qhs	BEACH AND DUNE SAND DEPOSITS – Loose well-sorted fine- to medium-grained sand
FRE,MSJ ●	Qpa	LATE PLEISTOCENE ALLUVIUM – Weakly consolidated slightly weathered poorly sorted irregularly interbedded clay, silt, sand, and gravel
	Qps	PLEISTOCENE BEACH AND DUNE SAND DEPOSITS (MERRIT SAND) – Loose well-sorted fine to medium sand
	Qpea	EARLY PLEISTOCENE ALLUVIUM – Moderately consolidated deeply weathered poorly sorted irregularly interbedded clay, silt, sand, and gravel
	Qpmt	MARINE TERRACE DEPOSITS – Weakly consolidated slightly weathered sand and gravel
	Qpmc	COLMA FORMATION – Pale, loose or friable well-sorted fine- to medium-grained sandstone with subordinate gravel, sandstone, siltstone, and claystone
	Qu	UNDIVIDED QUATERNARY DEPOSITS – Not recognizable as discrete map units because original form obliterated by urbanization
	Br	UNDIVIDED BEDROCK – Older than Pleistocene



GEOLOGIC MAP OF THE FLATLAND DEPOSITS OF THE SOUTHERN PART OF THE SAN FRANCISCO BAY REGION

Geology by D. B. Burke, E. J. Helley, K. R. LaJoie, J. C. Tinsley, and G. E. Weber, 1972 - 74

Figure 32

QUATERNARY

Holocene

Qr | Qg | Qls | Qa | Qlp

Surficial deposits

Qr, man-made rock fill

Qg, gravel and sand of stream channels

Qa, alluvium-gravel sand and clay

Qls, landslide debris

Qlp, landslide of serpentine debris

UNCONFORMITY

Pleistocene

Qoa

Older alluvium (dissected)

UNCONFORMITY

Qsp | Qsc | Qsa

Santa Clara Formation (terrestrial)

Qsp, conglomerate or breccia of serpentine detritus

Qsc, gravel, sand and clay

Qsa, clay

TERTIARY

Pliocene ?

QTb

Unnamed basalt (olivine basalt lava)

Tsc

Unnamed sandstone and conglomerate (terrestrial)

UNCONFORMITY

Miocene

Tbr

Briones sandstone (marine)

Tmc | Tmi | Tms

Monterey (Claremont) shale (marine)

Tmc, clay shale

Tmi, brittle siliceous shale

Tms, basal sandstone (fine grained)

UNCONFORMITY

Cret. or Eocene

KTsh | KTs

Unnamed formation (marine)

KTsh, clay shale

KTs, sandstone locally pebbly

CRETACEOUS

Upper ?

Ksh | Ksg | Kss

Berryessa Formation ? of Crittenden 1951 (marine)

Ksh, shale

Ksg, sandstone and conglomerate

Kss, sandstone

Lower (?)

kshl

Unnamed shale (Knoxville Formation of Crittenden, 1950, marine)

sc | br | tr

Vein rocks

sc, silica-carbonate rock (alteration of serpentine)

br, fault ? breccia

tr, travertine

CRETACEOUS

db | an | sp | spr

Mafic and related rocks (intrusive)

db, diabase

an, andesitic rock

sp, serpentine and serpentinized ultramafic rocks

spr, serpentine rubble

JURASSIC ?

fs | f | fc | fl | fg | fsr | gl

Franciscan rocks (severely shattered marine eugeosynclinal rocks)

fs, graywacke sandstone and minor claystone

f, hard monolithic fragments

fc, varicolored chert

fl, limestone

fg, greenstone (altered from basaltic rocks)

fsr, pervasively sheared shale and graywacky

gl, glaucophane rock

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

U.S. GEOLOGICAL SURVEY
OPEN FILE MAP

SCALE 1:24 000

1 — ½ — 0 — 1 MILE

1000 — 0 — 1000 — 2000 — 3000 — 4000 — 5000 — 6000 — 7000 FEET

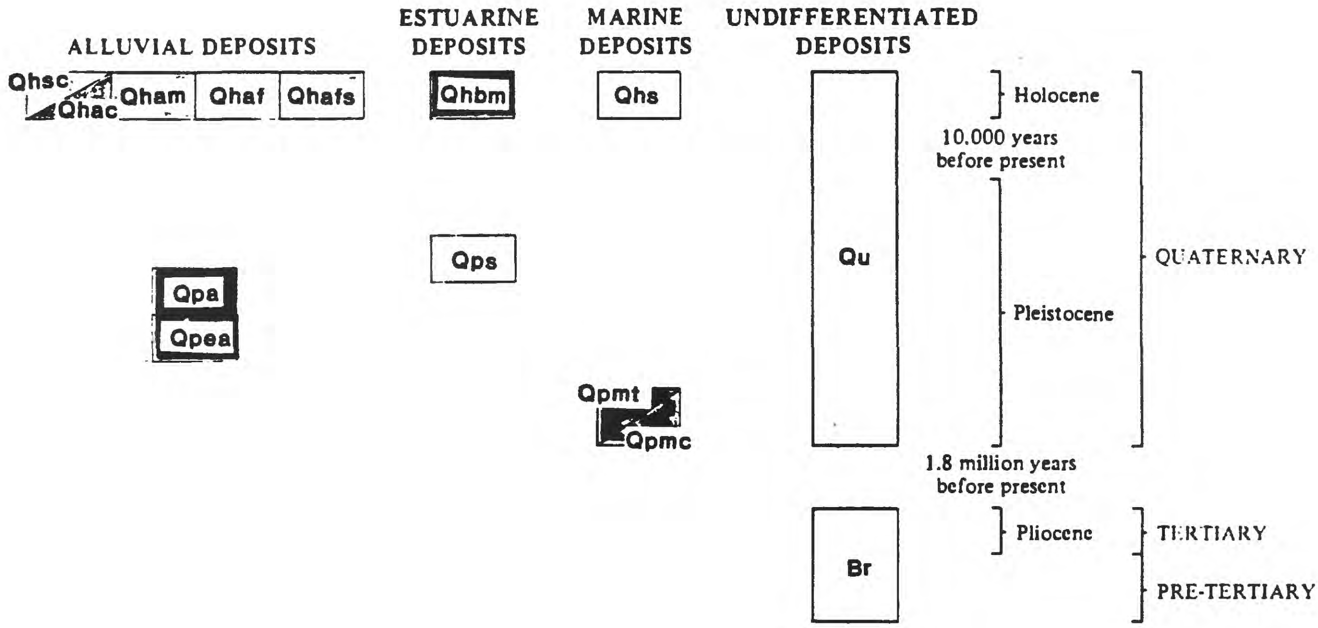
1 — 5 — 0 — 1 KILOMETER

PRELIMINARY GEOLOGIC MAP OF THE MORGAN HILL QUADRANGLE, SANTA CLARA COUNTY, CALIFORNIA

By Thomas W. Dibblee Jr., 1973

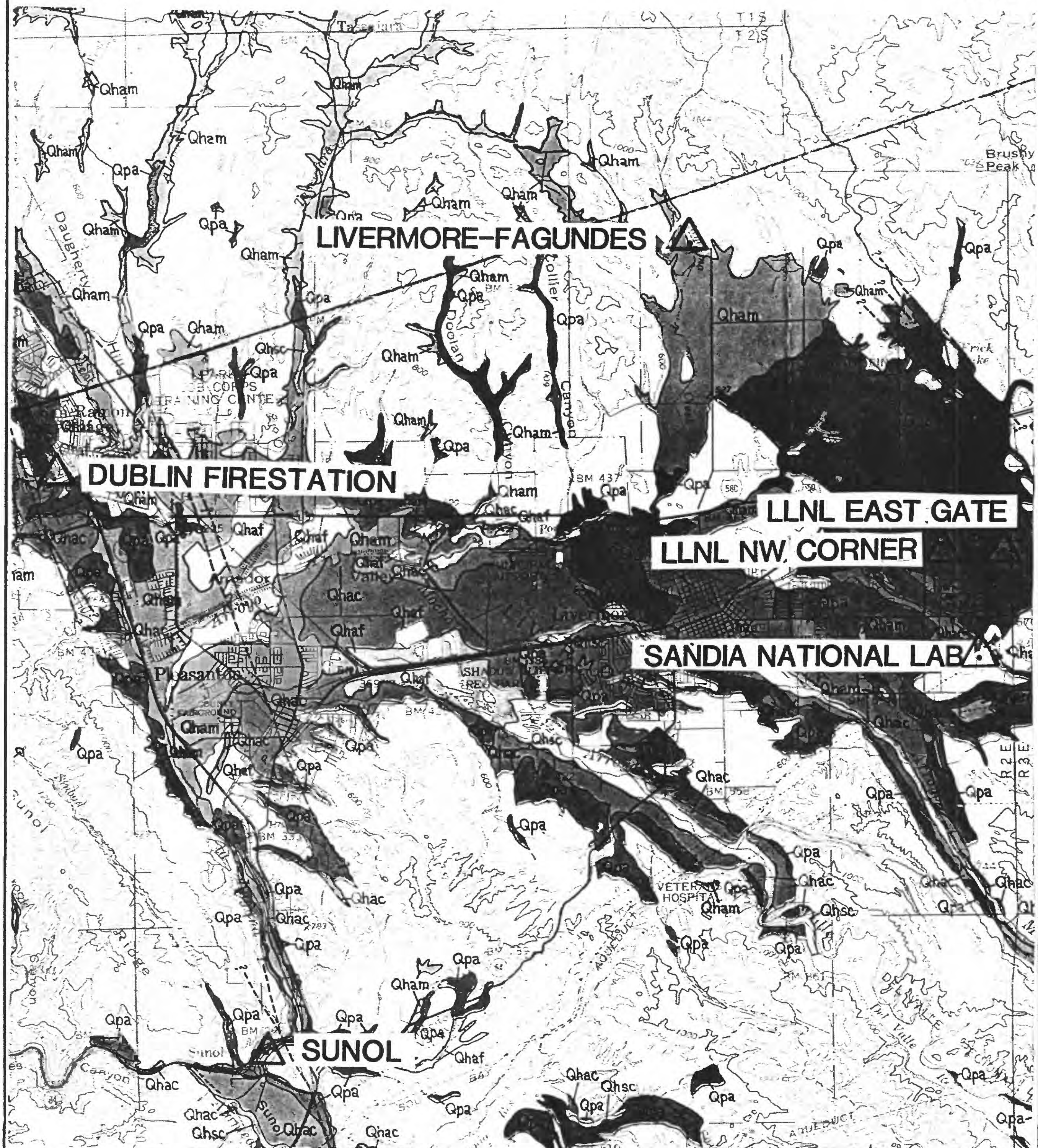
Figure 33

CORRELATION OF MAP UNITS



DESCRIPTION OF MAP UNITS

	Qhsc	STREAM CHANNELS – Open alluvial channels with movable beds, mapped where scale permits
SNL ●	Qhac	COARSE-GRAINED ALLUVIUM – Unconsolidated, moderately sorted permeable sand and silt with coarse sand and gravel; more abundant toward fan heads
LIV ●	Qham	MEDIUM-GRAINED ALLUVIUM – Unconsolidated moderately sorted moderately sorted permeable fine sand, silt, and clayey silt with a few thin beds of coarse sand
DUB ●	Qhaf	FINE-GRAINED ALLUVIUM – Unconsolidated plastic moderately to poorly sorted carbonaceous silt and clay
	Qhafs	FINE-GRAINED SALT - AFFECTED ALLUVIUM – Unconsolidated plastic moderately to poorly sorted carbonaceous silt and clay. Irregularly bedded with carbonate nodules
	Qhbm	BAY MUD – Unconsolidated water-saturated dark plastic carbonaceous clay and silty clay
	Qhs	BEACH AND DUNE SAND DEPOSITS – Loose well-sorted fine- to medium-grained sand
LLNL-NW ● LLNL-E	Qpa	LATE PLEISTOCENE ALLUVIUM – Weakly consolidated slightly weathered poorly sorted irregularly interbedded clay, silt, sand, and gravel
	Qps	PLEISTOCENE BEACH AND DUNE SAND DEPOSITS (MERRIT SAND) – Loose well-sorted fine to medium sand
	Qpea	EARLY PLEISTOCENE ALLUVIUM – Moderately consolidated deeply weathered poorly sorted irregularly interbedded clay, silt, sand, and gravel
	Qpmt	MARINE TERRACE DEPOSITS – Weakly consolidated slightly weathered sand and gravel
	Qpmc	COLMA FORMATION – Pale, loose or friable well-sorted fine- to medium-grained sandstone with subordinate gravel, sandstone, siltstone, and claystone
	Qu	UNDIVIDED QUATERNARY DEPOSITS – Not recognizable as discrete map units because original form obliterated by urbanization
	Br	UNDIVIDED BEDROCK – Older than Pleistocene



SCALE 1:125 000

2 1 0 2 4 6 8 10 MILES

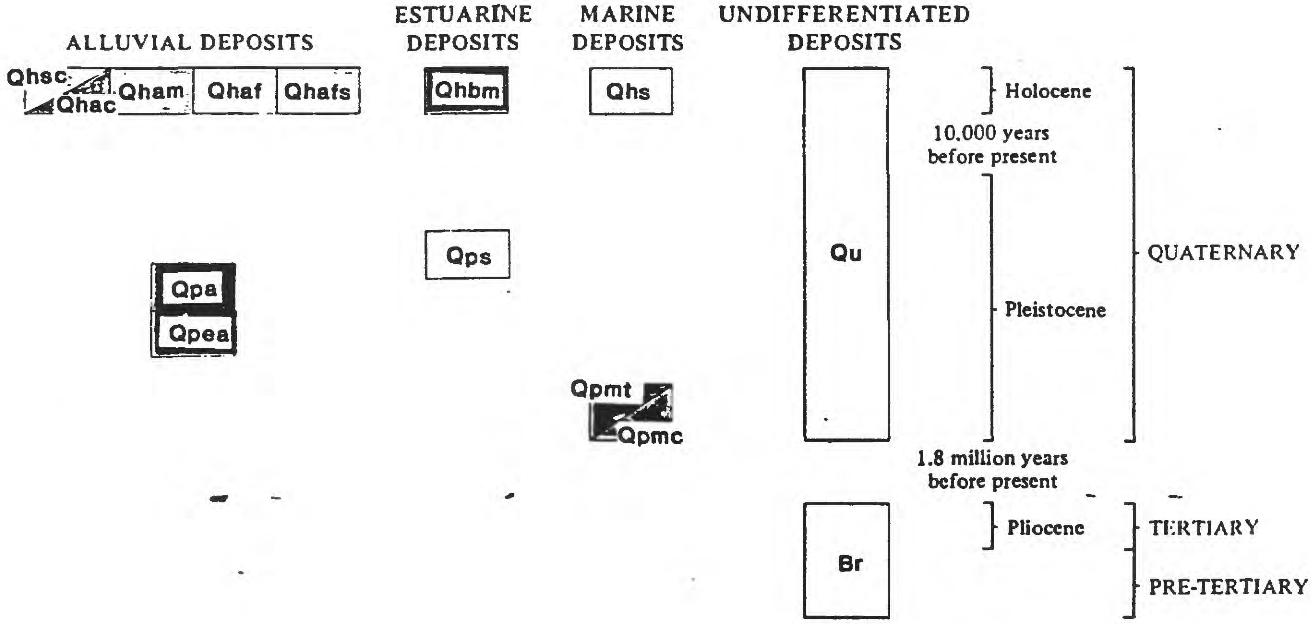
2 1 0 2 4 6 8 10 KILOMETERS

GEOLOGIC MAP OF THE FLATLAND DEPOSITS OF THE SOUTHERN PART OF THE SAN FRANCISCO BAY REGION

Geology by D. B. Burke, E. J. Helley, K. R. LaJoie, J. C. Tinsley, and G. E. Weber, 1972 – 74

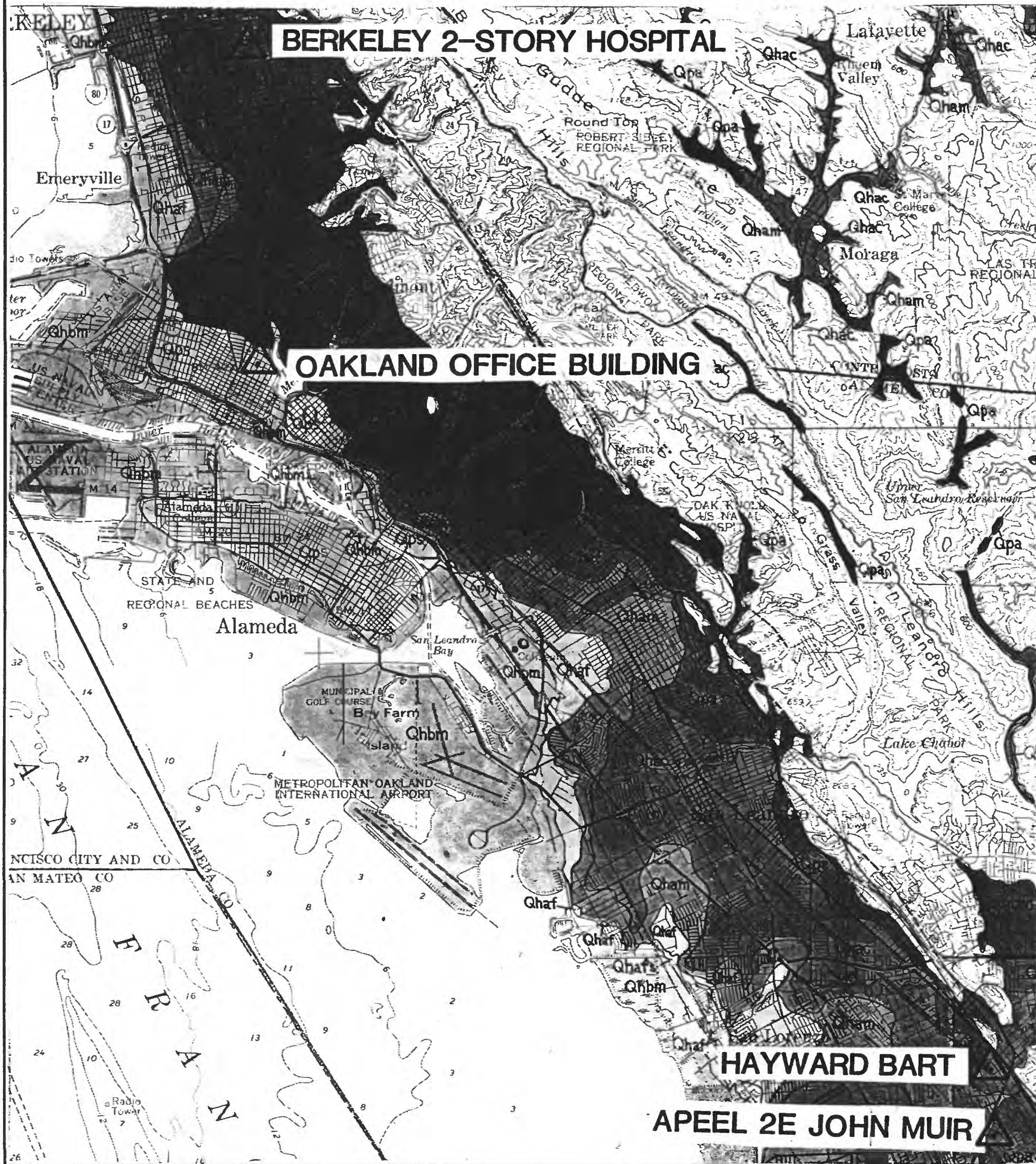
Figure 34

CORRELATION OF MAP UNITS



DESCRIPTION OF MAP UNITS

	Qhsc	STREAM CHANNELS – Open alluvial channels with movable beds; mapped where scale permits
	Qhac	COARSE-GRAINED ALLUVIUM – Unconsolidated, moderately sorted permeable sand and silt with coarse sand and gravel; more abundant toward fan heads
	Qham	MEDIUM-GRAINED ALLUVIUM – Unconsolidated moderately sorted moderately sorted permeable fine sand, silt, and clayey silt with a few thin beds of coarse sand
	Qhaf	FINE-GRAINED ALLUVIUM – Unconsolidated plastic moderately to poorly sorted carbonaceous silt and clay
	Qhafs	FINE-GRAINED SALT - AFFECTED ALLUVIUM – Unconsolidated plastic moderately to poorly sorted carbonaceous silt and clay. Irregularly bedded with carbonate nodules
	Qhbm	BAY MUD – Unconsolidated water-saturated dark plastic carbonaceous clay and silty clay
AP2,HBART	Qhs	BEACH AND DUNE SAND DEPOSITS – Loose well-sorted fine- to medium-grained sand
BER ●	Qpa	LATE PLEISTOCENE ALLUVIUM – Weakly consolidated slightly weathered poorly sorted irregularly interbedded clay, silt, sand, and gravel
OOB ●	Qps	PLEISTOCENE BEACH AND DUNE SAND DEPOSITS (MERRIT SAND) – Loose well-sorted fine to medium sand
	Qpea	EARLY PLEISTOCENE ALLUVIUM – Moderately consolidated deeply weathered poorly sorted irregularly interbedded clay, silt, sand, and gravel
	Qpmt	MARINE TERRACE DEPOSITS – Weakly consolidated slightly weathered sand and gravel
	Qpmc	COLMA FORMATION – Pale, loose or friable well-sorted fine- to medium-grained sandstone with subordinate gravel, sandstone, siltstone, and claystone
	Qu	UNDIVIDED QUATERNARY DEPOSITS – Not recognizable as discrete map units because original form obliterated by urbanization
	Br	UNDIVIDED BEDROCK – Older than Pleistocene



SCALE 1:125 000

2 1 0 2 4 6 8 10 MILES

2 1 0 2 4 6 8 10 KILOMETERS

GEOLOGIC MAP OF THE FLATLAND DEPOSITS OF THE SOUTHERN PART OF THE SAN FRANCISCO BAY REGION

Geology by D. B. Burke, E. J. Helley, K. R. LaJoie, J. C. Tinsley, and G. E. Weber, 1972 - 74

Figure 35

(BRIO.

°52'30"

EXPLANATION

QUATERNARY

Recent

Qls

Landslide debris
Clayey, silty sand that has moved down steep slope on Yerba Buena Island.

Qaf

Artificial fill
Sand, clay, or miscellaneous refuse.

Qrc

Reworked colluvium
Silty, clayey sand derived from underlying sandstone of the Franciscan group; moved downslope by water and gravity; in places reworked by wind.

Qbm

Bay mud
Sandy, clayey silt with shells and other organic material. Underlies most artificial fill.

Pleistocene

Qm

Merritt sand
Beach or near-shore deposit of slightly clayey, silty sand.

Qtc

Temescal formation
Alluvial-fan deposit comprising interfingering lenses of clayey gravel, sandy silty clay, and sand-clay-silt mixtures.

Qa

Alameda formation
Upper exposed few feet composed of sandy, silty clay with few pebbles; lower part consists of continental and marine sand, clay, gravel. Maximum known thickness, 1,050 feet.

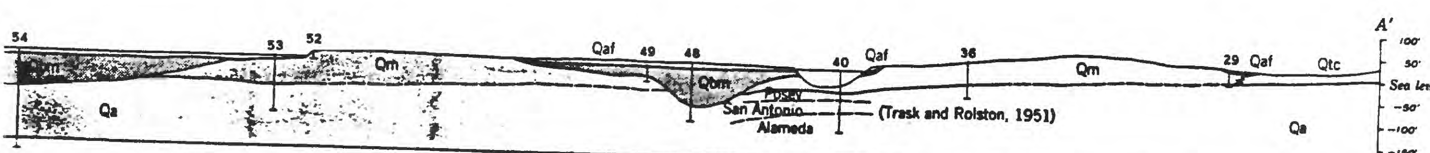
JURASSIC CRETACEOUS

Jk

Knoxville formation (Jurassic)
Shale with some beds of graywacke.

KJf

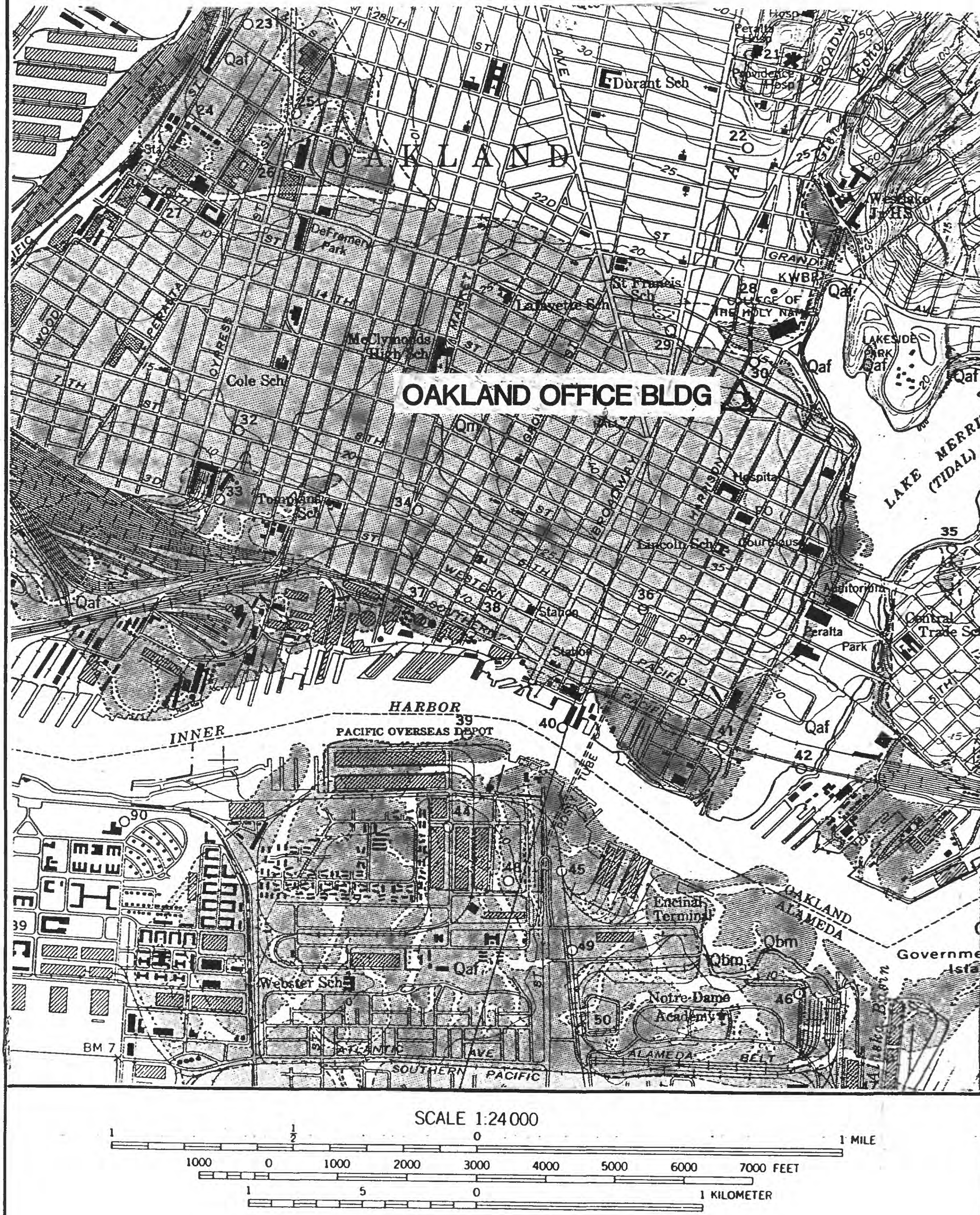
Franciscan group (Jurassic and Cretaceous)
Graywacke with small amounts of shale.



SECTION ALONG LINE A-A'
Vertical exaggeration 7X

DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

MISCELLANEOUS GEOLOGIC INVESTIGATIONS
MAP I-239



AREAL AND ENGINEERING GEOLOGY OF THE OAKLAND WEST QUADRANGLE, CALIFORNIA

By

Dorothy H. Radbruch

1957

Figure 36

EXPLANATION

GEOLOGIC PERIODS AND APPROXIMATE AGES IN YEARS	GEOLOGIC FORMATIONS
QUATERNARY PERIOD RECENT EPOCH (few thousand years)	**Qal** Alluvium *Gravels and sands recently deposited by Big Sur River below the Gorge.*
PLEISTOCENE EPOCH (few thousand to one million years)	**Qty** Younger terraces *Gravels deposited by Big Sur River.* **Qto** Older terraces *Highest terrace gravels deposited by ancient Big Sur River.*
TERTIARY PERIOD MIOCENE EPOCH (10 to 15 million years)	**Tsm** Santa Margarita formation *Fine-to coarse-grained buff to gray sandstone probably deposited below sea level. Includes coarse fault breccia of black chert fragments near Sur Fault.*
CRETACEOUS(?) PERIOD (60 to 110 million years)	**K** Black slate *Exposed where Big Sur River crosses Sur Hill Fault zone.*
JURASSIC PERIOD UPPER JURASSIC EPOCH (110 to 120 million years)	**Jfv** Franciscan volcanics *Dark fine-grained to porphyritic igneous rocks intruded into Franciscan sedimentary rocks* **Jfch** **Jf** **Jfsh** Franciscan formation Sedimentary rocks *Gray sandstone (ss); black shale (sh); black and red chert (ch); conglomerate (cg)*
PRE-JURASSIC PERIOD (Age unknown but probably over 200 million years)	**Sur** Sur series *Coarse-banded gneiss, quartzite and gray Gabilan limestone; derived from sedimentary rocks by intense heat, pressure, and chemical change. Intruded by Santa Lucia granite. (Outcrops on Pine Ridge trail)*

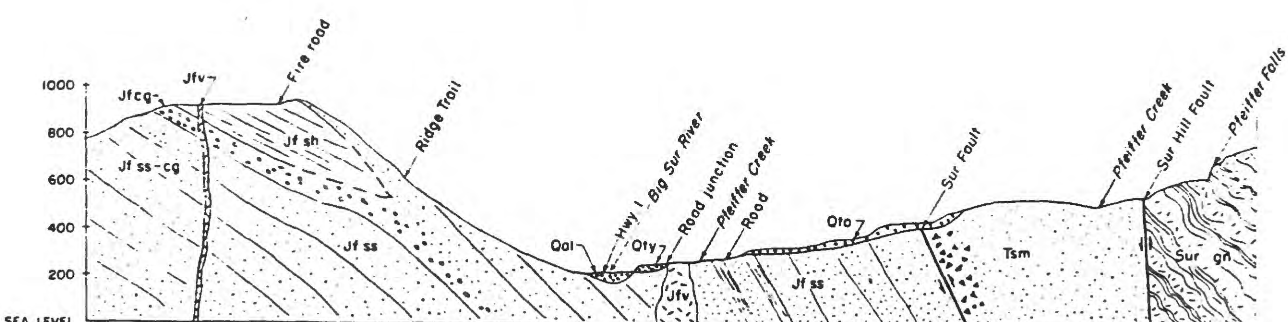
30 Dip and strike of beds

——— Trace of fault exposed

— — — Fault location uncertain

——— Contact between rock formations

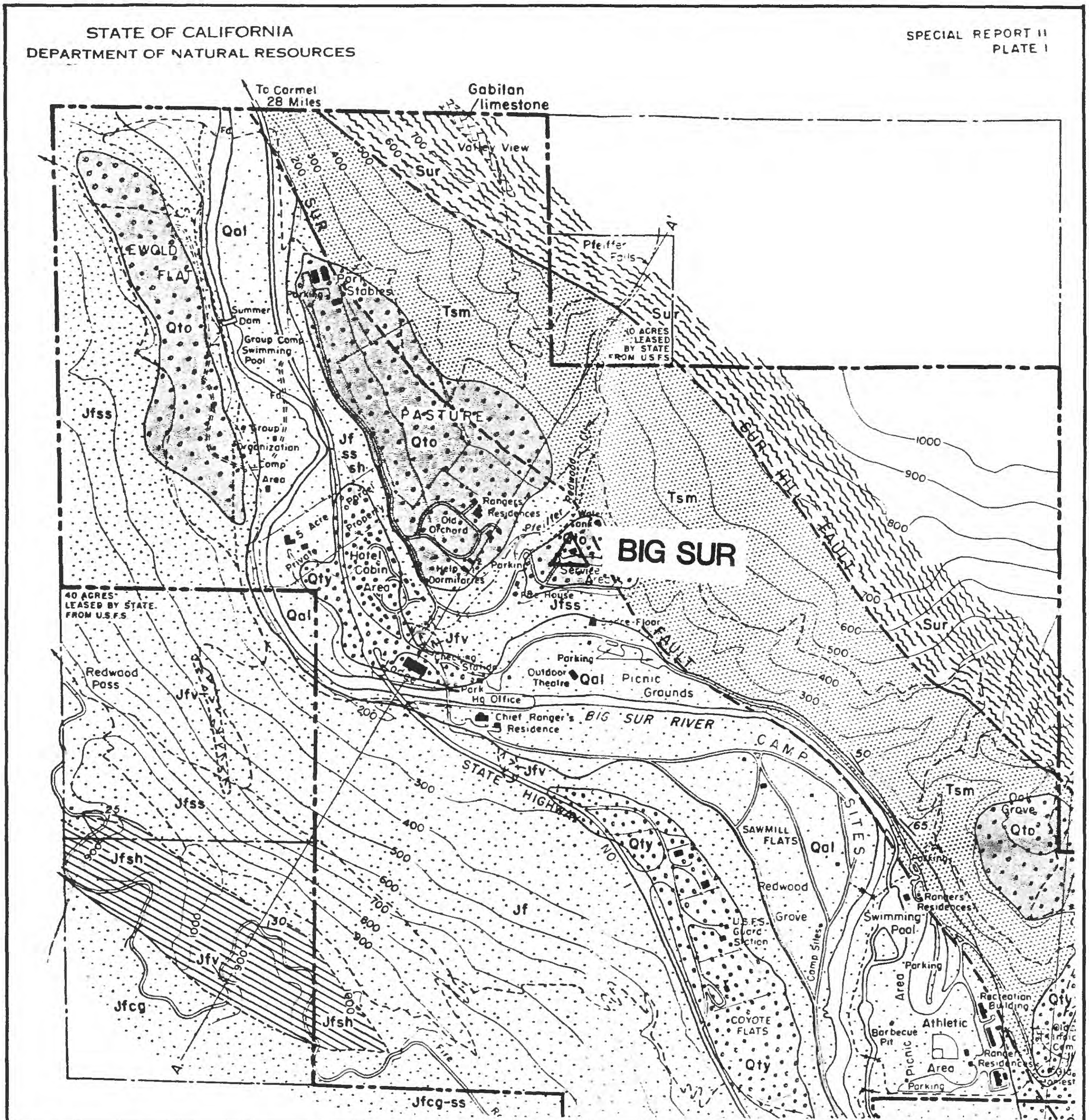
- - - - Contact position uncertain



A SECTION ALONG LINE AA' SHOWING ROCK FORMATIONS AND PROBABLE STRUCTURE A'

0 200 400 600 800 FEET

HORIZONTAL AND VERTICAL SCALE



GEOLOGIC MAP OF PFEIFFER BIG SUR STATE PARK

MONTEREY COUNTY, CALIFORNIA

STATE DIVISION OF MINES
OLAF P. JENKINS, CHIEF

SCALE

400 0 400 800 1200 FEET

Base map by U.S. Department of the Interior, National Park Service, cooperating with State Division of Beaches and Parks 1940 & 1946

Geology surveyed by Gordon B. Oakeshott 1950

Figure 37

DESCRIPTION OF MAP UNITS

EAST OF SOQUEL CREEK

Qc COLLUVIUM
For descripti n, see West of Soquel Creek column

Qal ALLUVIAL DEPOSITS, UNDIFFERENTIATED
For descripti n, see West of Soquel Creek column

Qyf YOUNGER FLOOD-PLAI DEPOSITS (Holocene): Unconsolidated, relatively fine grained, heterogeneous deposits of sand and silt, commonly with relatively thin, discontinuous layers of clay. Gravel content increases toward the Santa Cruz Mountain and is locally abundant within channel and lower point bar deposits in n tural levees and channels of meandering streams. Thickness generally les than 20 ft. Moderate permeability and porosity. Depth to water table c mmonly less than 5 ft. Relatively high susceptibility to flooding exce t in areas protected by artificial levees. Gravel-rich layers may be used f r artificial ground-water recharge (Muir, 1972). High liquefaction potential. I cludes Metz, Mocho, and Corralitos Soil Series (Storie and others, 1944)

Qof OLDER FLOOD-PLAIN EPOSITS (Holocene): Unconsolidated, relatively fine grained sand, silt, a d clay. More than 20C ft thick beneath parts of the Pajaro and San Loren o River flood plain. Lower parts of these thick fluvial aggradational deposits are ighly graveliferous, and serve as major ground-water aquifers beneath the P jaro Valley (Muir, 1972). Rivers are presently entrenched as much as 20 ft below surface of these deposits except along coast. Moderate permeability nd porosity. Depth to water table variable; generally more than 10 ft, c mmonly less than 5 ft near coast. High susceptibility to flooding only near the coast. High liquefaction potential in areas where water table h gh, elsewhere moderately high to moderately low. Includes Pajaro, Soquel, Salin s, and Botella Soil Series

Qf ALLUVIAL FAN DEPOSI S (Holocene): Unconsolidated, moderately to poorly sorted sand, silt, and gra el, with layers of silty clay. Generally coarsest nearest the mountain front. Thickness uncertain, but may locally be greater than 50 ft. Present strea entrenched along entire fan. Depth to water table ranges from 10 to 20 ft; l cally perched water tables may occur. Moderate permeability. Relatively lo susceptibility to flooding. Possible area for ground-water recharge. Mo ly moderately low liquefaction potential but moderately high where water s urated and well-sorted sand and silt present. Includes Soquel and Salinas So l Series, and locally may include Elder Soil Series

Qb BASIN DEPOSITS
For descripti , see West of Soquel Creek column

Qds DUNE SAND (Holocen Unconsolidated, well-sorted, fine- to medium-grained sand. Deposited as l near strip of coastal dunes. May be as much as 80 ft thick. High porosity nd permeability. Well drained. Low susceptibility to flooding. Moderately hig liquefaction potential. Soils poorly developed or absent. Accelerated er sion likely in areas where vegetation disturbed or removed

Qbs BEACH SAND
For descriptio , see West of Soquel Creek column

Qcf ABANDONED CHANNEL F LL DEPOSITS (Holocene): Unconsolidated, plastic, poorly sorted clay, silty clay, and silt. Deposited within abandoned channels on younger and older floo -plain deposits. Thickness generally less than 10 ft. Low permeability. Poor drainage. High susceptibility to flooding. High liquefaction potential. Ma include Alviso, Clear Lake, and Soquel Soil Series

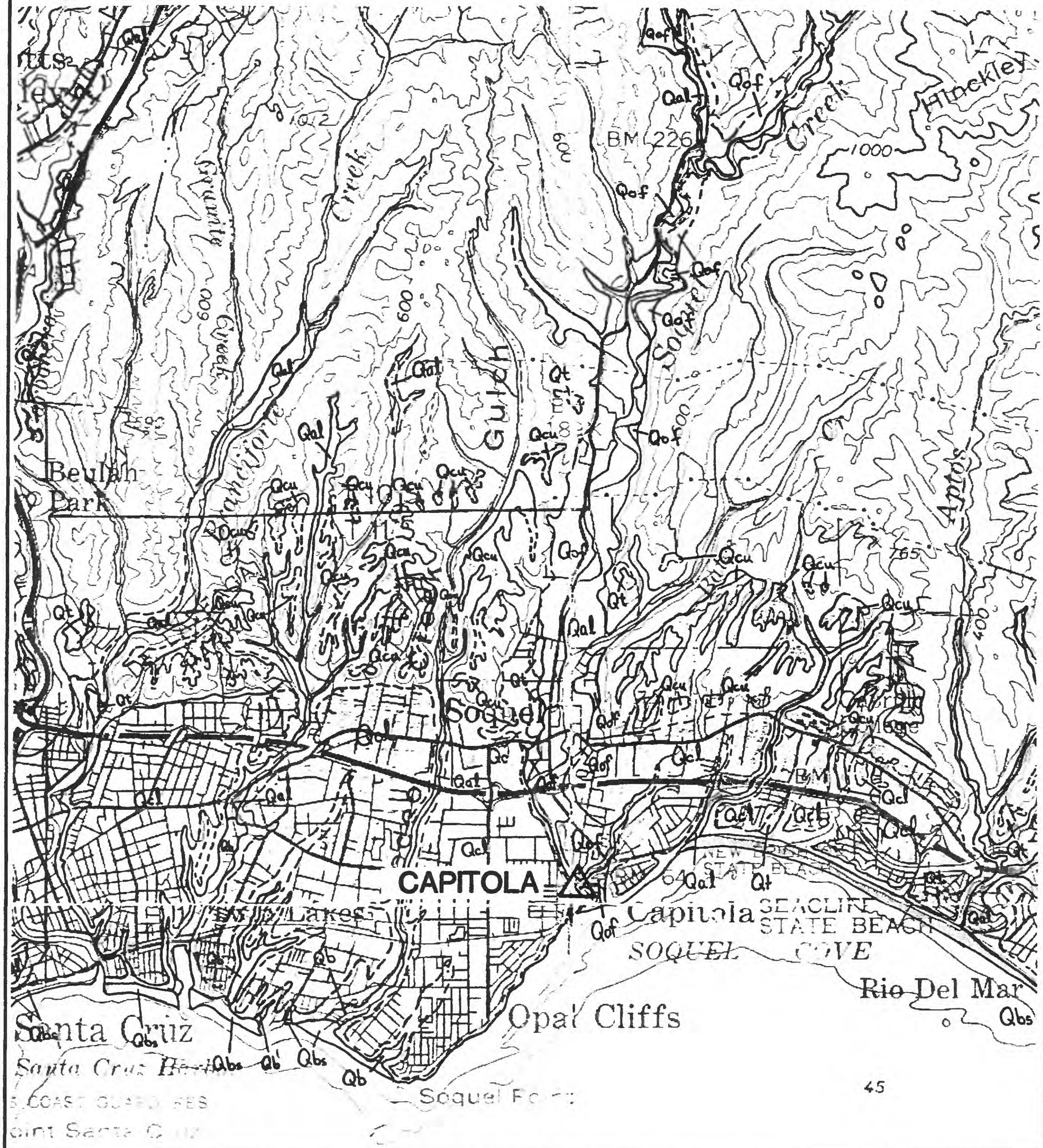
Qes EOLIAN DEPOSITS OF UNSET BEACH
For descriptio , see West of Soquel Creek column

Qt TERRACE DEPOSITS, NDIFFERENTIATED
For descripti n see, West of Soquel Creek column

QTc CONTINENTAL DEPOSI S, UNDIFFERENTIATED (Pliocene? and Pleistocene): Semiconsolidated, relatively fi e grained, oxidized sand and silt. Generally underlie fluvial lithofacies (Caf). May represent highly weathered eolian deposits formed on Pliocene mari e deposits (Purisima Formation). Moderate permeability and porosity. Low liquefaction potential. Erosion problems in areas where poorly consolidated parts of unit are exposed. Includes Moro Cojo Soil Series

DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

MISCELLANEOUS FIELD STUDIES
MAP MF– 648



SCALE 1:62 500

1 ½ 0 1 2 3 4 5 MILES

1 .5 0 1 2 3 4 5 6 7 KILOMETERS

MAPS SHOWING GEOLOGY AND LIQUEFACTION POTENTIAL OF QUATERNARY DEPOSITS IN SANTA CRUZ COUNTY, CALIFORNIA
by
William R. Dupré
1975

Figure 38

NE. OF SAN ANDREAS FAULT

QUATERNARY

Holocene

Qg | Qa

Surficial sediments
Qg-stream gravel and sand
Qa-alluvium

Qls | Qlv

Landslide rubble
Qls-landslide of non volcanic debris
Qlv-landslide of volcanic debris

Pleistocene

Qoa | Qoa_3 | Qoa_2 | Qoa_1

Older alluvium
Qoa-undifferentiated
Qoa_3-lowest (youngest) terrace deposits
Qoa_2-intermediate terrace deposits
Qoa_1-highest (oldest) terrace deposits

UNCONFORMITY

QIv

Boulder gravel of volcanic debris
(Dos Picachos Gravels of Taliaferro 1945)

Plio. & Pleist.

QTs | QTb

Valley deposits (gravel, sand, silt)
QTs-Santa Clara Formation (San Benito Gravel of Wilson, 1943, Taliaferro, 1945)
QTb-Olivine basalt*

Pliocene

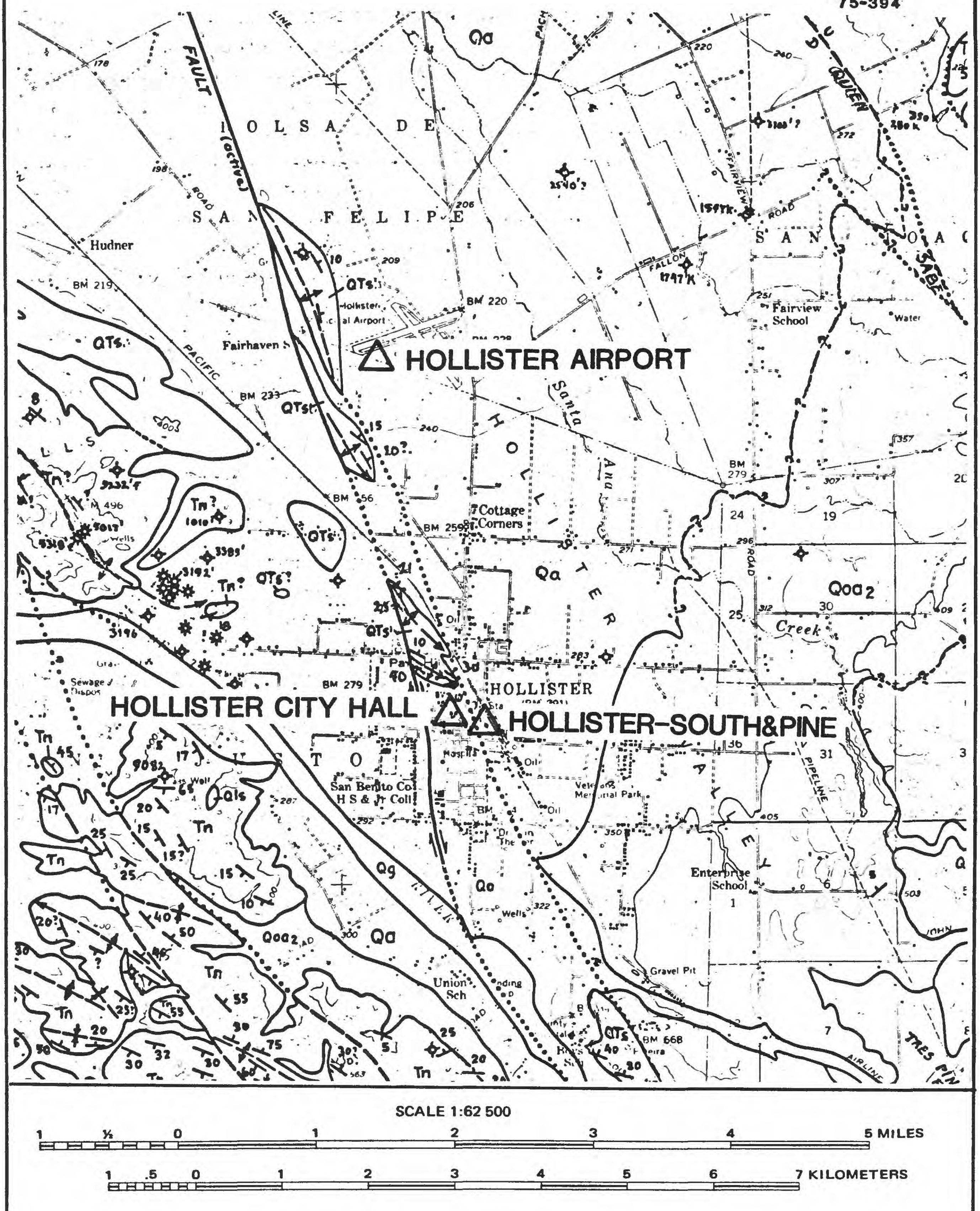
Tn | Te

Sedimentary rocks
(weakly consolidated clastic sedimentary rocks of Pliocene age; mapped as Purisima Formation by Taliaferro, 1945)
Tn-nonmarine sedimentary rocks (greenish gray to rarely reddish claystone, siltstone and interbedded friable buff-gray sandst.)
Te-Etchegoin Formation (brownish gray thick bedded sandstone and minor interbedded gray micaceous siltstone; brackish-marine & marine)

U.S. GEOLOGICAL SURVEY

OPEN FILE MAP

75-394



GEOLOGIC MAP OF THE HOLLISTER QUADRANGLE, CALIFORNIA

Geology by T.W. Dibblee Jr. & T.H. Rogers

Figure 39

Qg
Qr
Qa

Surficial deposits
Qg- sand and gravel of present stream channels
Qr- river sand
Qa- valley alluvium

Qls

Landslide debris

Qos | Qoa
Qog

Older surficial deposits
Qos-old dune sand
Qoa-older alluvium
Qog-older gravel and sand

UNCONFORMITY

Qar

Aromas Sand
(of Allen, 1950; Bowen, 1965)
(old wind-blown sand)

QTp

Paso Robles Formation
(valley gravel, sand and clay)

UNCONFORMITY

Tsm

Santa Margarita Sandstone
(white, marine and terrestrial; upper Miocene)

Tmd | Tms
Tm | Tmg

Monterey Shale
and unnamed units
(marine, upper Miocene)
Tmd- diatomite of Monterey Shale (Canyon del Rey Diatomite Member of Bowen, 1965)
Tm- siliceous shale of Monterey Shale (Aguajito Shale Member of Bowen, '65)
Tms-unnamed sandstone (marine and terrestrial white arkosic sandstone and conglomerate)
Tmg-granitic conglom. and sandstone (terrestrial)

Tts

Marine sandstone
(light gray, middle Miocene; Los Laureles Sandst. Mbr. of Monterey Fm. & Los Tularcitos Sandst. Mbr. of Chamisal Fm. of Bowen, 1965)

UNCONFORMITY

qm | gd | grd

Granitic rocks
qm, primarily quartz monzonite
gd, primarily granodiorite
grd, granodiorite

hqd

Dioritic rocks
hqd-hornblende-biotite quartz diorite to diorite

ml/ms | msc

Metasedimentary rocks
ml-marble
ms-schist-gneiss
(include admixtures of dioritic & granitic rocks)
msc-mica-quartz plagioclase schist

Holocene
?
Pleistocene
QUATERNARY
Plio. & Pleist.
QUATERNARY AND TERTIARY
Miocene
TERTIARY
MESOZOIC
MESO. OR OLDER

U.S. GEOLOGICAL SURVEY

OPEN FILE MAP

GEOLOGIC MAP OF THE SALINAS QUADRANGLE, CALIFORNIA

COMPILED BY THOS. W. DIBBLEE JR., 1973

Figure 40

QUATERNARY

Holocene

Qr | Qa | Qls

Surficial deposits
Qr, man made rock fill
Qa, alluvium, (gravel, sand & clay)
Qls, landslide debris

UNCONFORMITY

Pleistocene

Qoa

Older alluvium

UNCONFORMITY

Qsc

Santa Clara Formation
(non-marine, gravel, sand and clay)

UNCONFORMITY

TERTIARY

rh

Alum. Rock Rhyolite of Crittenden, 1951

Pliocene

Tor | Tb

Orinda Formation
non-marine conglomerate sandstone, red siltstone
Tb - basalt

Miocene

Tbr

Briones Sandstone
(marine sandstone and siltstone, upper Miocene)

Tm

Monterey Shale
Claremont Shale Member
(siliceous shale, mid. Miocene)

Tt

Temblor Sandstone
(marine middle Miocene)

UNCONFORMITY

CRETACEOUS

Ksh | Kss | Kcg

Marine sedimentary rocks
Ksh and Kss, Berryessa Form. of Crittenden, 1951
Ksh, micaceous shale
Kss, sandstone
Kcg, Oakland Conglomerate of Crittenden, 1951

JURASSIC AND/OR CRETACEOUS

sp | sc

Serpentine
sc, silica-carbonate rock

fs | fc | gl | f | fg

Franciscan rocks
fs, undiff. sandstone, (graywacke and micac. shale)
fc, chert
fg, greenstone
gl, glaucophane blue schist
f, mixed rocks, mostly micaceous shale or siltstone, pervasively sheared; contains fragments mostly of graywacke sandstone

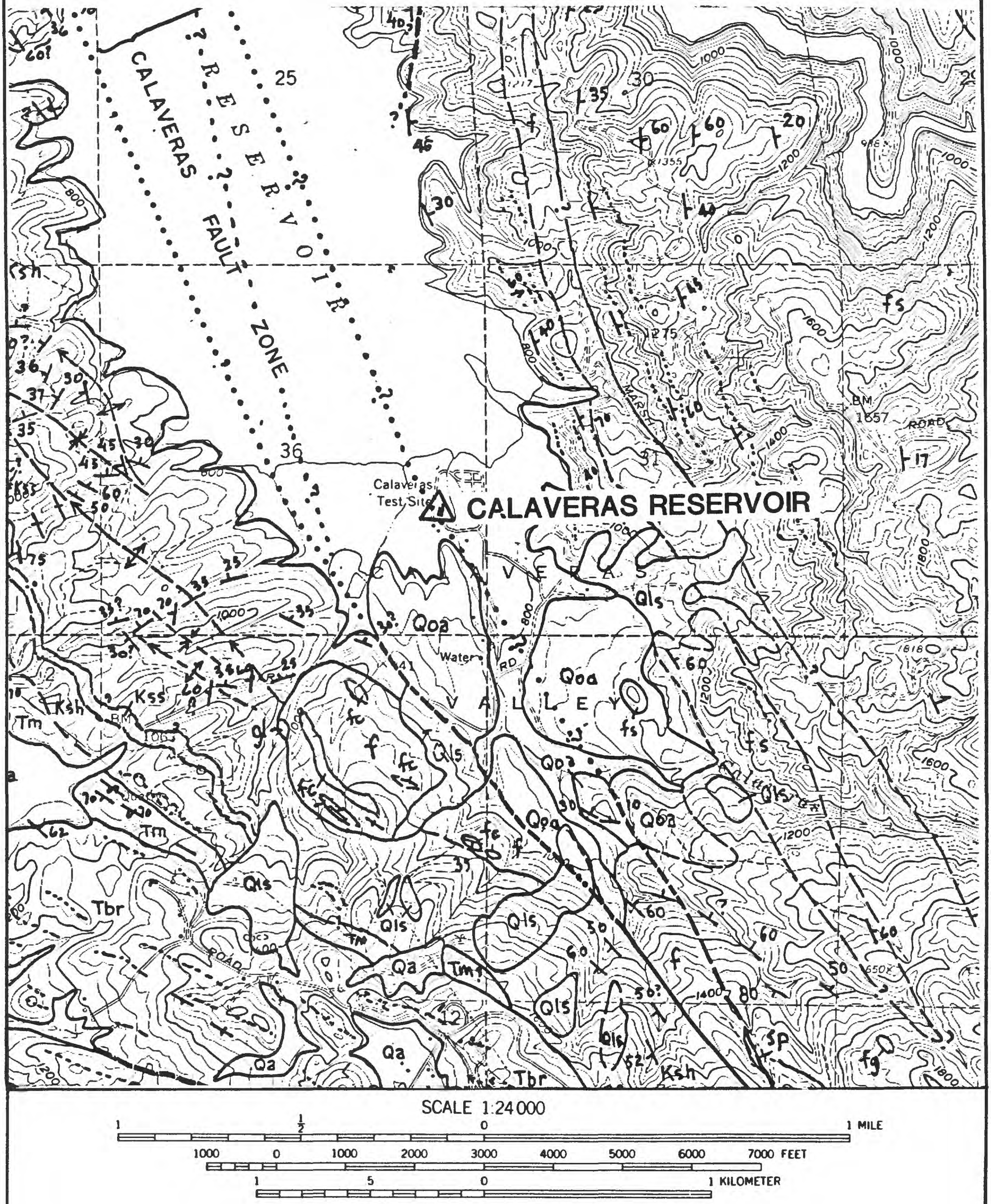
Contact
(dashed where gradational or approximately located)

U / D

Fault
(dashed where inferred; dotted where concealed U-upthrown block, D-downthrown block, relatively; single arrow indicates observed dip of fault; double parallel arrows indicate probable lateral move-

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

**U.S. GEOLOGICAL SURVEY
OPEN-FILE MAP**



PRELIMINARY GEOLOGIC MAP OF THE CALAVERAS RESERVOIR QUADRANGLE, ALAMEDA AND SANTA CLARA COUNTIES, CALIFORNIA
By Thomas W. Dibblee Jr., 1973

Figure 41

Qg
Qf | Qa | Qls

Surficial deposits
Qg, stream gravel and sand
Qf, alluvial fan gravel
Qa, alluvium (gravel, sand and clay)
Qls, landslide debris

Qoa

Older alluvium

UNCONFORMITY

Qsc

Santa Clara Formation (valley sediments, gravel and clay)

UNCONFORMITY

Holocene ? Pleistocene — QUATERNARY

a

Andesitic rock

Tbr

Briones Sandstone (marine, Upper Miocene)

Tm | Tma
Tma

Monterey Shale (Claremont Shale Member)
Tm, siliceous shale
Tma, clay shale

Miocene — TERTIARY

UNCONFORMITY

Ksh | Kshu | Kssu
Kcgo
Kshl

Marine sedimentary rocks
Ksh, micaceous shale, undivided
Kshu and Kssu, Berryessa Form. of Crittenden, 1950
Kshu, shale
Kssu, sandstone
Kcgo, Oakland conglomerate of Crittenden, 1950
Kshl, Knoxville Formation of Crittenden, 1950. micac. shale

CRETACEOUS

sp

Serpentine

fs | fg | fc | f | gl

Franciscan rocks
fs, sandstone (graywacke) and micac. phyllitic shale
fg, greenstone
fc, chert
f, mixed rocks, mostly graywacke and shale pervasively sheared
gl, glaucophane blueschist

JURASSIC AND/OR CRETACEOUS

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

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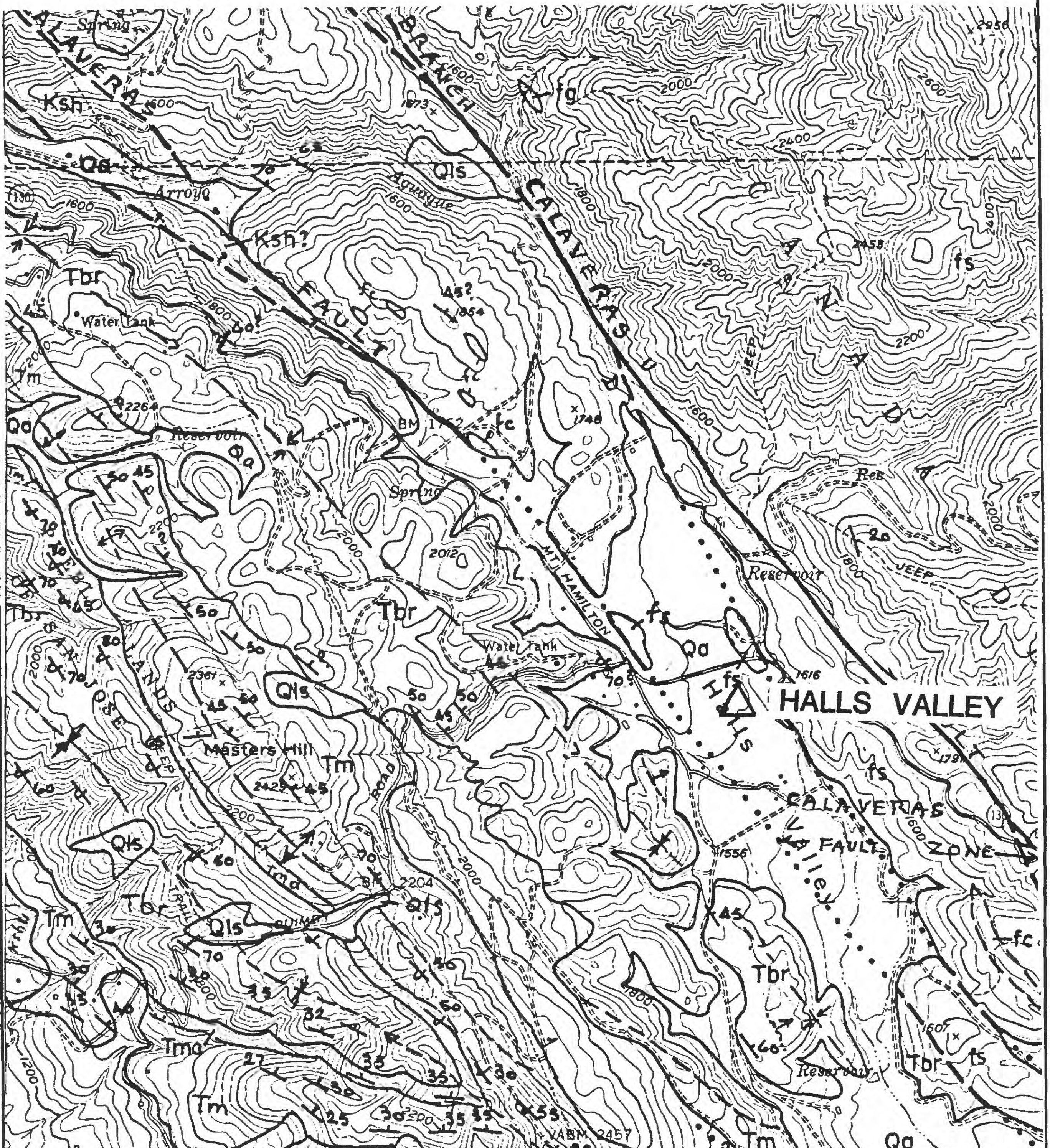

SCALE 1:24 000

1 ½ 0 1 MILE

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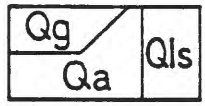
1 .5 0 1 KILOMETER

PRELIMINARY GEOLOGIC MAP OF THE LICK OBSERVATORY QUADRANGLE, SANTA CLARA COUNTY, CALIFORNIA

By Thomas W. Dibblee Jr., 1972

Figure 42

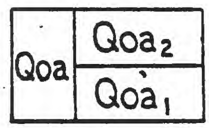
UNITS NORTHEAST OF SAN ANDREAS FAULT



Surficial sediments
Qg; gravel and sand of stream channels
Qa; alluvium of flood plains
Qls; landslide debris

Holocene

UNCONFORMITY



Older alluvium
Qoa; terrace deposits
Qoa_2; lower terraces
Qoa_1; higher, older terraces

UNCONFORMITY

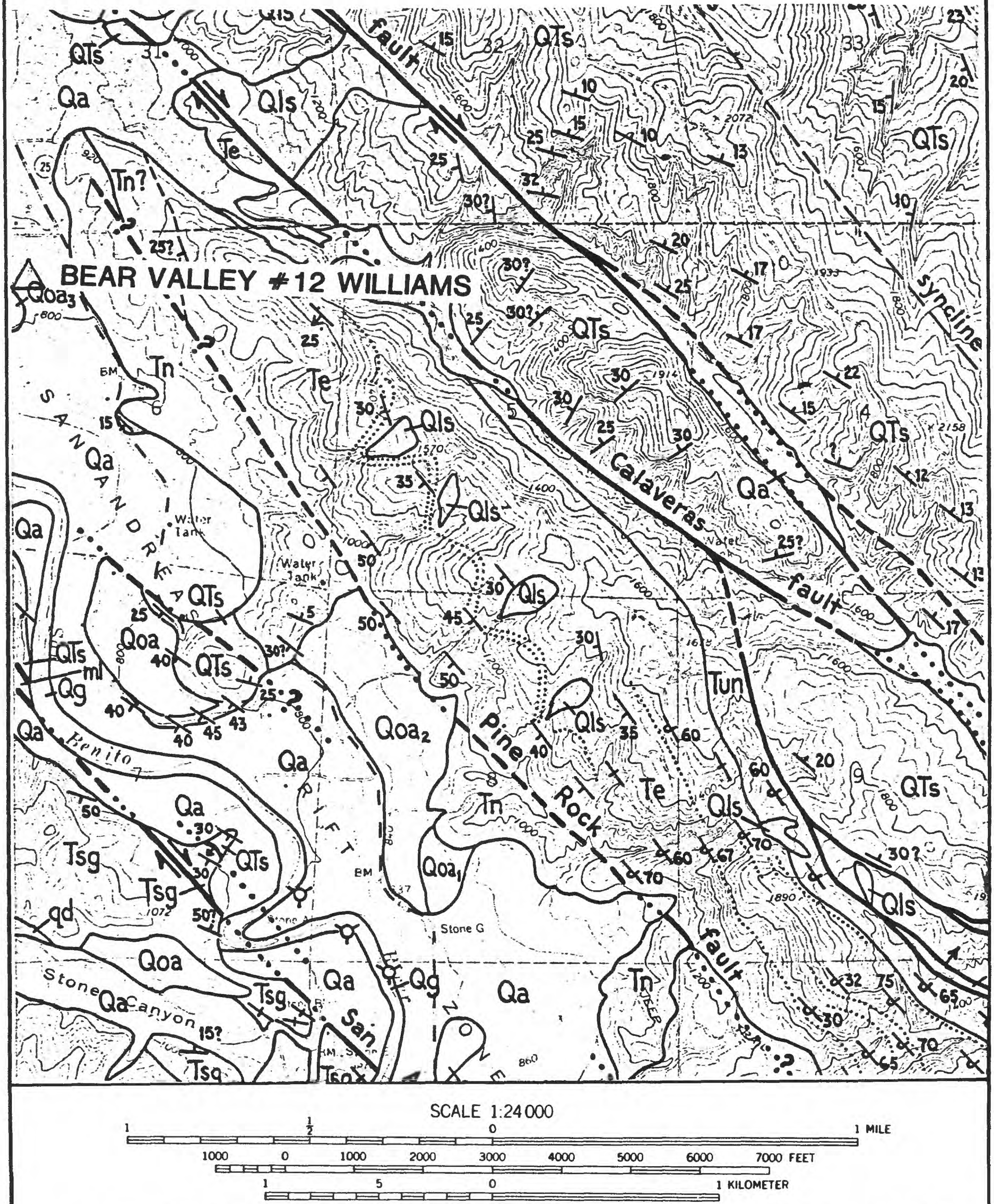
Valley sediments
Santa Clara Formation or San Benito Gravel of Wilson, (1943)
QTs; weakly indurated gravel, or conglomerate, sand and clay
QTv; gravel of andesitic volcanic detritus

Pleistocene

QUATERNARY

DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

OPEN FILE REPORT 79-703



PRELIMINARY GEOLOGIC MAP OF THE CHERRY PEAK QUADRANGLE, SAN BENITO COUNTY, CALIFORNIA

By Thomas W. Dibblee, Jr.

1979

Figure 43

UNITS NORTHEAST OF SAN ANDREAS FAULT

Qg | Qa | Qls

Surficial sediments
Qg; gravel and sand of stream channels
Qa; alluvium of flood plains
Qls; landslide debris

Holocene

UNCONFORMITY

Qoa | Qoa$_2$ | Qoa$_1$

Older alluvium
Qoa; terrace deposits
Qoa$_2$; lower terraces
Qoa$_1$; higher, older terraces

UNCONFORMITY

QTs | QTv

Valley sediments
Santa Clara Formation or San Benito Gravel of Wilson, (1943)
QTs; weakly indurated gravel, or conglomerate, sand and clay
QTv; gravel of andesitic volcanic detritus

Pleistocene

QUATERNARY

DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

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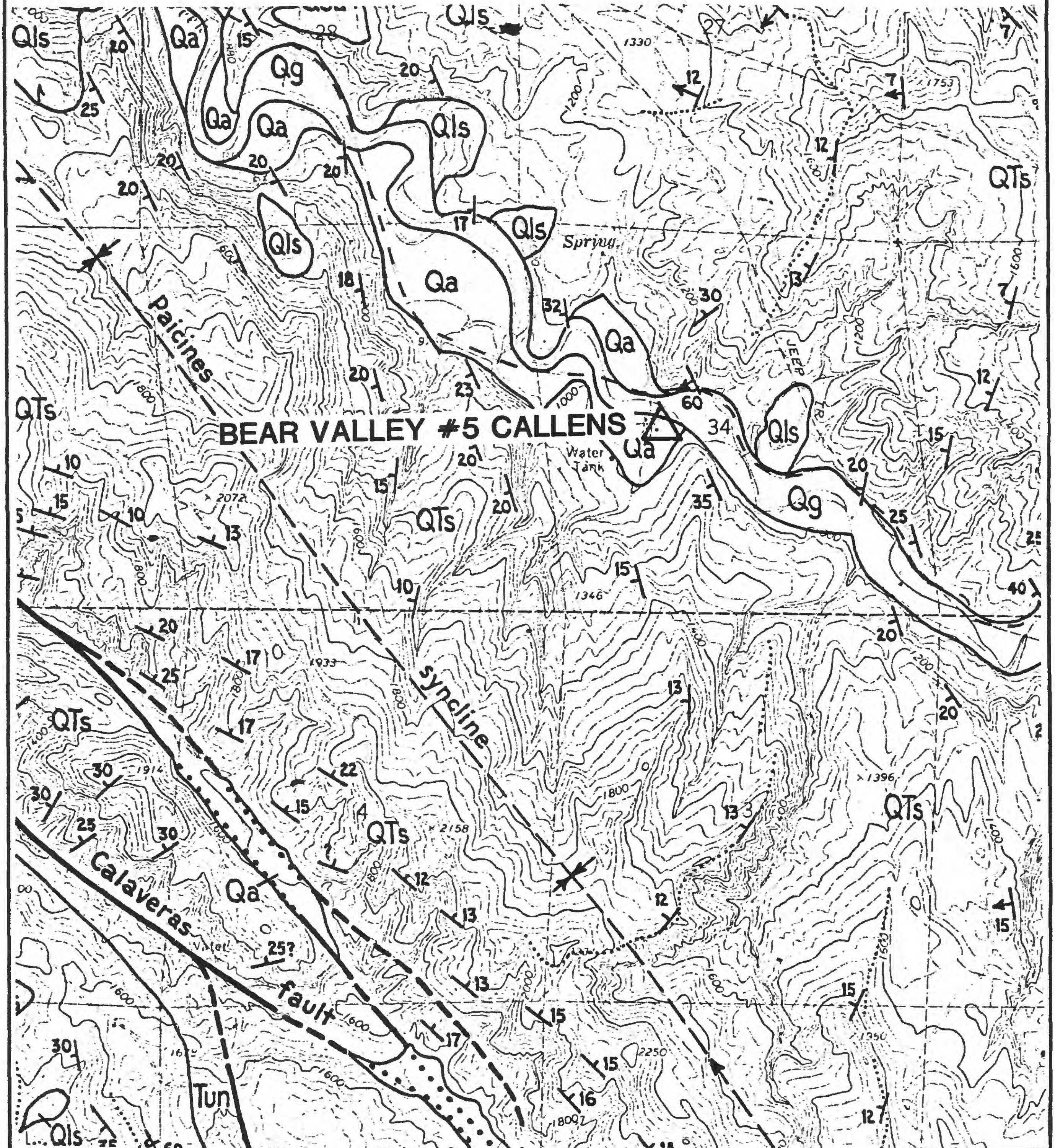


SCALE 1:24 000

1 ½ 0 1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 .5 0 1 KILOMETER

PRELIMINARY GEOLOGIC MAP OF THE CHERRY PEAK QUADRANGLE, SAN BENITO COUNTY, CALIFORNIA

By Thomas W. Dibblee, Jr.
1979

Figure 44

UNITS SOUTHWEST OF SAN ANDREAS FAULT

Qg / Qa | Qls

Surficial deposits
Qg; gravel and sand of stream channels
Qa; alluvium of small valleys
Qls; landslide debris

(Holocene — QUATERNARY)

UNCONFORMITY

QTp / gs / f

Valley deposits (Paso Robles Formation)
QTp; greenish clays, sands and pebble gravel
f; landslide masses of Franciscan detritus at base of valley deposits
gs; Franciscan greenstone detritus at base of valley deposits

(Pliocene and Pleistocene)

UNCONFORMITY

Tvd | Tvb | Tvp | Tsg | Tm

Volcanic and sedimentary rocks
Tvd; intrusive dacite-rhyolite
Tvb; breccia of rhyolitic detritus
Tvp; Pinnacles Formation of Wilson, (1943) rhyolitic breccia and tuff-breccia
Tsg; terrestrial conglomerate of unsorted granitic detritus minor rhyolitic detritus
Tm; Monterey Shale, marine and brackish-marine; white-weathering siliceous shale; upper Miocene

(Miocene — TERTIARY)

UNITS NORTHEAST OF SAN ANDREAS FAULT

Qg / Qa | Qls

Surficial deposits
Qg; gravel and sand of stream channels
Qa; alluvium
Qls; landslide debris

(Holocene — QUATERNARY)

UNCONFORMITY

Qoa

Older alluvium

(Pleistocene)

UNCONFORMITY

QTs

Valley sediments
Santa Clara Formation or San Benito Gravel of Wilson, (1943)
Weakly indurated gravel or conglomerate sand or sandstone and claystone

Tn / Te / Tun

Sedimentary rocks
Tn; terrestrial pebbly to sandy greenish clay
Te; Etchegoin Formation, marine light brown fossiliferous sandstone and gray siltstone
Tun; terrestrial red and green clay, sand, and pebble conglomerate of Franciscan detritus

(Pliocene — TERTIARY)

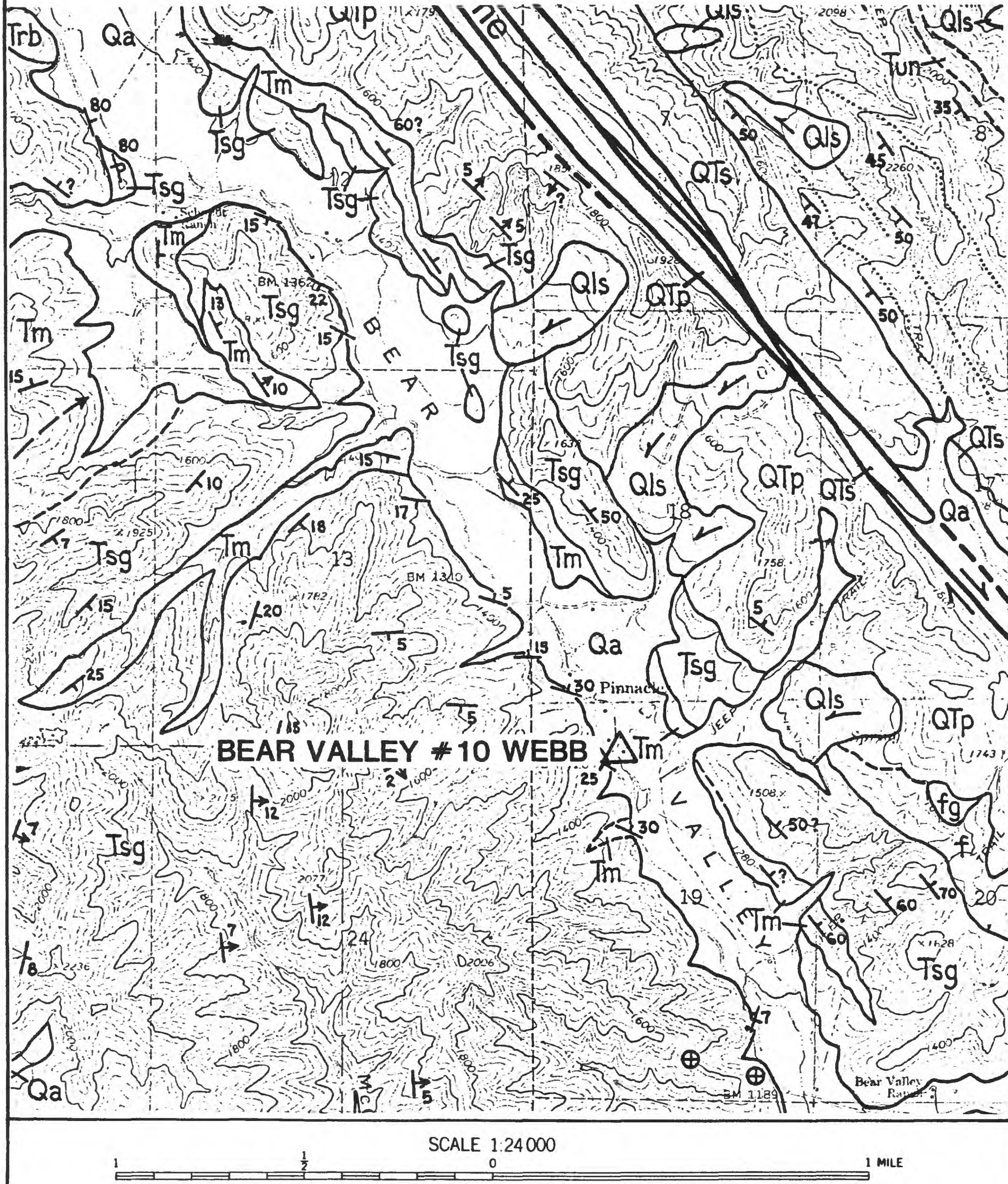
Tsm

Santa Margarita Formation
Marine and brackish gray sandstone, siltstone and calcareous reefs; fossiliferous; upper Miocene

(Miocene)

DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

OPEN FILE REPORT 79-701



SCALE 1:24000

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PRELIMINARY GEOLOGIC MAP OF THE BICKMORE CANYON QUADRANGLE, SAN BENITO AND MONTEREY COUNTIES, CALIFORNIA

By Thomas W. Dibblee, Jr.
1979

Figure 45

Qa | Qls

Surficial deposits

Qa; alluvium
Qls; landslide debris*

(Holocene — QUATERNARY)

Unconformity

Qoa

Older alluvium

(Pleistocene — QUATERNARY)

Unconformity

QTt

Tassajara Formation

QTt; weakly indurated light greenish-gray mudstone, minor thin lenses of sandstone and pebble conglomerate

Tri

Rhyolitic intrusive

(Pliocene and/or Pleistocene — TERTIARY AND/OR QUATERNARY)

Tps

Nonmarine sedimentary rocks

Tps; weakly indurated pebble conglomerate, sandstone and greenish gray mudstone; few tuff beds

(Pliocene — TERTIARY)

Tn
Tmss
Tmsl
Tmso

Sedimentary rocks

Tn; Neroly Formation(?), mostly nonmarine, partly marine claystone, siltstone and sandstone, locally pebbly
Tmss; marine gray to tan sandstone, locally pebbly with clam shell beds, minor siltstone; (includes Briones and Cierbo Sandstones)
Tmsl; marine siltstone, massive, gray, some interbedded sandstone, locally has conglomerate at base
Tmso; Sobrante Sandstone (?), marine wacke sandstone and pebbly conglomerate

(Miocene — TERTIARY)

Unconformity

Tds

Domengine Sandstone

Tan, arkosic sandstone

Tmgs / Tmg

Meganos (?) Formation

Tmg; mainly clay shale
Tmgs; sandstone, locally pebbly at base

(Eocene — TERTIARY)

Unconformity (?)

Km
Kmi

Moreno Shale

Km; micaceous claystone
Kmi; semi-siliceous shale

Kp / Kps

Panoche Formation

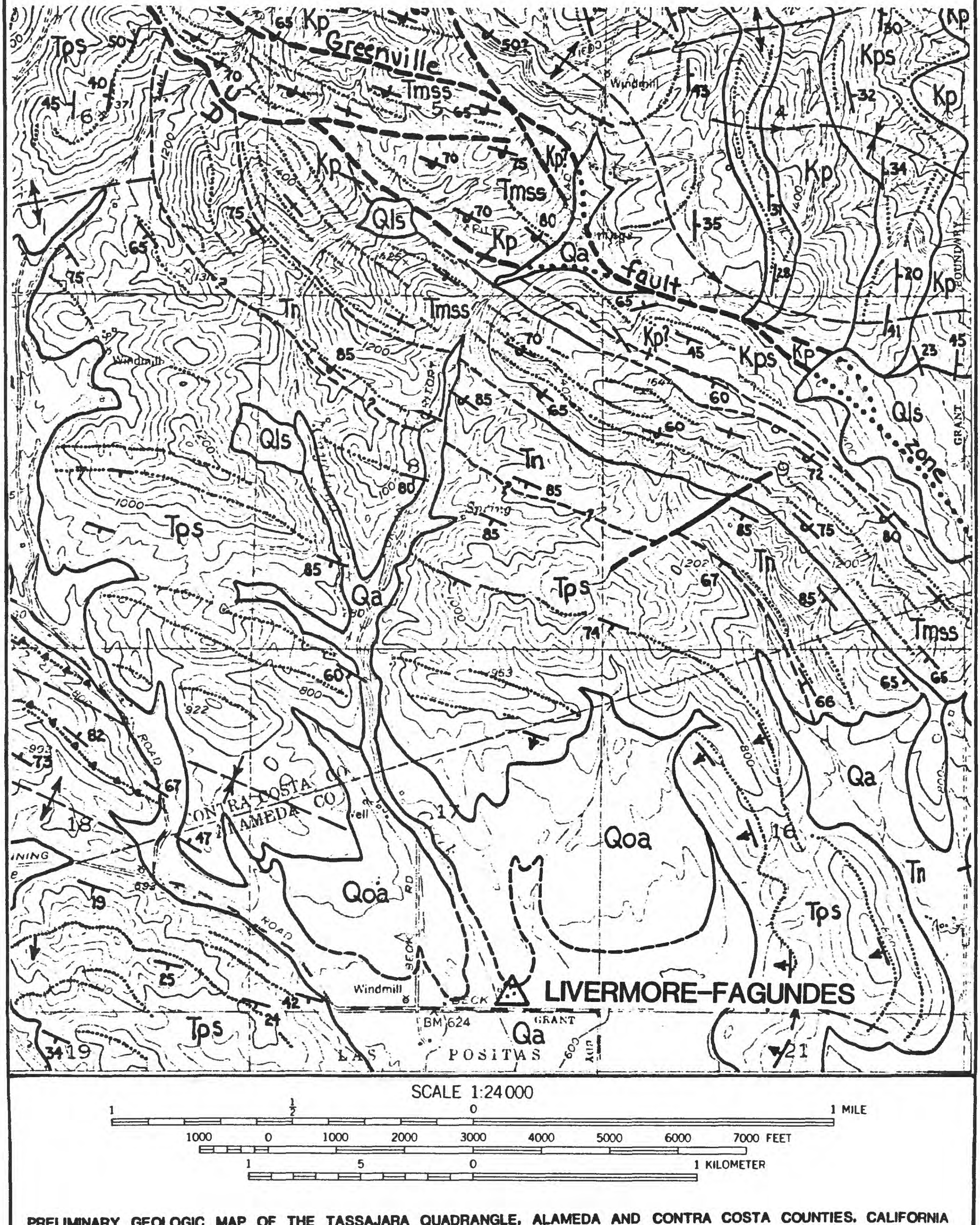
Kp; micaceous clay shale, some thin sandstone interbeds
Kps; arkosic sandstone, locally contains large concretions; thin shale interbeds

(Upper Cretaceous — CRETACEOUS)

DEPARTMENT OF THE INTERIOR

UNITED STATES GEOLOGICAL SURVEY

OPEN-FILE REPORT 80- 544



PRELIMINARY GEOLOGIC MAP OF THE TASSAJARA QUADRANGLE, ALAMEDA AND CONTRA COSTA COUNTIES, CALIFORNIA

by

Thomas W. Dibblee, Jr.

1980

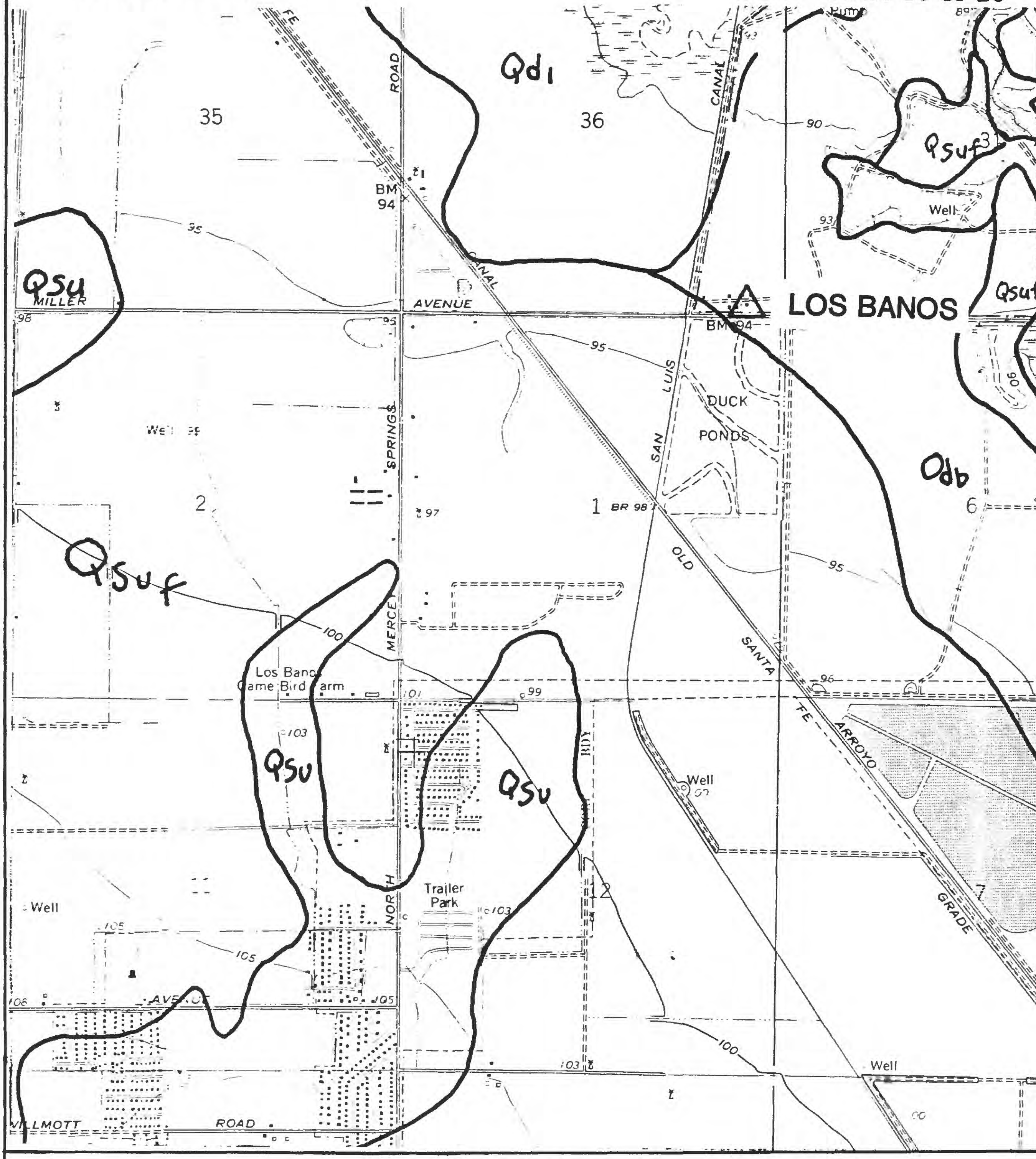
Figure 46

Qaf	Artificial fill.
Qd	Dos Palos alluvium (early Holocene to modern)
	Divided into:
Qd_t	Fine- to coarse-grained, arkosic, terrace levee, point bar and abandoned channel deposits along the San Joaquin River and associated sloughs of Sierra Nevada provenance.
Qd_c	Coarse-grained, arkosic, channel deposits along the San Joaquin River and associated sloughs of Sierra Nevada provenance.
Qd_b	Fine-to-coarse grained, arkosic overbank deposits on the floodbasin of the San Joaquin River and associated sloughs
Qd_l	Areas of active lake, pond, and marsh deposition.
Qd_e	Areas of active eolian deposition or wind reworking of arkosic floodbasin deposits.
Qdm_b	Dos Palos alluvium and Modesto Formation (Marchand and Allwardt, 1981) floodbasin deposits undifferentiated (late Pleistocene to early Holocene)
	Patterson alluvium (early Holocene to modern)
	Divided into:
Qp	Coarse-grained terrace and upper-fan deposits of Coast Range provenance.
Qp_c	Coarse-grained stream channel deposits of Coast Range provenance.
Qp_m	Coarse to fine-grained mudflow deposits of Coast Range provenance.
Qp_f	Fine-grained middle and lower-fan deposits of Coast Range provenance.
Qps	Patterson and San Luis Ranch alluvium undifferentiated (early Holocene).
Qs	San Luis Ranch alluvium (late Pleistocene and early Holocene)
	Upper member. Divided into:
Qsu	Principally coarse-grained terrace and upper-fan deposits of Coast Range provenance.
Qsu_m	Coarse to fine-grained mudflow deposits of Coast Range provenance.
Qsu_f	Fine-grained middle and lower-fan and floodplain deposits of Coast Range provenance.
Qsu_c	Fine to coarse-grained colluvial deposits of Coast Range provenance.
	Lower member. Divided into:
Qsl	Principally coarse-grained terrace and upper-fan deposits of Coast Range provenance.
Qsl_m	Fine- to coarse-grained mudflow deposits of Coast Range provenance.
Qsl_l	Fine-grained middle and lower-fan deposits of Coast Range provenance.
Qsl_c	Fine-to-coarse grained colluvial deposits of Coast Range provenance.
Qm	Modesto Formation (Marchand and Allwardt, 1981), upper member (late Pleistocene).
	Divided into:
Qm	Fine-grained, arkosic lower-fan deposits of Sierra Nevada provenance.
Qm_b	Fine-grained arkosic, overbank deposits on the floodbasin of the San Joaquin River and associated sloughs of Sierra Nevada provenance.
Ql	Los Banos alluvium (middle and late Pleistocene)
	Principally coarse-grained terrace, pediment and upper-fan deposits of Coast Range provenance.
	Locally divided into:
Qlu	Upper Member
Qlm	Middle member
Qll	lower member
Ql_s	Original surface upon which Los Banos alluvium accumulated but has since been removed.
QTt	Tulare Formation (Upper Pliocene and Pleistocene) Fine to coarse-grained floodplain, alluvial-fan and terrace deposits derived principally from the central Diablo Range.
Tol	Oro Loma Formation of Briggs (1953) (late Miocene and early(?) Pliocene) Fine to coarse-grained floodplain and alluvial-fan deposits derived from the central Diablo Range. Locally contains lacustrine clay and silt near top.
Tc	Carbona Formation of Pelletier (1951) (late Miocene and early(?) Pliocene).
Tvs	Valley Springs Formation (Bartow, 1981) (upper Oligocene and lower Miocene)
Tp	sandstone of Poverty Flat (Collins, 1950) (upper Eocene and lower Oligocene).
Tk	Kreyenhagen Shale (Anderson, 1905) (middle and upper Eocene).
Td	Domengine Sandstone (Anderson, 1905) (middle Eocene)
Tls	Laguna Seca Formation of Payne (1951) (Paleocene and lower Eocene).
Tt	Tesla Formation (Huey, 1943) (Paleocene and lower Eocene).
TKgv	Great Valley Sequence (Cretaceous and early Paleogene (?))
KJf	Franciscan assemblage (late Jurassic(?) to Cretaceous).

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

OPEN-FILE REPORT 82-526

Plate 10 of 26



SCALE 1:24000

1 ½ 0 1 MILE

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1 .5 0 1 KILOMETER

GEOLOGIC MAP OF LATE CENOZOIC DEPOSITS OF THE WEST-CENTRAL SAN JOAQUIN VALLEY, CALIFORNIA

by

W. R. Lettis 1982

Figure 47

SW of San Andreas Fault

QUATERNARY

Holocene

Qrs
River sand

Qc
Clay

Qa
Alluvium

?

Qls
Landslide debris

UNCONFORMITY

Pleistocene

Qoa
Older alluvium

UNCONFORMITY

QTp
Paso Robles Fm.
(terrestrial gravel, sand and clay)

LOCAL UNCONFORMITY ? ?

TERTIARY

Pliocene

Tus
Unnamed sandstone

Tcg
Unnamed conglom.

Tpo
Pancho Rico Fm.
(marine diat. mudstone)

?

Miocene

Tas
Arkosic sandst.

Tsg
Conglomerate & sandst. of granitic and volcanic debris (terrestrial)

Tmc
Tm
Monterey Shale
Tmc, claystone and siltstone
Tm, siliceous shale

Tvs
Vaqueros Sandstone ?

Oligocene

Tvp
Pinnacles Fm.
(volcanic breccia & tuff)

Td | Tvb
Volcanic rocks
Td, intr. & extr. felsite (dacite, rhyolite and andesite)
Tvb, vent breccia

MESOZOIC

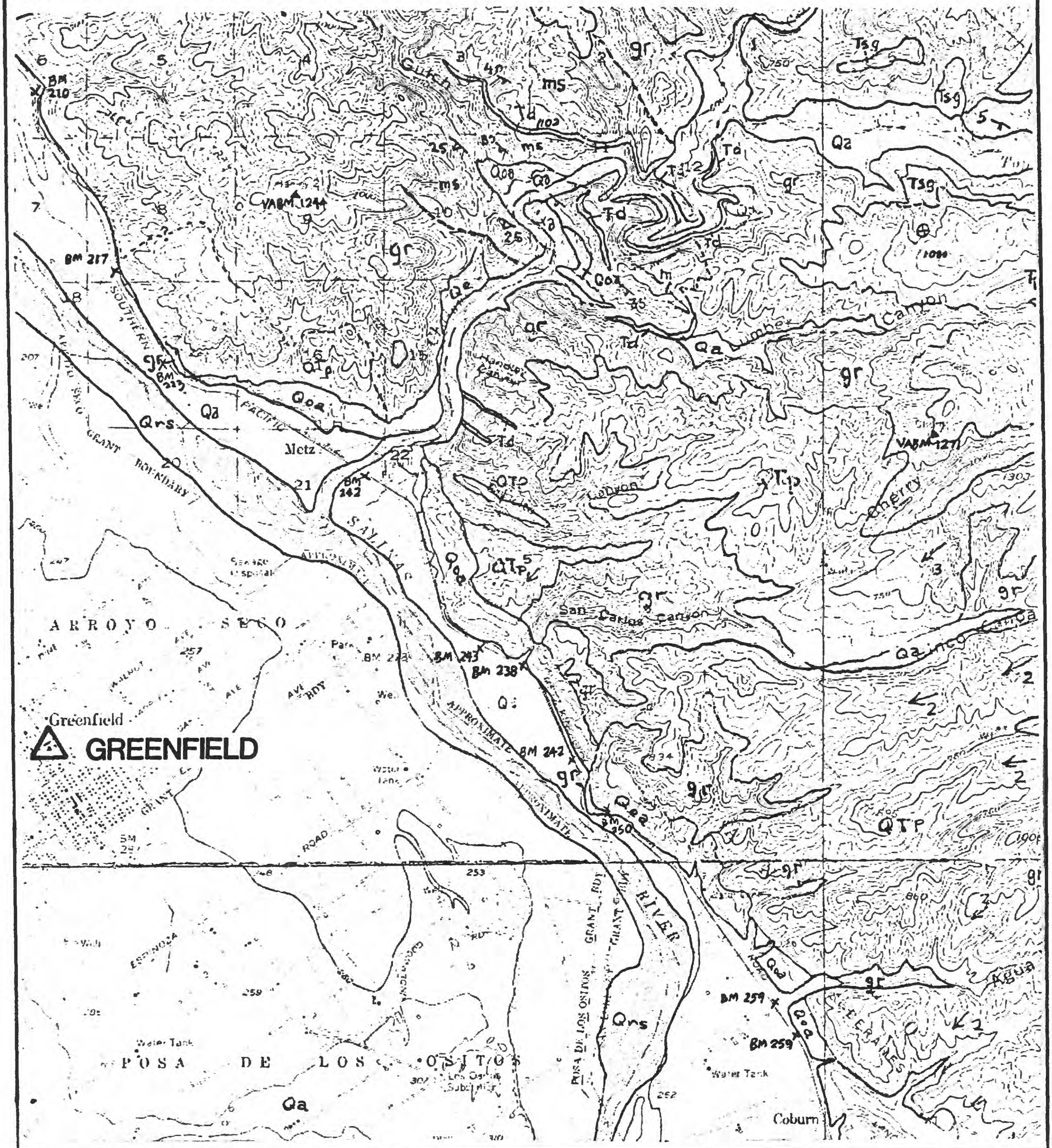
gr
Granitic rocks
(quartz diorite, granodiorite and quartz monzonite)

PALEOZOIC?

ms | m
Metasedimentary rocks
ms, schist-gneiss
m, marble

U.S. GEOLOGICAL SURVEY

OPEN FILE MAP



SCALE 1:24 000

1 ½ 0 1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 .5 0 1 KILOMETER

GEOLOGIC MAP OF THE GREENFIELD QUADRANGLE, CALIFORNIA

Geology by T. W. Dibblee Jr., 1969, 1970. N.W. part (NW and W. of Chalone Creek modified after Philip Andrews, 1936, U.C. Pub. Dept. Geol. Vol. 24, no. 1, pl. 38)

Figure 48

DESCRIPTION OF MAP UNITS

(see attached text for fuller description and discussion)

Qds HYDRAULIC-DREDGE SOILS (Holocene; post-1900)

Qpm PEAT AND MUD OF TIDAL WETLANDS AND WATERWAYS (Holocene)

ALLUVIUM OF SUPRATIDAL FLOOD PLAINS (Holocene) -- Consists of:

Qfp Alluvial-floodplain deposits, undivided

Ql Natural-levee deposits (Holocene)

Qb Flood-basin deposits (Holocene)

EOLIAN DEPOSITS (Pleistocene) -- Consist of:

Qe Eolian deposits, undivided (upper Pleistocene)

Qm2e Eolian deposits of upper member of the Modesto Formation (upper Pleistocene

Qoe Older eolian deposits (upper Pleistocene)

ALLUVIAL-FAN DEPOSITS DERIVED FROM GLACIATED DRAINAGE BASINS (Pleistocene) -- Consist of:

Qm MODESTO FORMATION (Pleistocene) -- Dense stipple - loose sand, probably eolian; light stipple - loose sand and silt, chiefly fluvial; no stipple - compact silt and very fine sand

RIVERBANK FORMATION (Pleistocene) -- As mapped, divided into:

Qr Riverbank Formation, undivided (upper Pleistocene)

Qry Younger unit of the Riverbank Formation (upper Pleistocene)

Qro Older unit of the Riverbank Formation (upper Pleistocene)

ALLUVIAL-FAN AND ALLUVIAL-TERRACE DEPOSITS DERIVED FROM UNGLACIATED DRAINAGE BASINS (Holocene and Pleistocene) -- Consist of:

ALLUVIUM OF PUTAH CREEK (Holocene and Pleistocene) -- Divided into:

Qyp Younger alluvium of Putah Creek (Holocene and(or) upper Pleistocene)

Qop Older alluvium of Putah Creek (upper Pleistocene)

ALLUVIUM OF MONTEZUMA HILLS AND VICINITY (Holocene and Pleistocene) -- Divided into:

Qym Younger alluvium of Montezuma Hills and vicinity (Holocene)

Qom Older alluvium of Montezuma Hills and vicinity (Pleistocene)

ALLUVIUM OF ANTIOCH AND VICINITY (Holocene and Pleistocene) -- Divided into:

Qya Youngest alluvium of Antioch and vicinity (Holocene)

Qia Intermediate alluvium of Antioch and vicinity (upper Pleistocene)

Qoa Oldest alluvium of Antioch and vicinity (upper Pleistocene)

ALLUVIUM OF MARSH CREEK AND VICINITY (Holocene and Pleistocene)

Qymc Younger alluvium of Marsh Creek and vicinity (Holocene and upper Pleistocene)

Qomc Older alluvium of Marsh Creek and vicinity (Pleistocene)

Qch ALLUVIUM OF CREEKS FROM THE CORRAL HOLLOW DRAINAGE TO BRUSHY CREEK (Holocene and(or) upper Pleistocene)

Qcr ALLUVIUM OF CALAVERAS RIVER AND VICINITY (Holocene and(or) upper Pleistocene)

Qmz MONTEZUMA FORMATION (Pleistocene)

TKb BEDROCK (Tertiary and upper Cretaceous)

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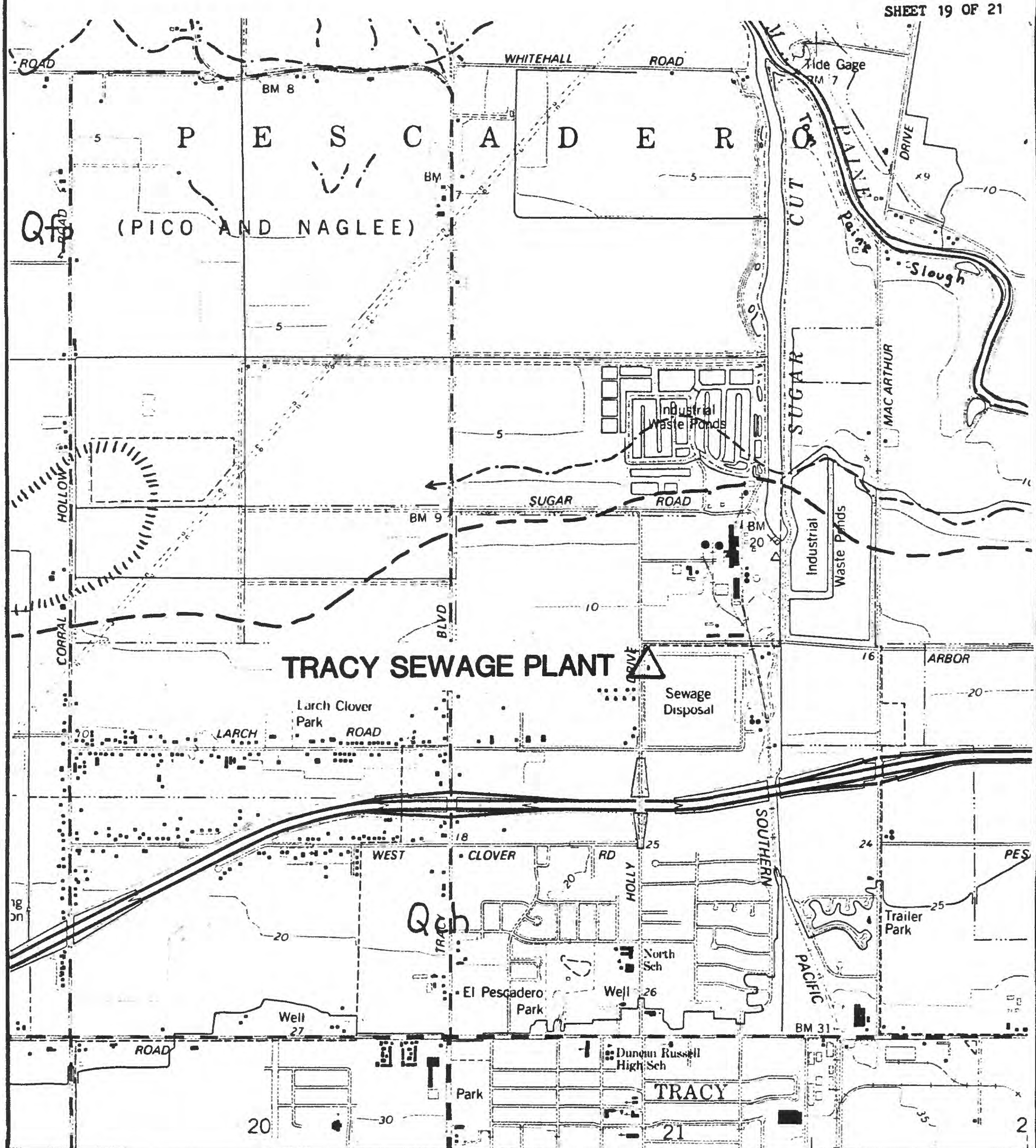
UNITED STATES GEOLOGICAL SURVEY

MISCELLANEOUS FIELD STUDIES
MAP MF — 1401

SHEET 19 OF 21



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1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 5 0 1 KILOMETER

UNION ISLAND

GEOLOGIC MAPS OF THE SACRAMENTO-SAN JOAQUIN DELTA, CALIFORNIA

By

Brian F. Atwater

1982

Figure 49

SW OF SAN ANDREAS FAULT

QUATERNARY

Holocene

- **Qr** River sand & gravel
- **Qa** Alluvium
- **Qls** Landslide rubble

Pleistocene

- **Qoa** Older alluvium

UNCONFORMITY

- **QTp** Paso Robles Fm. (valley sediments)

UNCONFORMITY

TERTIARY

Pliocene

- **Tpo** / **Tps** Pancho Rico Fm.
  Tpo, diatom. mudstone
  Tps, sandstone

UNCONFORMITY

MESOZOIC

- **gr** Granitic rocks

QUATERNARY

Holocene

- **Qr** River sand & gravel
- **Qa** Alluvium
- **Qls** Landsliderubble

Pleist.

- **Qoa** Older alluvium

UNCONFORMITY

TERTIARY

Pliocene

- **Te** / **Tep** Etchegoin Form.
  Tep, pebbly arkosic ss.
  Te, marine sandst. and siltstone
- **Tun** Unnamed non marine conglom. & red beds

UNCONFORMITY

Miocene

- **Tr** Reef Ridge Clay shale
- **Tcg** Unnamed red conglom. and sandstone
- **Tb** Basalt
- **Tm** Monterey Shale (silic. and clay shale)
- **Tt** Temblor Sandstone

UNCONFORMITY

Eocene

- **Tk** / **Tks** Kreyenhagen Shale (clay and sub-silic. shale, Tks, sandstone lenses)
- **Td** Domengine or Avenal (& Yokut) Sandstone
- **Tl** / **Tlc** Lodo Formation
  Tl, clay shale
  Tlc, Cantua Ss. Mbr.

UNCONFORMITY ?

CRETACEOUS

Upper

- **Km** Moreno Shale
- **Kp** / **Kps** / **Kpc** Panoche Formation
  Kp, clayshale
  Kps, sandstone
  Kpc, conglomerate

Lower

- **Kgf** / **Kgs** Gravelly Flat Formation of Ross and Colburn, 1966
  Kgf, dark shale
  Kgs, dark sandstone

JURASSIC OR CRETACEOUS

- **sp** Serpentine
- **db** Diabase
- **f** / **fs** / **fc** / **fg** Franciscan Rocks
  f, mixed rocks, shale, graywacke, chert, greenstone, etc.
  fs, graywacke, sandst.
  fc, chert
  fg, greenstone

UNITED STATES
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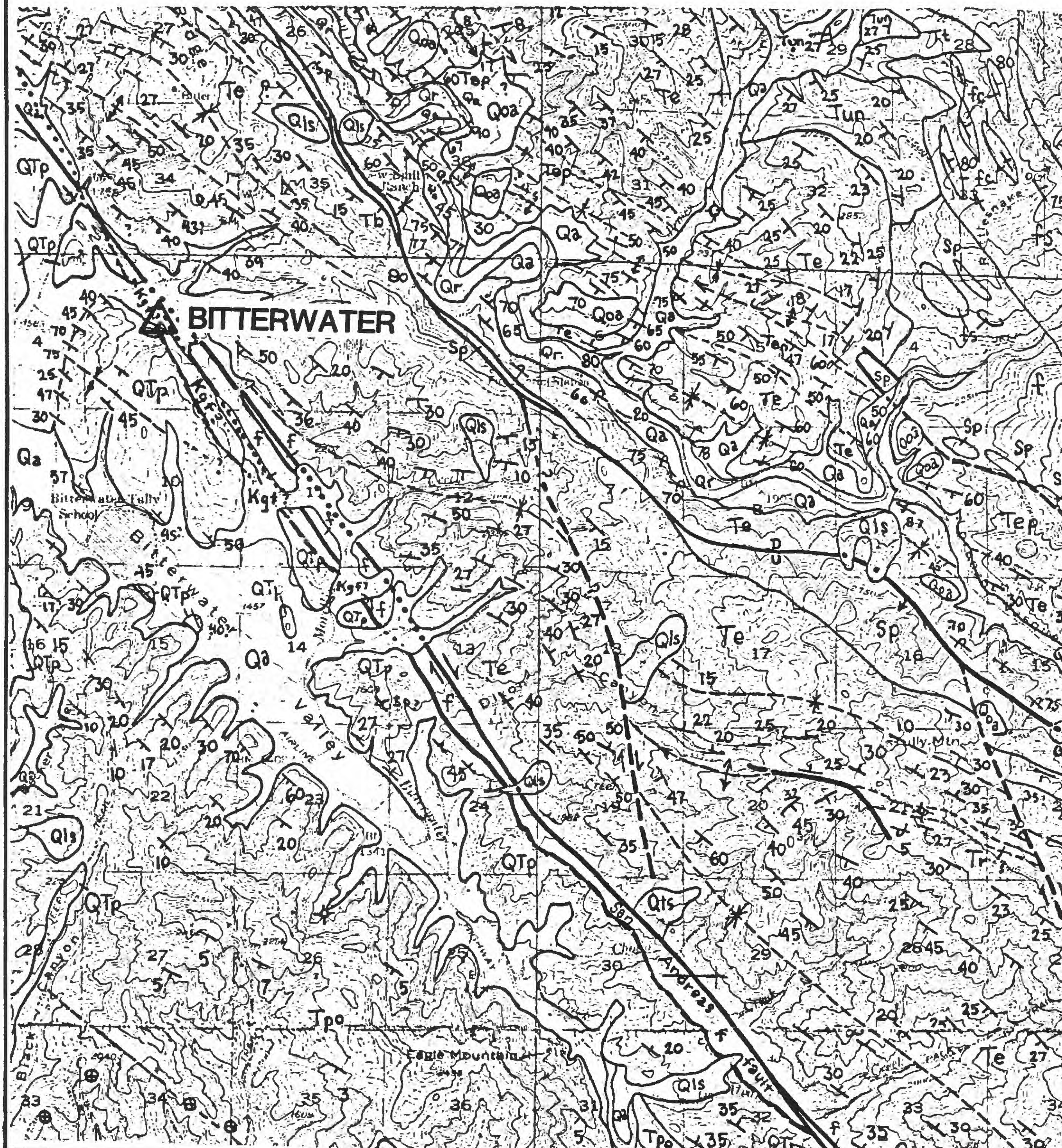
**U.S. GEOLOGICAL SURVEY
OPEN FILE MAP**



SCALE 1:62500

1 ½ 0 1 2 3 4 MILES

3000 0 3000 6000 9000 12000 15000 18000 21000 FEET

1 .5 0 1 2 3 4 5 KILOMETERS

GEOLOGIC MAP OF THE HERNANDEZ VALLEY QUADRANGLE, CALIFORNIA

Geology by T.W. Dibblee Jr., 1969-1970

Figure 50

DEPOSITS THAT OCCUR EAST AND WEST OF THE SAN ANDREAS FAULT ZONE

Qal | Qs | Qd | Qm | Qmf | Qls | Qaf | Qu | Qr | Qb | Qoal | Qf | Qmi | Qc

Surficial deposits

Pleistocene and (or) Holocene

QUATERNARY

Qal; alluvium; sand, gravel, silt, and clay; loose to soft and friable

Qs; beach sand; well to moderately sorted; loose to soft

Qd; dune sand; well sorted; loose to soft

Qm; marine and marsh deposits; mud, including much organic material, silty mud, silt, and sand; very soft to soft where wet

Qmf; marine and marsh deposits largely, overlain by artificial fill, the limits of which are not mapped. Landward boundary is historic margin of bay marshlands from Nichols and Wright (1971)

Qls; landslide deposits; largely bedrock debris

Qaf; artificial fill; of varying character, consisting of clay, silt, sand, rock fragments, organic material, and/or man-made debris. Distinguished on map only in southern Marin and San Francisco Counties; but present elsewhere, especially within Qmf

Qu; surficial deposits, undifferentiated, includes beach sand, marine deposits, artificial fill, alluvium, landslides, and, in South San Francisco quadrangle, some Colma Formation

Qr; volcanic gravel containing large angular blocks of rhyolite derived from Tsri; present only in northeast corner of Petaluma River quadrangle

Qb; older beach sand; reddish brown, friable, well sorted sand and fine gravel; laminated and locally cross-bedded; occurs along coast northwest of Point Reyes

Qoal; older alluvium; poorly sorted sandstone and conglomerate; poorly indurated; lens-shaped bedding irregularly present, crossbedding common; locally contains small wood fragments along San Andreas fault zone; includes thinly laminated siltstone or claystone with interbedded gravels

Qt; marine and stream terrace deposits; variably sorted and bedded sand, silt, and gravel; soft to poorly indurated

Qmi; Millerton Formation; (Pleistocene) deeply weathered, poorly indurated, marine and freshwater clays, silts, gravels, and conglomerate; maximum thickness 60 feet; occurs along Tomales Bay

Qc; Colma Formation (Pleistocene); fine- to medium-grained sand with minor amounts of sandy silt, clay, and gravel as interbeds. Sand well sorted and soft and friable; occurs on Angel and Yerba Buena Islands and in San Francisco

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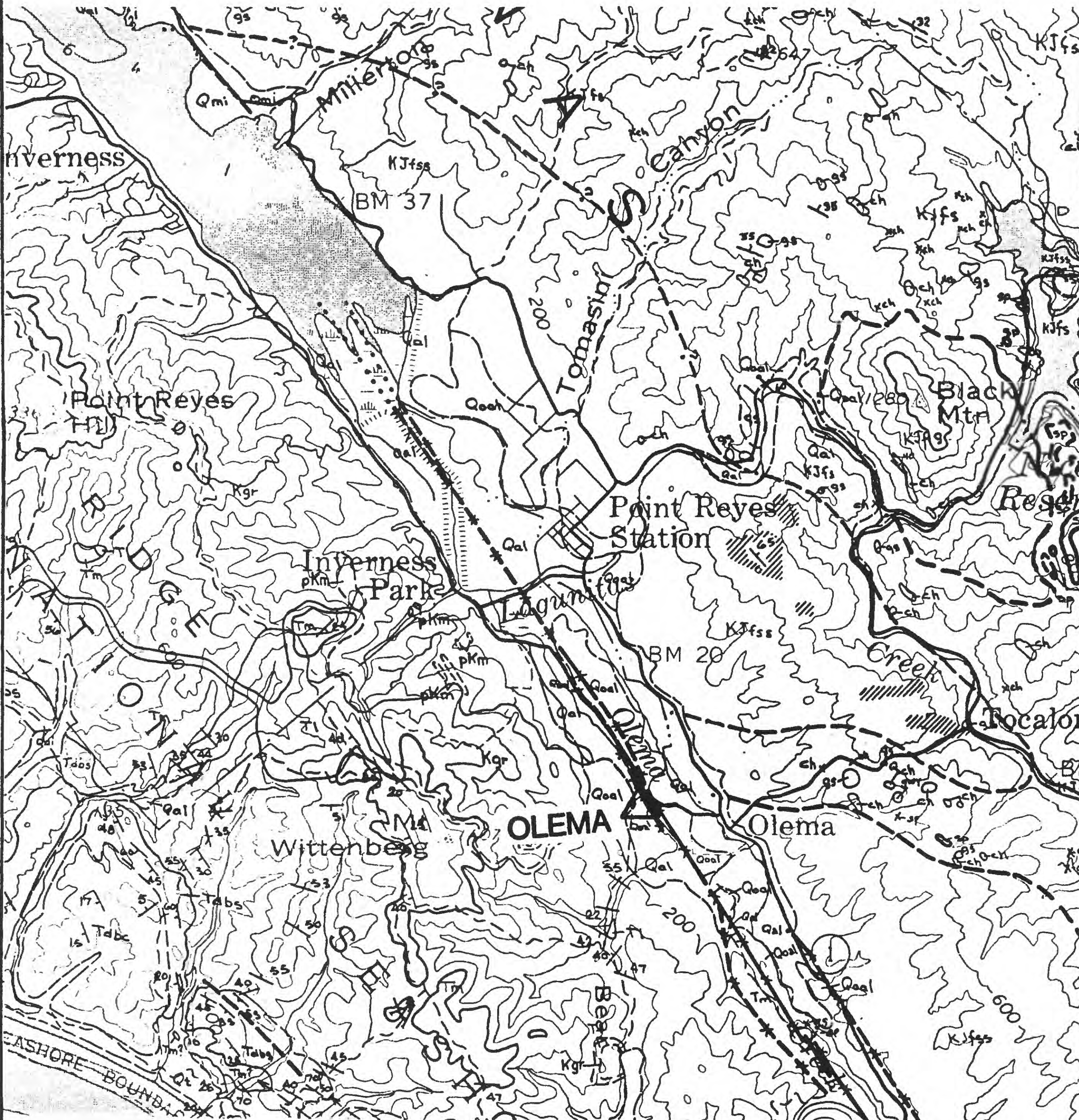
MISCELLANEOUS
FIELD STUDIES MAP MF 574



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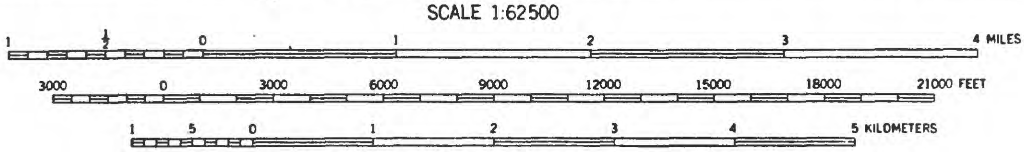

PRELIMINARY GEOLOGIC MAP OF MARIN AND SAN FRANCISCO COUNTIES AND PARTS OF ALAMEDA, CONTRA COSTA AND SONOMA COUNTIES, CALIFORNIA

by

M.C. Blake Jr., J.A. Bartow, V.A. Frizzell Jr., J. Schlocker, D. Sorg, C.M. Wentworth and R.H. Wright
1974

Figure 51

EXPLANATION

Generalized thickness contours, in feet, of young bay mud. Contour interval is 10 ft (3 m) or 20 ft (6 m). Hachures point towards areas where mud is thinner than the value of the surrounding contour.

——— Uncertainty in thickness generally less than or equal to one-half the local contour interval

— — — Uncertainty in thickness generally less than or equal to the local contour interval

------ Uncertainty in thickness may be greater than the local contour interval

Soft gray clay, probably young mud, located landward of historic tidal marshes

Locations of boreholes

• Borehole from which young bay mud was not reported

• Borehole from which top and bottom of young bay mud was reported

◦ Borehole from which top, but not bottom, of young bay mud was reported

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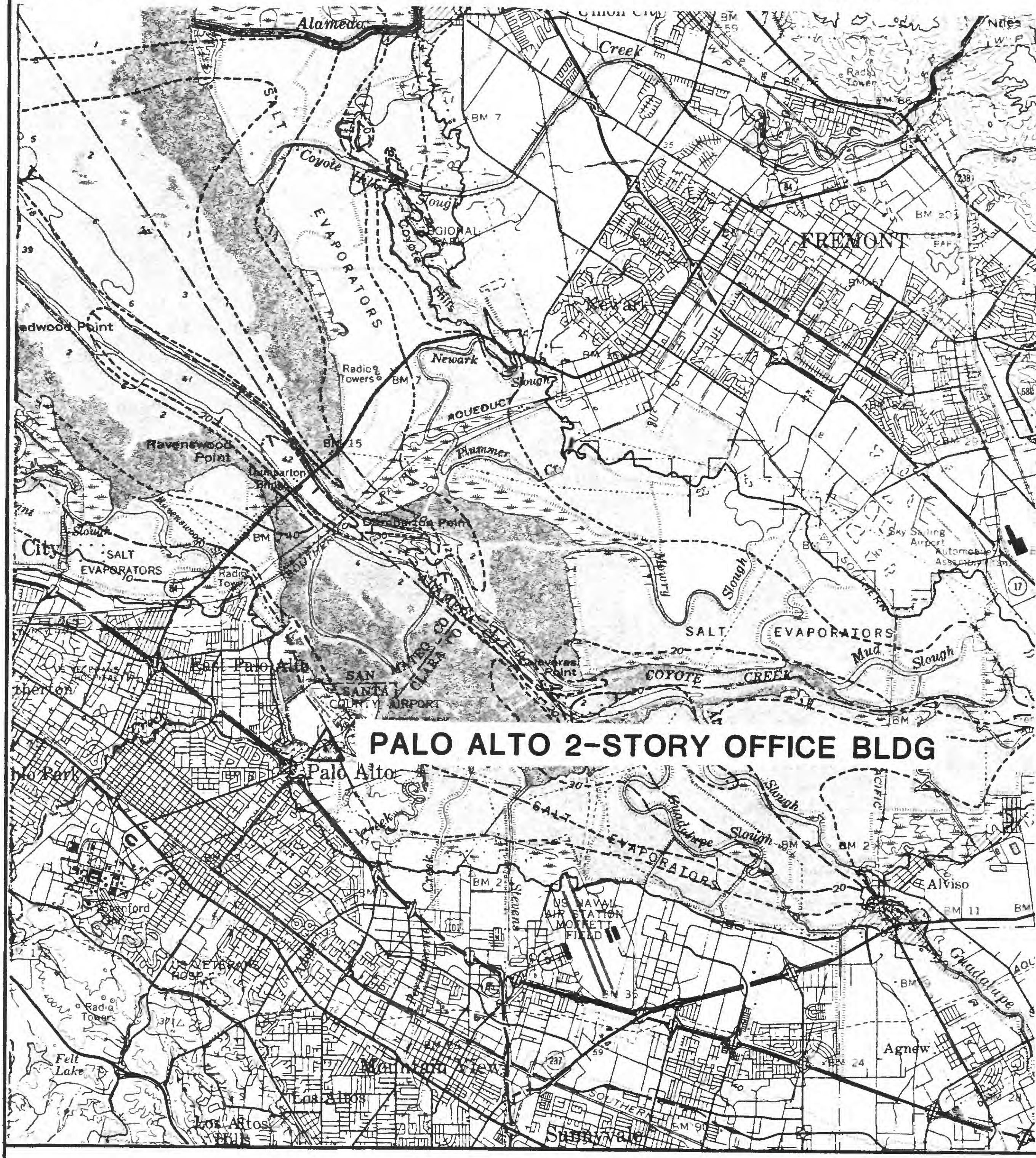
UNITED STATES GEOLOGICAL SURVEY

MISCELLANEOUS FIELD STUDIES
MAP MF – 976



SCALE 1:125 000

2 0 2 4 6 8 10 MILES

2 0 2 4 6 8 10 KILOMETERS

MAP SHOWING THICKNESS OF YOUNG BAY MUD, SOUTHERN SAN FRANCISCO BAY, CALIFORNIA

BY

SANDRA D. McDONALD, DONALD R. NICHOLS, NANCY A. WRIGHT, AND BRIAN ATWATER

1978

EXPLANATION

Generalized thickness contours, in feet, of young bay mud. Contour interval is 10 ft (3 m) or 20 ft (6 m). Hachures point towards areas where mud is thinner than the value of the surrounding contour.

———— Uncertainty in thickness generally less than or equal to one-half the local contour interval

— — — Uncertainty in thickness generally less than or equal to the local contour interval

------ Uncertainty in thickness may be greater than the local contour interval

▭ Soft gray clay, probably young mud, located landward of historic tidal marshes

Locations of boreholes

• Borehole from which young bay mud was not reported

• Borehole from which top and bottom of young bay mud was reported

◆ Borehole from which top, but not bottom, of young bay mud was reported

DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

MISCELLANEOUS FIELD STUDIES
MAP MF-976

MAP SHOWING THICKNESS OF YOUNG BAY MUD, SOUTHERN SAN FRANCISCO BAY, CALIFORNIA

BY

SANDRA D. McDONALD, DONALD R. NICHOLS, NANCY A. WRIGHT, AND BRIAN ATWATER

1978

Figure 53

EXPLANATION

Generalized thickness contours, in feet, of young bay mud. Contour interval is 10 ft (3 m) or 20 ft (6 m). Hachures point towards areas where mud is thinner than the value of the surrounding contour.

——— Uncertainty in thickness generally less than or equal to one-half the local contour interval

— — — Uncertainty in thickness generally less than or equal to the local contour interval

------ Uncertainty in thickness may be greater than the local contour interval

[box symbol] Soft gray clay, probably young mud, located landward of historic tidal marshes

Locations of boreholes

• Borehole from which young bay mud was not reported

• Borehole from which top and bottom of young bay mud was reported

◆ Borehole from which top, but not bottom, of young bay mud was reported

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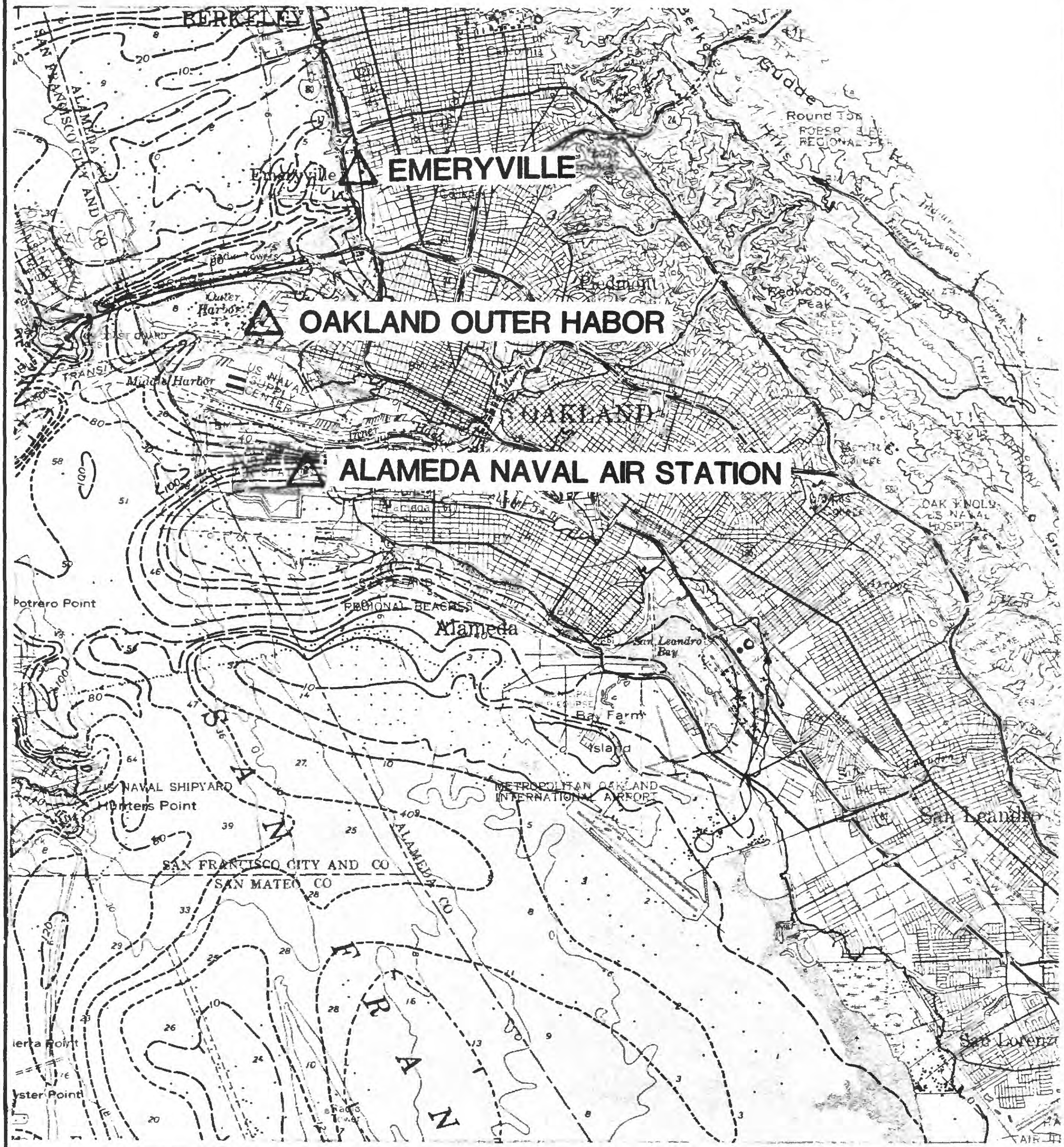
UNITED STATES GEOLOGICAL SURVEY

MISCELLANEOUS FIELD STUDIES
MAP MF – 976



SCALE 1:125 000

2 0 2 4 6 8 10 MILES

2 0 2 4 6 8 10 KILOMETERS

MAP SHOWING THICKNESS OF YOUNG BAY MUD, SOUTHERN SAN FRANCISCO BAY, CALIFORNIA

BY

SANDRA D. McDONALD, DONALD R. NICHOLS, NANCY A. WRIGHT, AND BRIAN ATWATER

1978

Figure 54

QUATERNARY

Qaf

ARTIFICIAL FILL. Deposits of rock, soil, garbage and trash, or bay mud placed by man upon natural surfaces, mostly for engineering purposes. Highly variable from place to place as to composition, degree of compaction, etc. Not shown for most highway fills, for dikes on bay marshlands, or within many areas of dense urban development. Qaf/Qm indicates artificial fill placed on bay mud.

DEBRIS FLOW LANDSLIDES. Predominantly deposits of unconsolidated and unsorted soil and rock debris (colluvium) that have moved downslope en masse or in increments by flow or creep processes. Slip surfaces in the base materials of these landslides are roughly planar and approximately parallel to the slope surface. Includes some soil and rock debris avalanche deposits that have accumulated outward from the base of slopes by rapid flow. Estimated maximum thickness in feet is indicated where such estimates could be made with reasonable confidence from surface observations.

BLOCK SLUMP LANDSLIDES. Masses of relatively intact to highly disrupted bedrock that have moved downslope by rotational slip along deep concave slip planes, or rarely, by translational slip along planar surfaces. Commonly flanked by, and succeeded downslope by, debris flow deposits.

Qm

BAY MUD. Marshlands, former marshlands, and mudflats bordering San Francisco and San Pablo Bays. Mostly at or below mean sea level; these are thick deposits of unconsolidated, low-density, semi-fluid, highly compressible, highly impermeable silty clay. They are rich in disseminated peaty material, contain lenses of peat, and are likely to contain lenses of sand in many areas. Bay mud is plastic and swells when wet, but shrinks and becomes hard when dry. In places where dikes have excluded tide water for many decades, the surface consists of a partly dried, somewhat firm crust as much as a few feet thick, but such crusts are underlain by the soft, saturated mud described above.

Qa

ALLUVIUM. Unconsolidated deposits of clay, silt, sand, and gravel underlying the bottom lands of the main stream valleys, consisting of materials transported and deposited by the streams.

Qc

COLLUVIUM. Unconsolidated and unsorted soil material and weathered rock fragments accumulated on or at the base of slopes by natural gravitational or slope wash processes. Derived by weathering and decomposition of bedrock materials underlying the slopes. Covers most slopes, but mapped only where assumed to be more than about 5 feet thick. May include some unrecognized landslide deposits. Includes Colma Formation on Angel Island.

TERTIARY

Tv

VOLCANIC ROCKS, UNDIFFERENTIATED. Small exposures of andesite, dacite, and rhyolite, most of which are dikes, but some of which may be remnants of lava flows similar to those found near Novato on Burdell Mountain; all range in color from dark gray to purplish or pinkish.

CRETACEOUS

Ks

SANDSTONE AND SHALE, with very minor amounts of conglomerate. Occurrences of principal rock types and associations in this unit are indicated on the map by the following lithologic symbols.

ss — Sandstone, mainly thickly bedded, medium- to coarse-grained arkose composed predominantly of fairly well sorted, angular to subrounded grains of quartz and feldspar, with minor fine-grained matrix. Also includes arkosic-wacke, which differs from the arkose only in that it contains grains of rock fragments as well as quartz and feldspar. Both types of sandstone are light gray where fresh, but buff to almost white in typical weathered exposures. Individual beds are as much as 50 feet thick, so exposures commonly appear massive, with evidence of bedding obscure.

sh — Shale, generally well-bedded siltstone, dark gray where fresh, light gray, buff, or more or less stained brown by iron oxides along joints where weathered.

ssh — Sandstone and shale. Thin beds of light gray, fine-grained, quartz-rich sandstone that grade upward into and alternate rhythmically with, thin beds of gray to black shale, the thickness of individual graded sandstone-shale couplets typically ranging from 2 to about 6 inches.

cg — Conglomerate, composed of well-rounded pebbles in a sandy matrix.

It was not possible to follow and delineate contacts between these various lithologic varieties in the field. All of them typically yield light to medium brown, sandy or silty, moderately well-drained, non-swelling soils.

KJs

SANDSTONE AND SHALE. The sandstone (ss) is predominantly thickly bedded, medium- to coarse-grained graywacke composed of unsorted angular to subangular grains of quartz, feldspar, and dark rock fragments, with abundant fine-grained, clayey matrix. Typically gray or greenish gray where fresh, but brown where weathered. Some sandstones in this unit approach arkose in composition, with appropriately lighter colors. The shale (sh) is dark gray where fresh, brown where weathered. Relatively rare alternating thin beds of sandstone and shale (ssh), similar in composition and appearance to those within the unit Ks, are associated with this unit. In some places, these rocks are slightly to severely sheared or brecciated, and may grade gradually or abruptly into melange matrix. They all tend to yield brownish or buff, clay-rich, relatively poorly drained soils.

KJch

CHERT. Principally thinly bedded, hard, brittle, radiolarian chert; typical individual beds are one to a few inches thick and separated from each other by thin films or layers of shale. Mostly brown, but also greenish or light gray. Locally contains thick beds of brown chert or red or yellow jasper. Yields rocky, permeable soils.

JURASSIC

KJg

BASALTIC VOLCANIC ROCKS, all more or less altered. Predominantly greenstone, originally basalt erupted in a submarine environment, and exhibiting pillow structure in places where well exposed. Mostly dark gray green or dull green in fresh exposures, but dull greenish brown to reddish brown where weathered. Yields brown or reddish-brown, swelling, clay-rich soils.

mc mv KJsch

SEMI-SCHIST, PHYLLITE, AND SCHIST, with associated metachert and metavolcanic rocks. Predominantly slightly to well foliated or lineated metamorphosed sedimentary and volcanic rocks. The metasedimentary rocks, most of which were originally thinly bedded graywacke and shale are typically fine grained and are dark gray to bluish where freshly exposed in deep cuts, but pale gray to buff or brown in weathered exposures. In many places, these metasedimentary rocks appear superficially similar to unmetamorphosed graywacke. They are principally composed of quartz, with lesser amounts of mica, chlorite, glaucophane, jadeite, lawsonite, and pyrite that vary in proportion from place to place, and they commonly contain closely to widely spaced thin veins of white quartz. Metachert (mc), which occurs as sporadic small but prominent outcrops and elongated exposures, is white, pinkish, pale bluish, or reddish brown. In most places it exhibits the thin bedding characteristic of radiolarian chert, from which it was derived. The metavolcanic rocks (mv), are mostly dense, massive to schistose, fine-grained, metamorphosed basaltic rocks that are dull green, greenish gray, or bluish where fresh, but brown or greenish brown where weathered.

The metasedimentary rocks, except metachert, are deeply weathered in most places, and yield pale buff to brown, clay-rich soils that almost characteristically contain small angular fragments of white quartz derived from the thin veins in the bedrock. These soils contain swelling clay minerals, and are relatively unstable on slopes. The metavolcanic rocks weather to reddish brown, rocky, clay-rich soils.

fm

FRANCISCAN MELANGE. A tectonic mixture consisting of small to large masses of resistant rock types, principally of sandstone, greenstone, chert, and serpentine, but including various exotic metamorphic rock types, embedded in a matrix of pervasively sheared or pulverized rock material. The melange represents one or more immense, geologically ancient fault zones that resulted from the collision of two major plates of the earth's crust, the North American and the Pacific plates, during late Mesozoic and possibly early Cenozoic time. The various rock types along the interaction zone were differentially sheared or crushed, and mixed in such a way that the fragments or masses that resisted shearing, all of which are bounded by faulted surfaces, were brought into disoriented, commonly chaotic juxtaposition. It is these resistant masses or fragments that are seen in outcrop, the weak, finely sheared matrix in which they are embedded being easily weathered and eroded so that exposures of it are seldom apparent in natural terrain. Melange most commonly yields irregularly hummocky topography, the topographic irregularities often resulting both from differential erosion of the resistant masses embedded in the weak matrix and from abundant landsliding. Where they were seen at the surface, the resistant rock masses are indicated separately on the map, but many more of them are certain to be present than so indicated. These separate masses are outlined to scale, where possible, but boundaries of many are indeterminate from field observations alone. Masses too small to be delineated at this scale are indicated by the symbol X. Melange matrix tends to weather to brownish gray or black, clay-rich, swelling soils that are generally easily distinguished from those derived from other geologic units underlying upland portions of the mapped area. Unsheared rock masses enclosed within the matrix yield local zones of soils characteristic of these various source rocks, mostly soils similar in texture and appearance to those mentioned for similar rock types under Ks, KJg, and KJsch. Exposures of rock masses within the sheared melange matrix are identified separately by lithologic symbols as follows:

ss — Sandstone and shale. Mainly graywacke-type sandstone, with or without relatively minor amounts of shale; these are generally similar to the unit labelled KJs in very large masses. Includes dark-gray, tough metagraywacke and some masses of arkosic sandstone similar to that found in Ks.

ssh — Sandstone and shale. Alternating thin beds of sandstone and shale, similar to that so labelled within Ks.

cg — Conglomerate. Small isolated outcrops of hard, dark-colored rocks composed of well-rounded pebbles in a sandy matrix. The pebbles are chiefly of gray chert.

ch — Chert and allied siliceous rocks. Mainly isolated prominent outcrops of reddish-brown, greenish, or light-gray, thinly bedded radiolarian chert, but includes prominent exposures of massive, red, yellow, or mottled jasper.

gs — Greenstone. More or less altered or metamorphosed basaltic igneous rocks similar to KJg, except occurring in small, isolated masses.

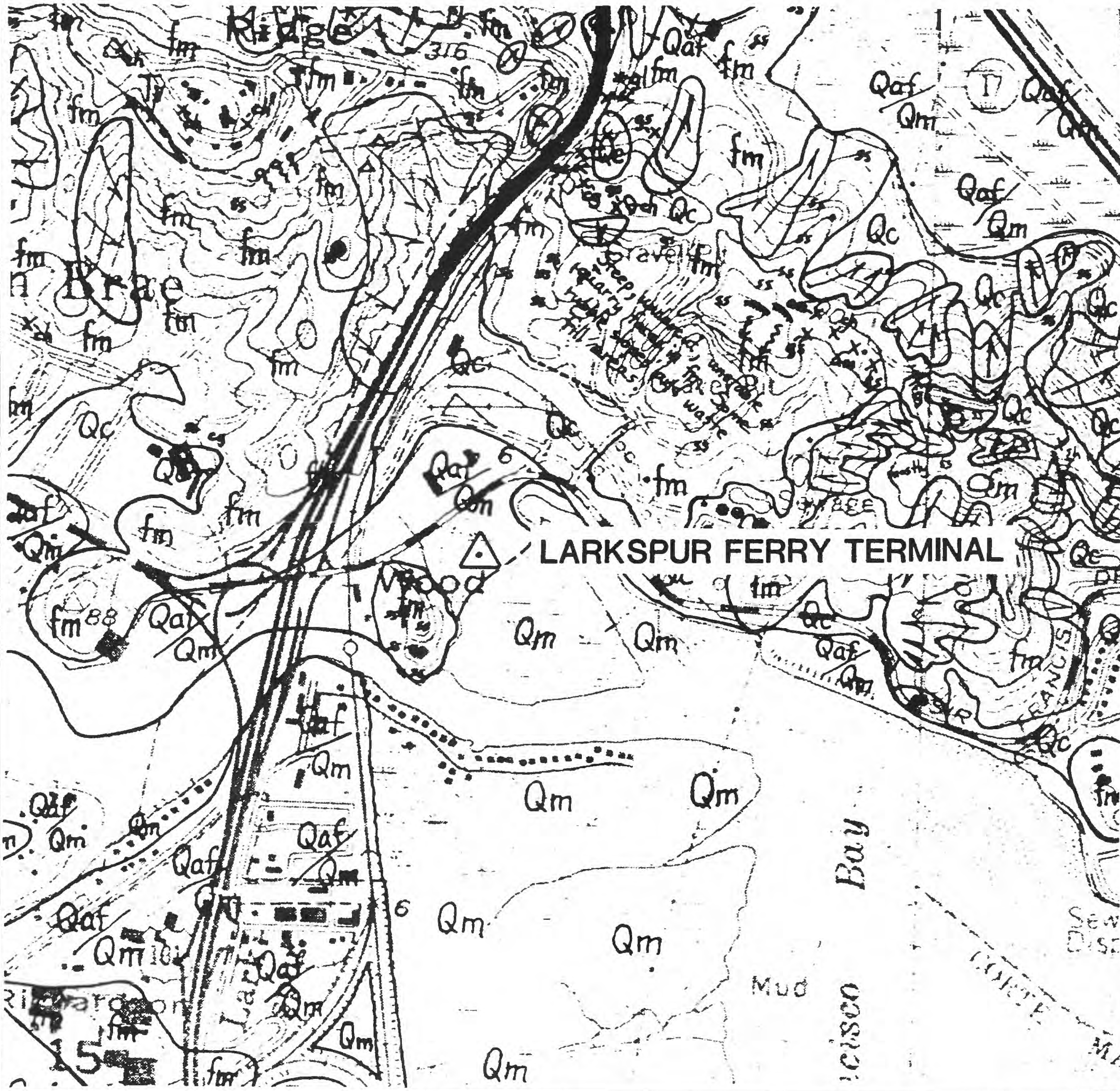
gl — Metamorphic rocks. Chiefly dense, coarsely crystalline, dark-bluish, glaucophane-bearing schists or gneisses and dark-green eclogite. These characteristically occur as small prominent outcrops, mostly less than a few tens of feet in maximum dimension. Includes masses of fine-grained semi-schist, phyllite metachert, and metavolcanic rocks similar to KJsch, that are found within areas principally underlain by melange matrix.

am — Amphibolite. Dense, dark-colored rocks composed principally of black hornblende and white feldspar.

sp — Serpentine. Pale-green to dark-green, fine-grained, metamorphic rocks composed almost entirely of the magnesium silicate minerals lizardite and chrysotile, commonly with abundant, finely disseminated magnetite. Most or all derived by metamorphism of various kinds of peridotite, igneous rocks that originated in the mantle, below the earth's crust. In this area, the serpentine is closely sheared, so that most outcrops reveal abundant curved, polished surfaces. Occurs as tiny to very large lenses or irregular-shaped sheet-like masses that are mostly or entirely limited to melange or other fault zones. Because of its unique chemical characteristics, serpentine weathers very slowly, and it tends to crop out prominently, with thin, poor-quality soils sparsely distributed between more abundant rock exposures.

CALIFORNIA DIVISION OF MINES AND GEOLOGY
JAMES E. SLOSSON, STATE GEOLOGIST

GEOLOGY FOR PLANNING IN CENTRAL AND SOUTHEASTERN MARIN COUNTY, CALIFORNIA
OFR 76-2 S.F. PLATE 1E
TIBURON PENINSULA AND SAUSALITO GEOLOGY



.5 0 1 KILOMETER

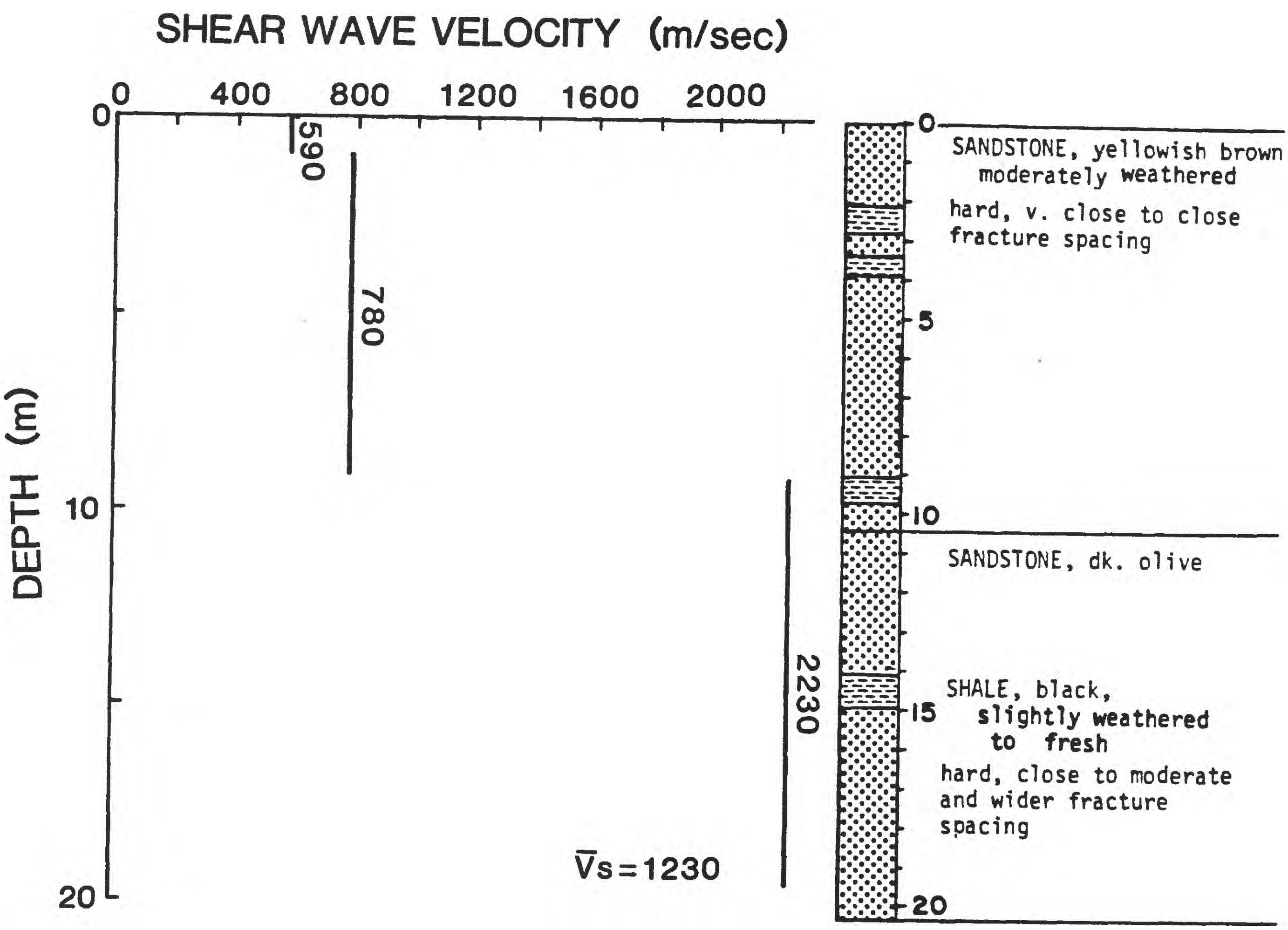
SCALE 1:12,000

GEOLOGY OF THE TIBURON PENINSULA, SAUSALITO, AND ADJACENT AREAS
MARIN COUNTY, CALIFORNIA

Compiled by Salem J. Rice and Theodore C. Smith

1976

Figure 55

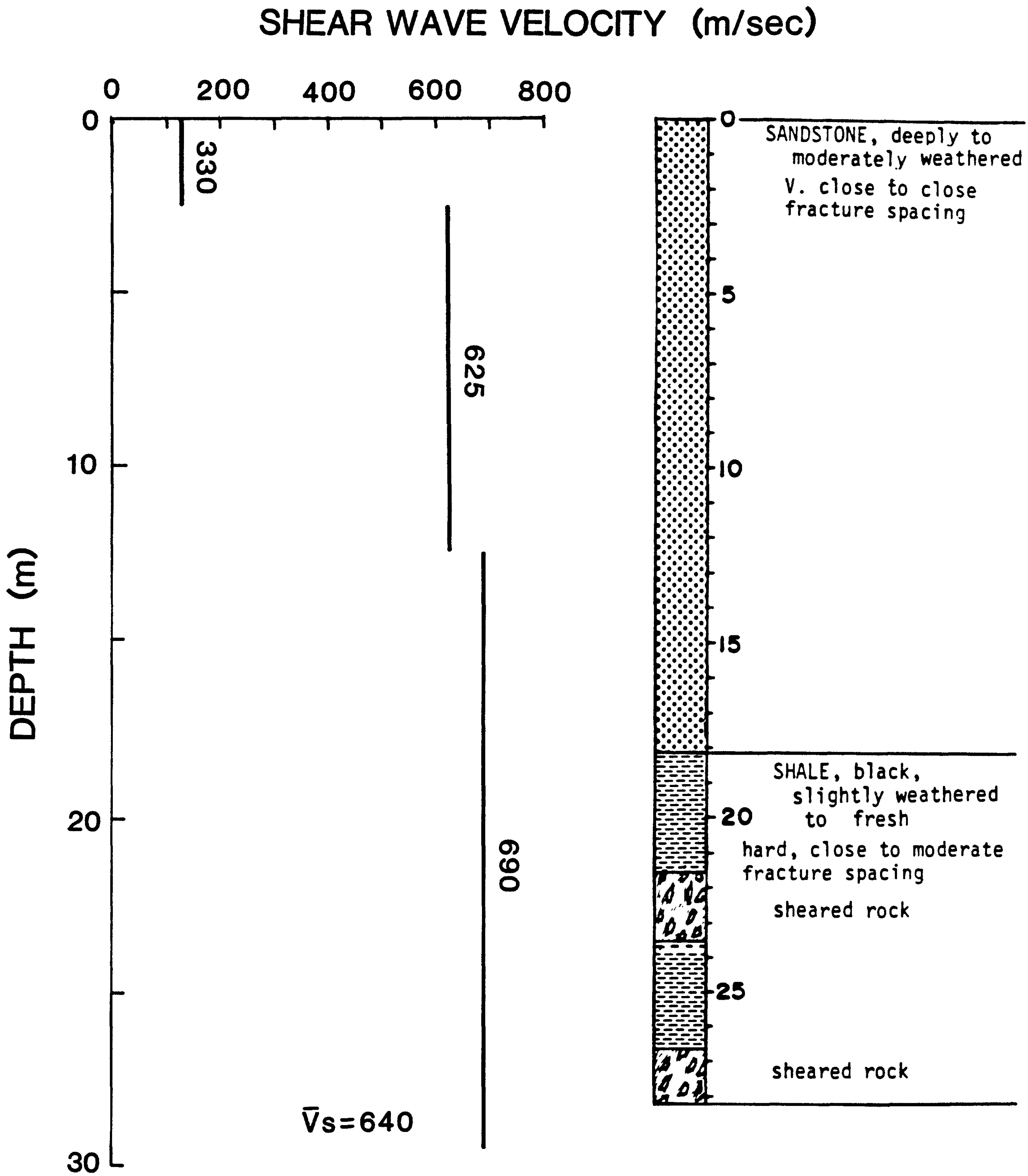


Geologic unit: Sandstone of the Franciscan assemblage

Measured velocity profile for site:

GILROY #1 GAVILAN WATER TANK

Figure 56

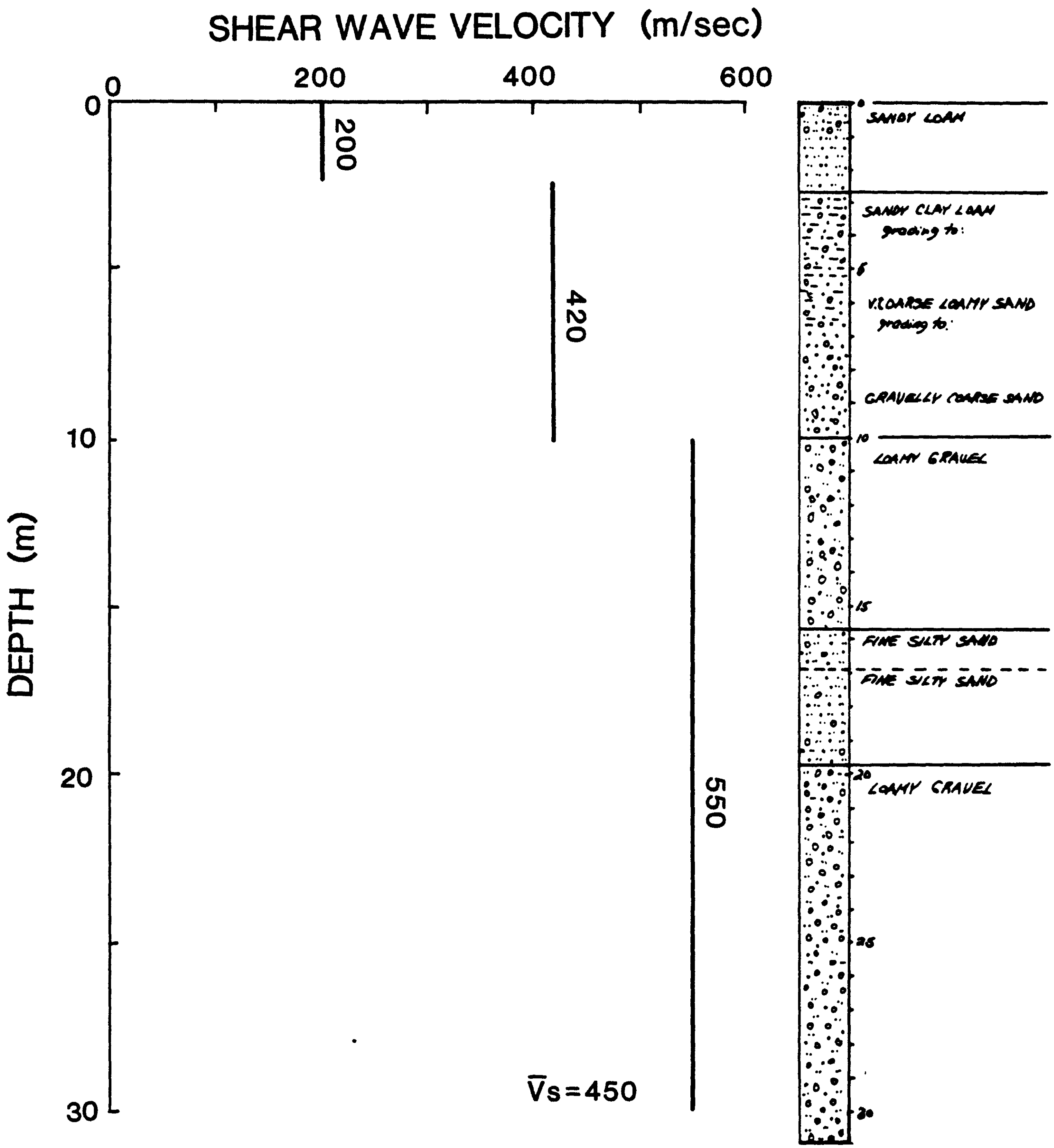


Geologic unit: Unnamed marine sedimentary rocks

Measured velocity profile for site:

GILROY#6 CANADA ROAD

Figure 57

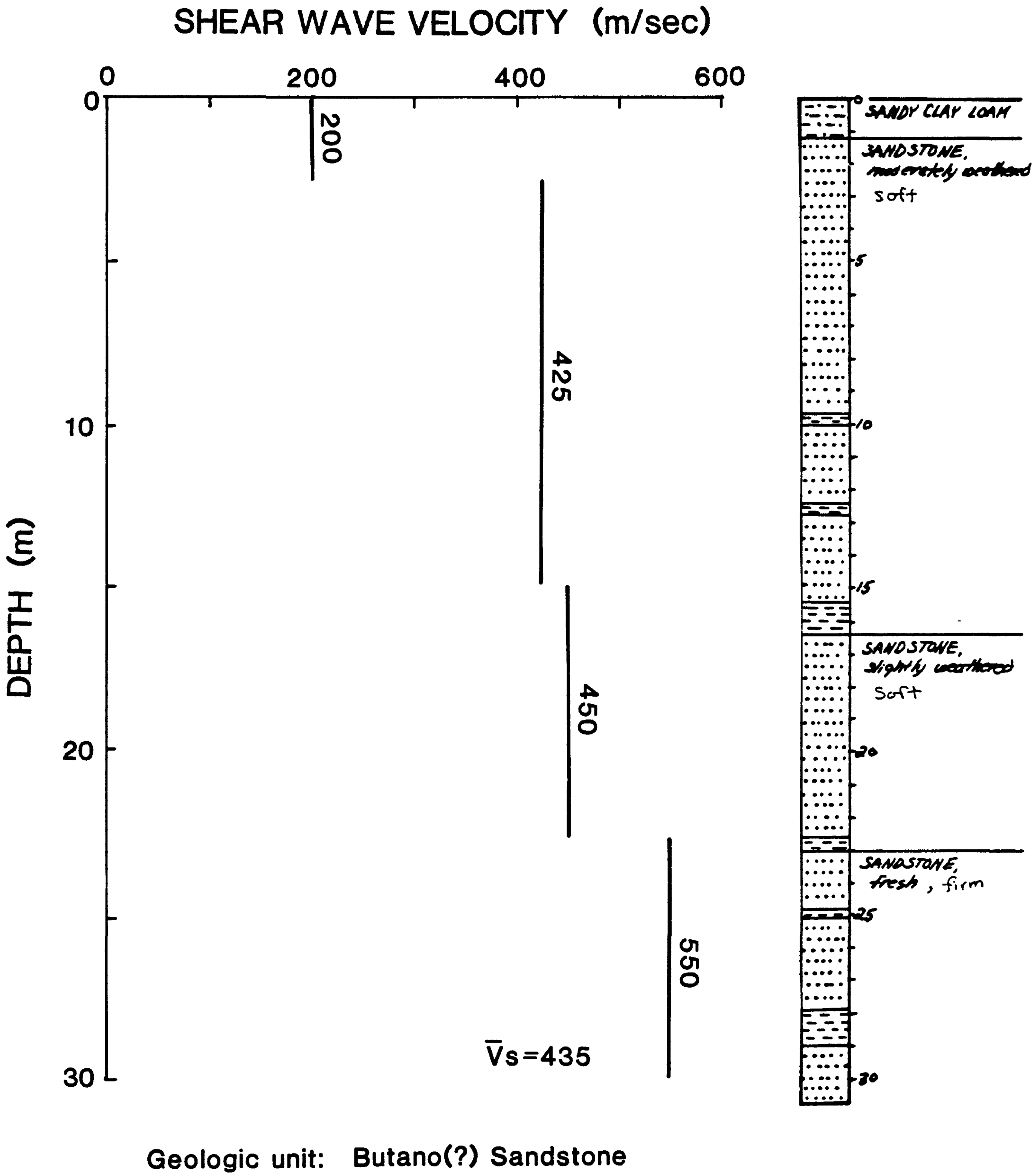


Geologic unit: Santa Clara Formation

Measured velocity profile for site:

APEEL #9 CRYSTAL SPRINGS

Figure 58

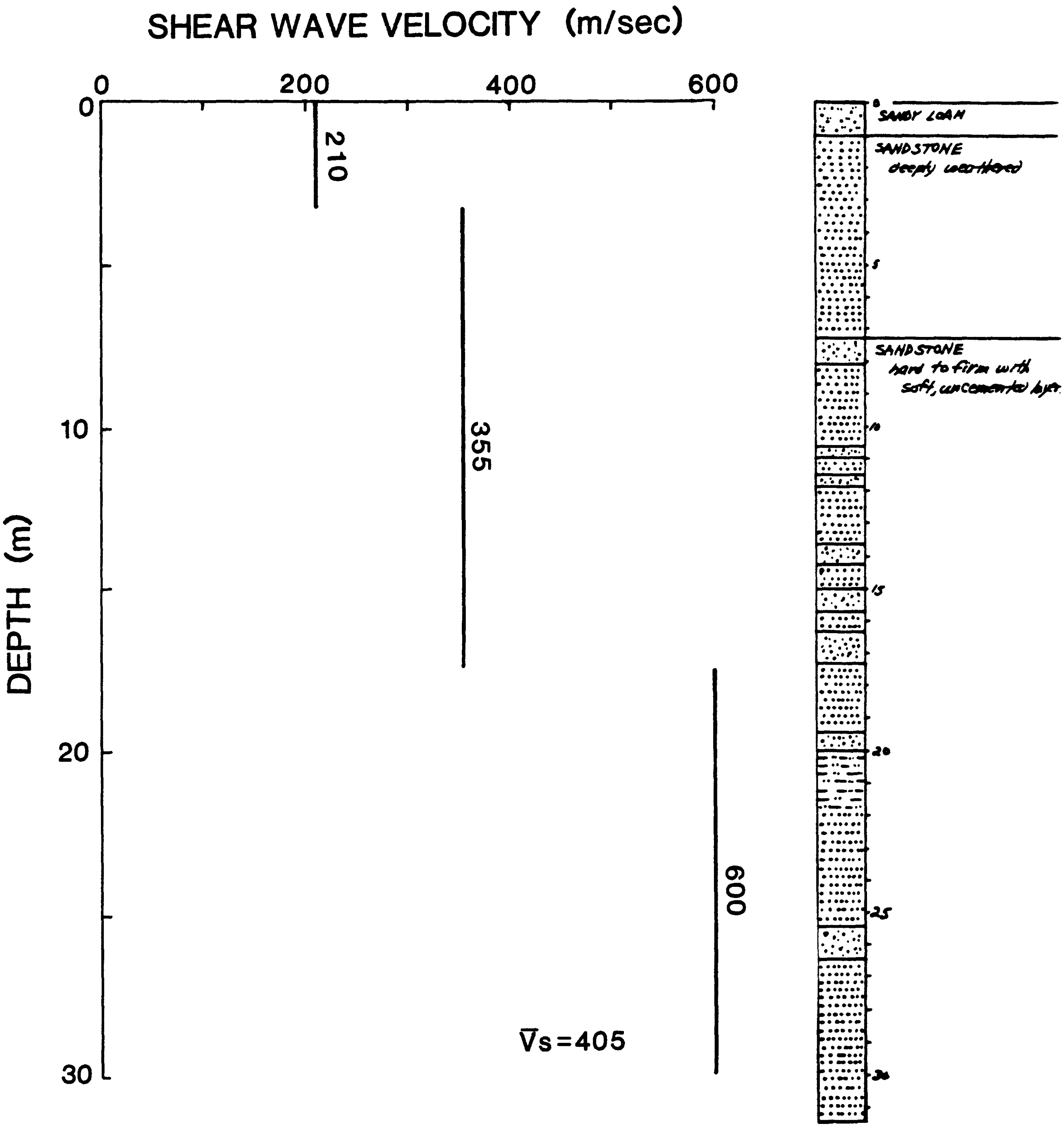


Geologic unit: Butano(?) Sandstone

Measured velocity profile for site:

APEEL #7

Figure 59

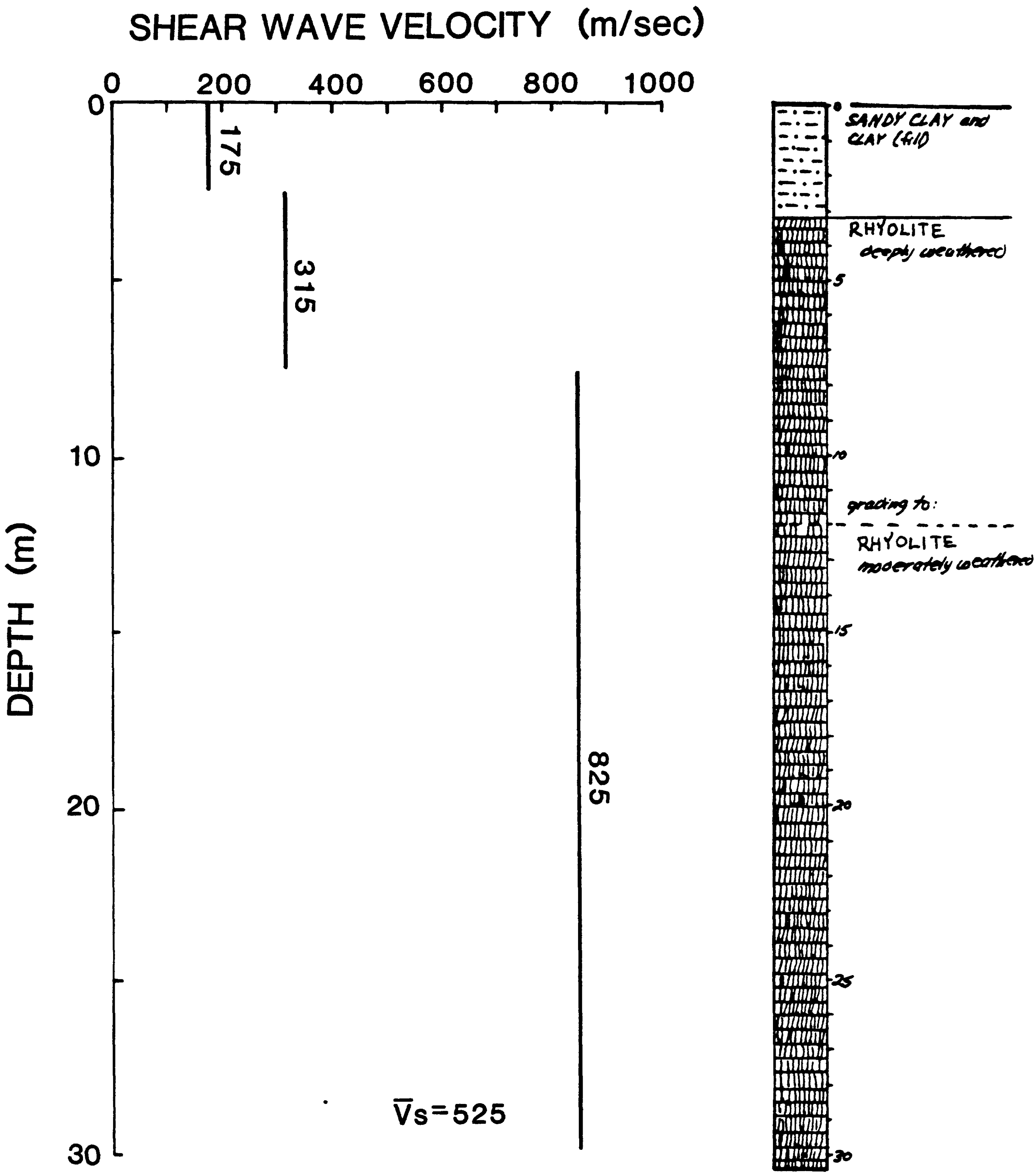


Geologic unit: Butano Sandstone

Measured velocity profile for site:

APEEL # 10

Figure 60

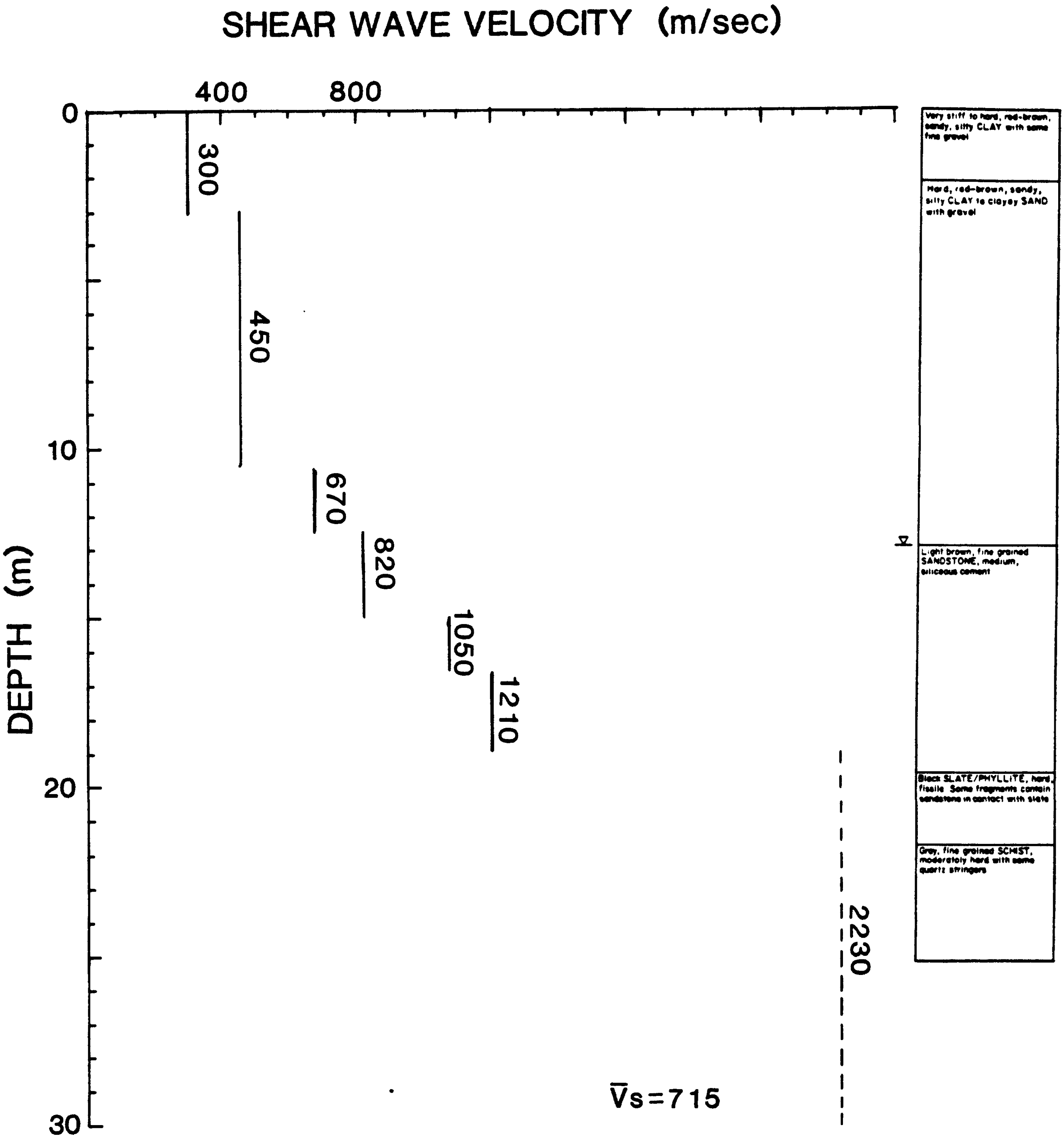


Geologic unit: Leona Rhyolite

Measured velocity profile for site:

APEEL #3E HAYWARD-CSUH STADIUM GROUNDS

Figure 61

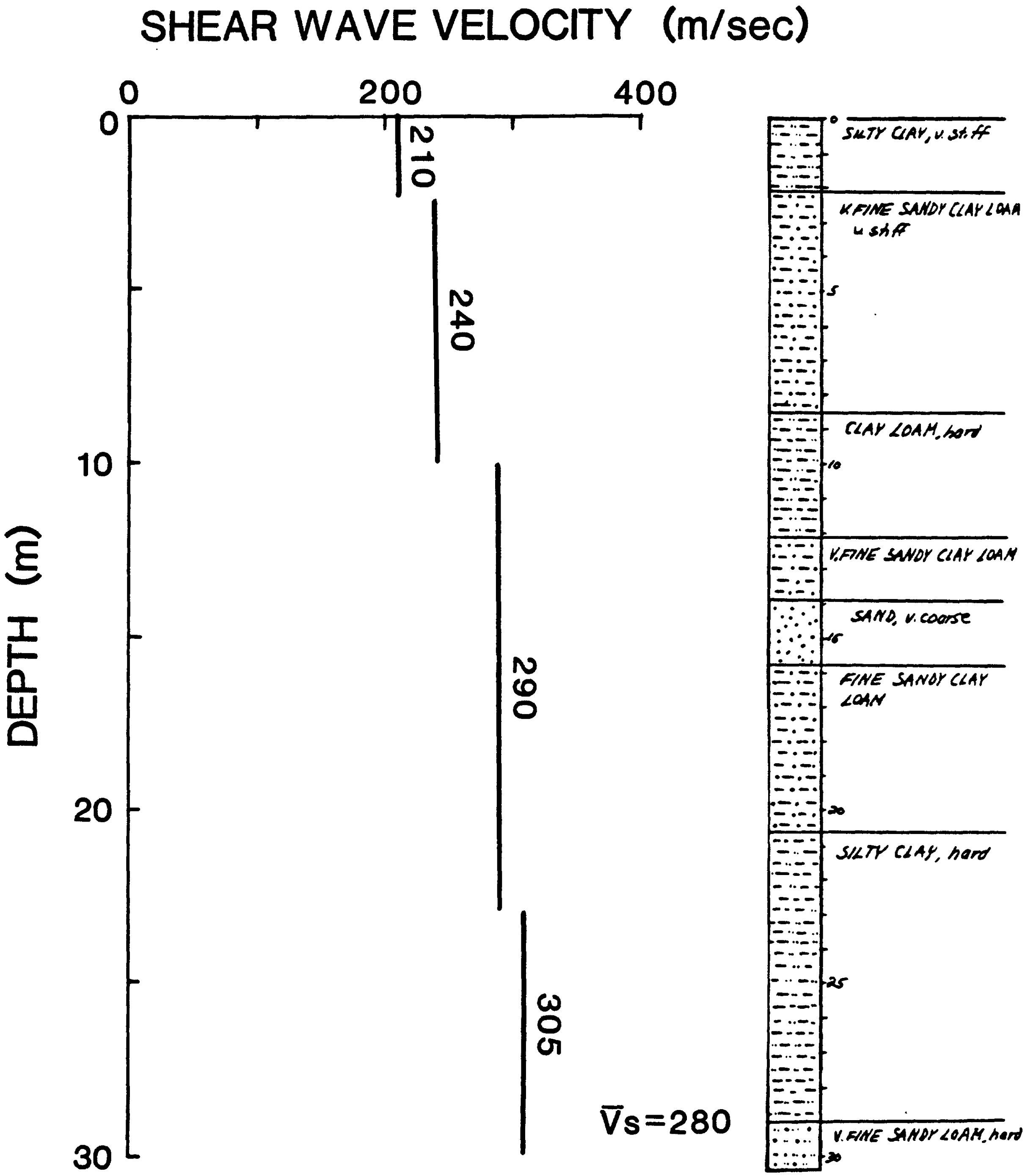


Geologic unit: Late Pleistocene alluvium/Franciscan sandstone

Measured velocity profile at site:

GILROY-GAVILAN COLLEGE

Figure 62

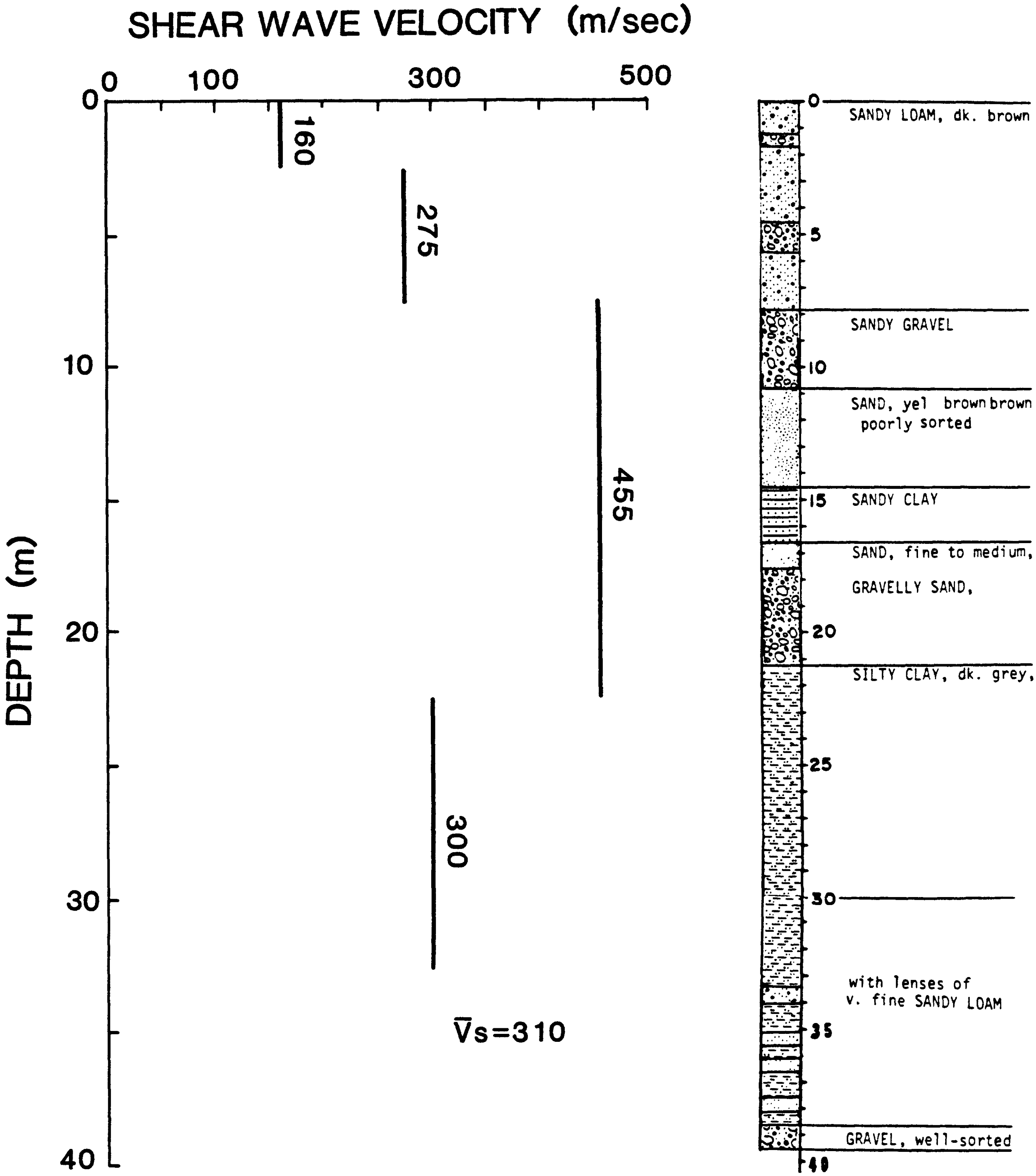


Geologic unit: Late Pleistocene alluvium

Measured velocity profile for site:

APEEL #2E JOHN MUIR SCHOOL

Figure 63

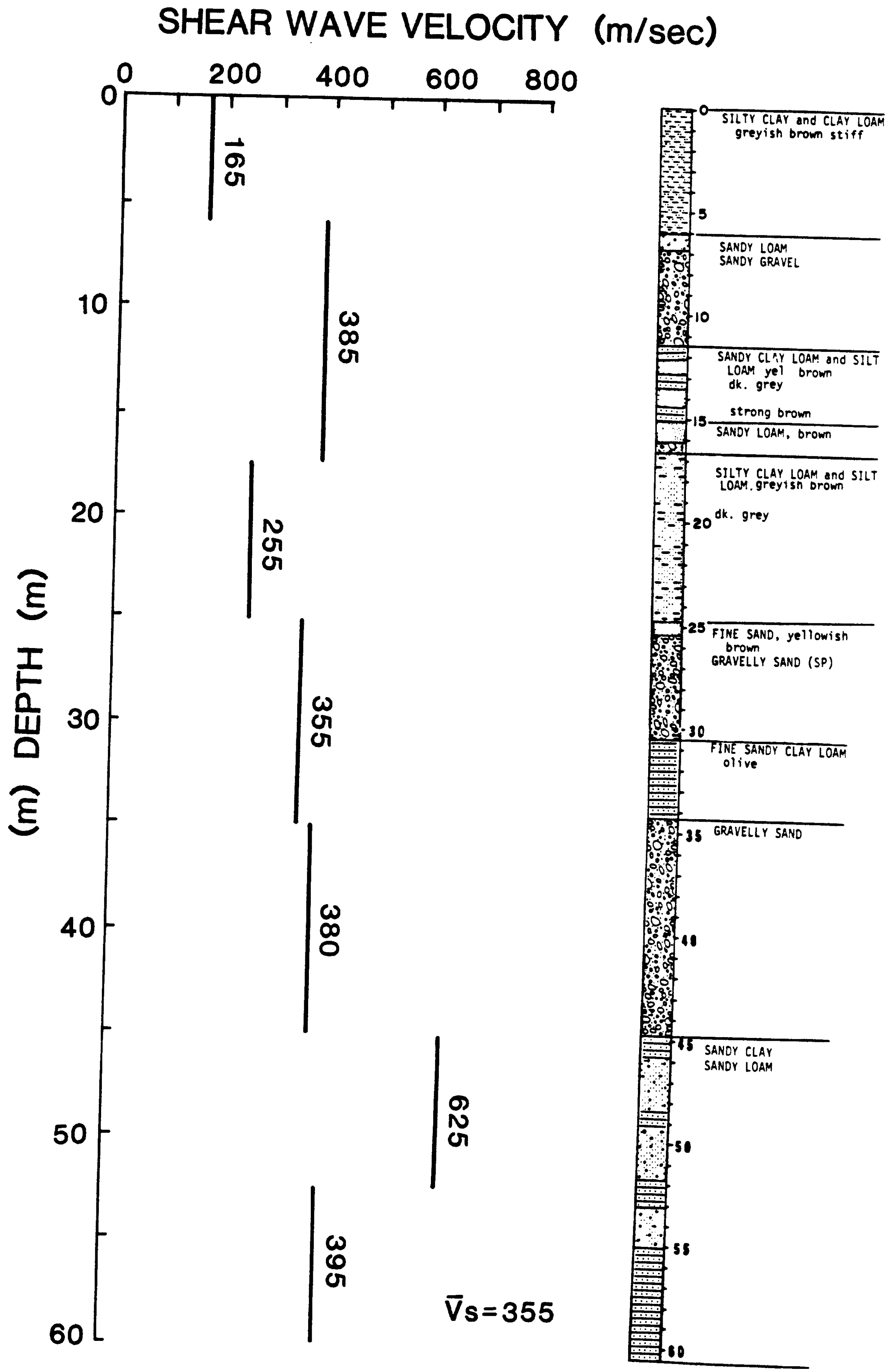


Geologic unit: Holocene coarse-grained alluvium

Measured velocity profile for site:

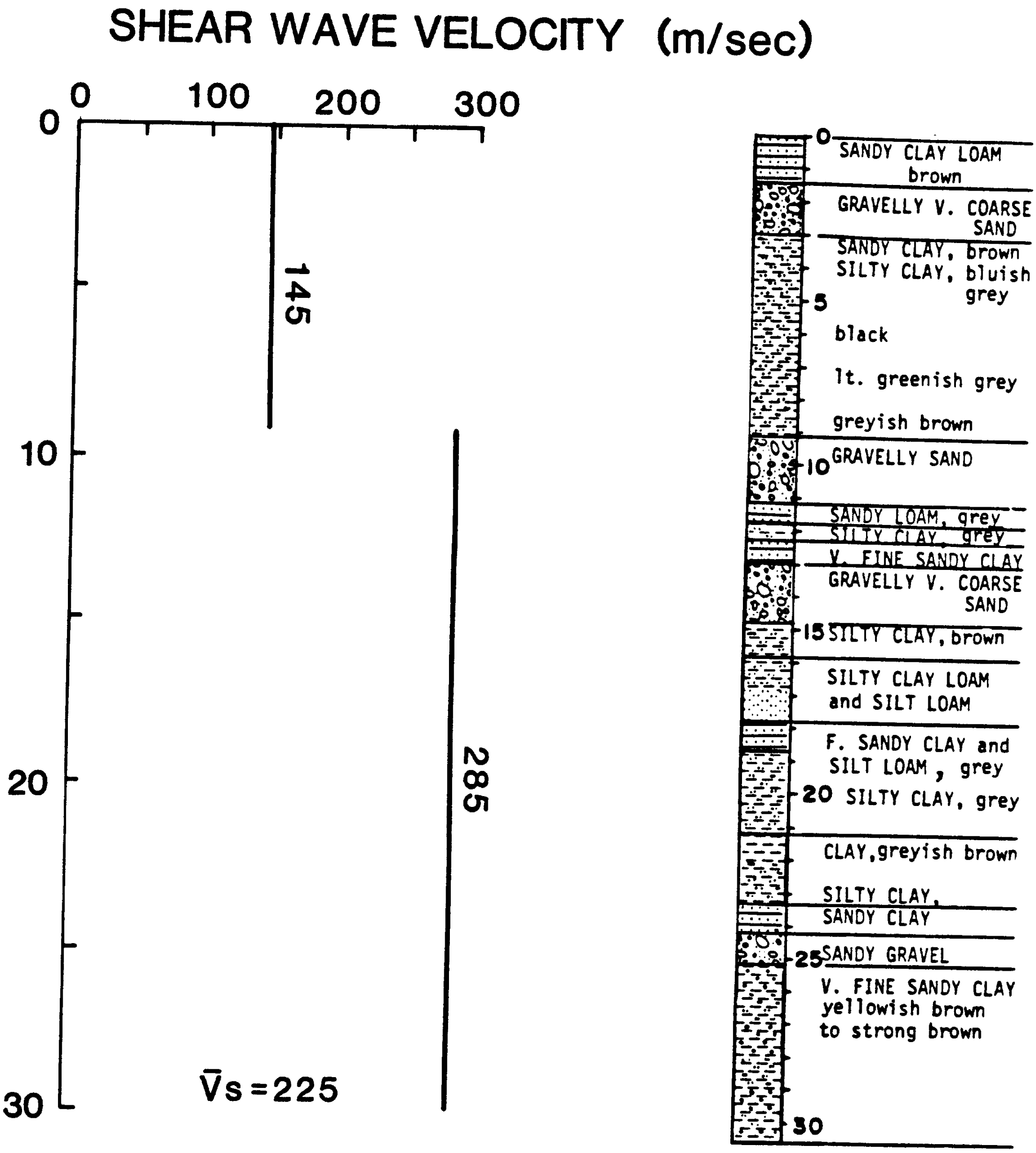
GILROY #2 MISSION TRAILS MOTEL

Figure 64



Geologic unit: Holocene fine-grained alluvium
Measured velocity profile for site:
GILROY #3 SEWAGE TREATMENT PLANT

Figure 65

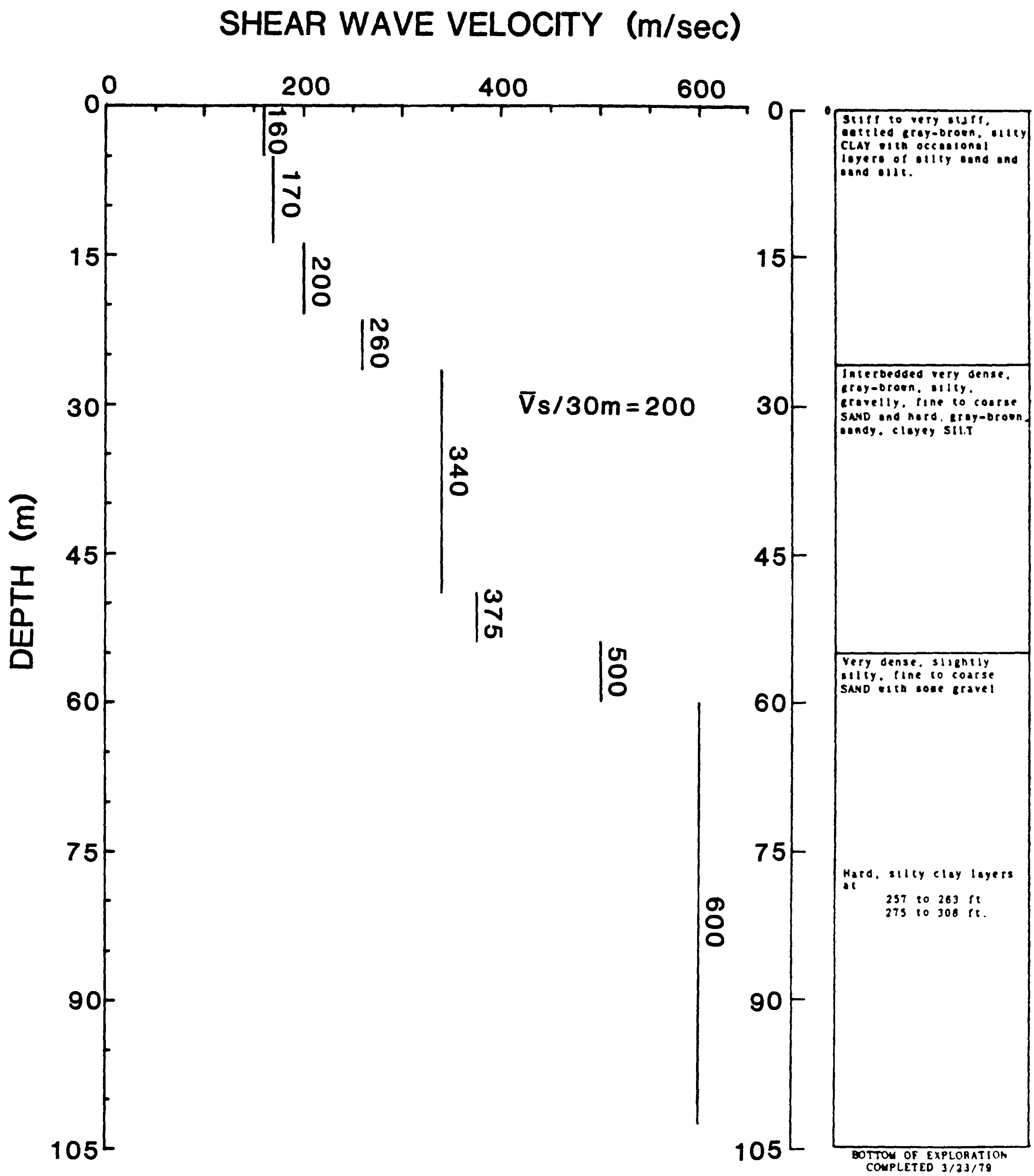


Geologic unit: Holocene medium-grained alluvium

Measured velocity profile for site:

GILROY #4 SAN YSIDRO SCHOOL

Figure 66

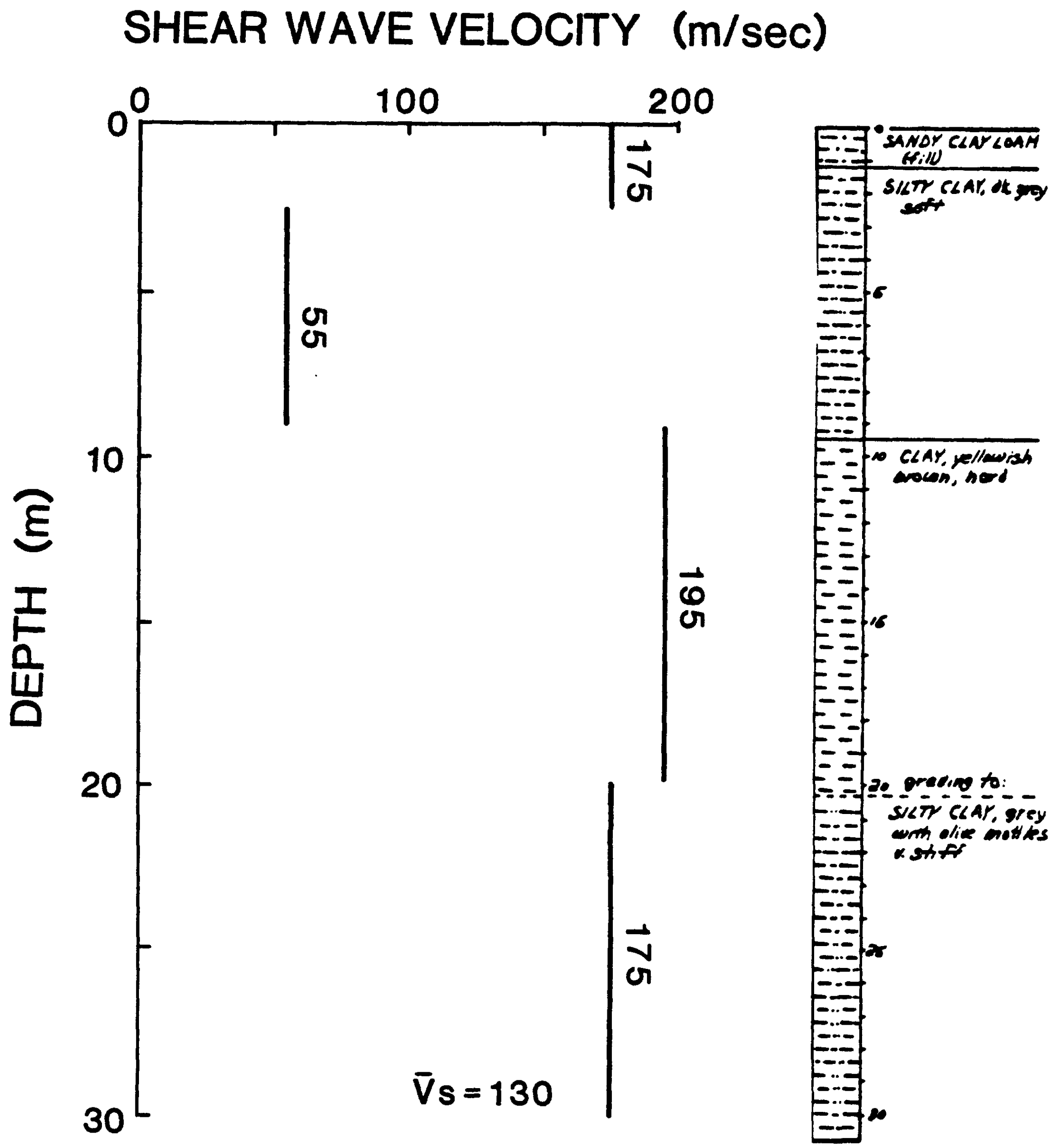


Geologic unit: Holocene fine-grained alluvium

Measured velocity profile for site: HOLLISTER CITY HALL

Estimated velocity profile for sites: HOLLISTER AIRPORT
HOLLISTER-SOUTH&PINE

Figure 67

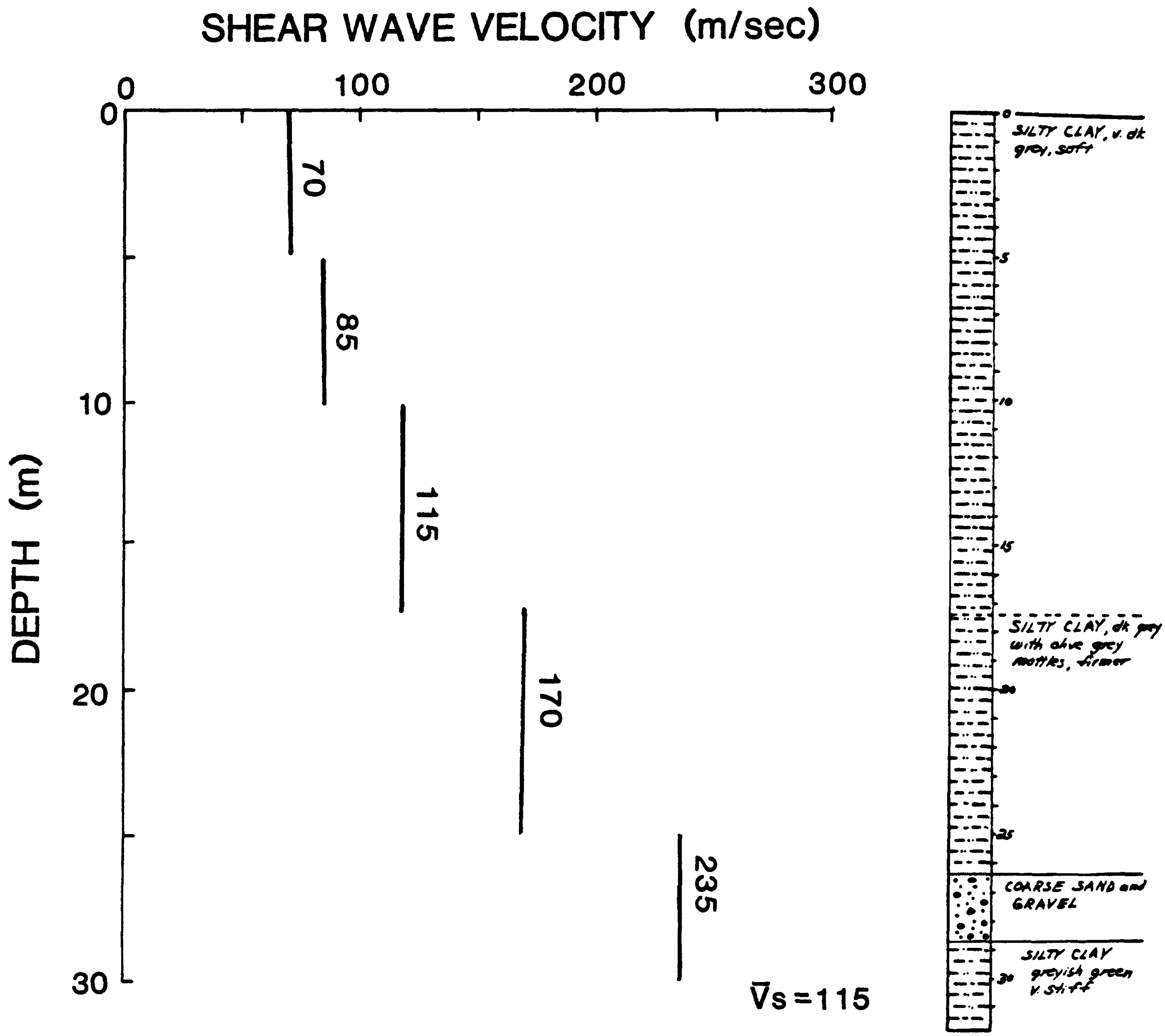


Geologic unit: Artifical fill/Bay mud

Measured velocity profile for site:

APEEL #2 REDWOOD CITY

Figure 68

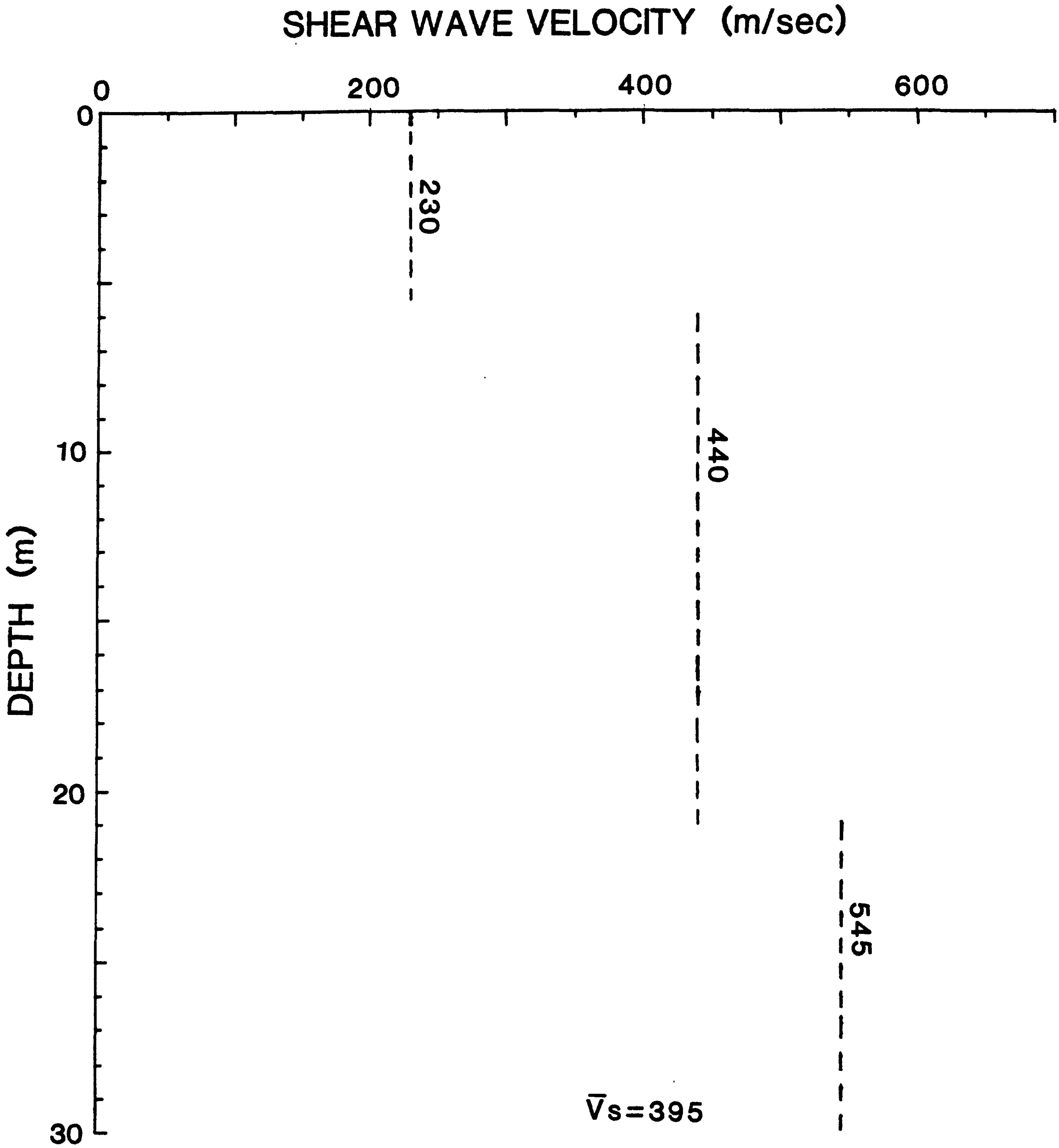


Geologic unit: Artifical fill/Bay mud

Measured velocity profile for site:

FOSTER CITY -REDWOOD SHORES (APEEL 1)

Figure 69

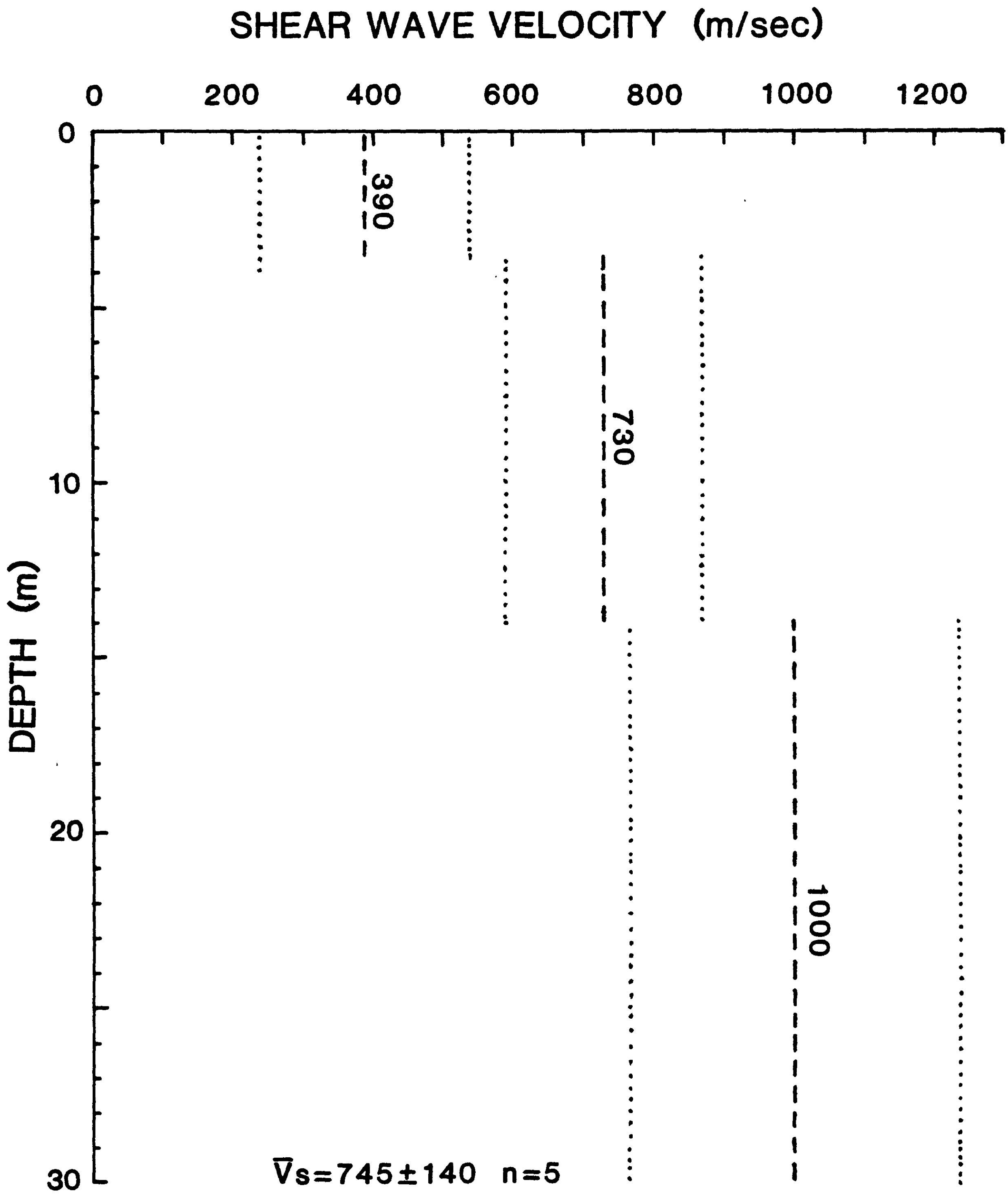


Geologic unit: Landslide derived from marine shale and sandstone of Highland Way

Estimated velocity profile for site:

CORRALITOS

Figure 70

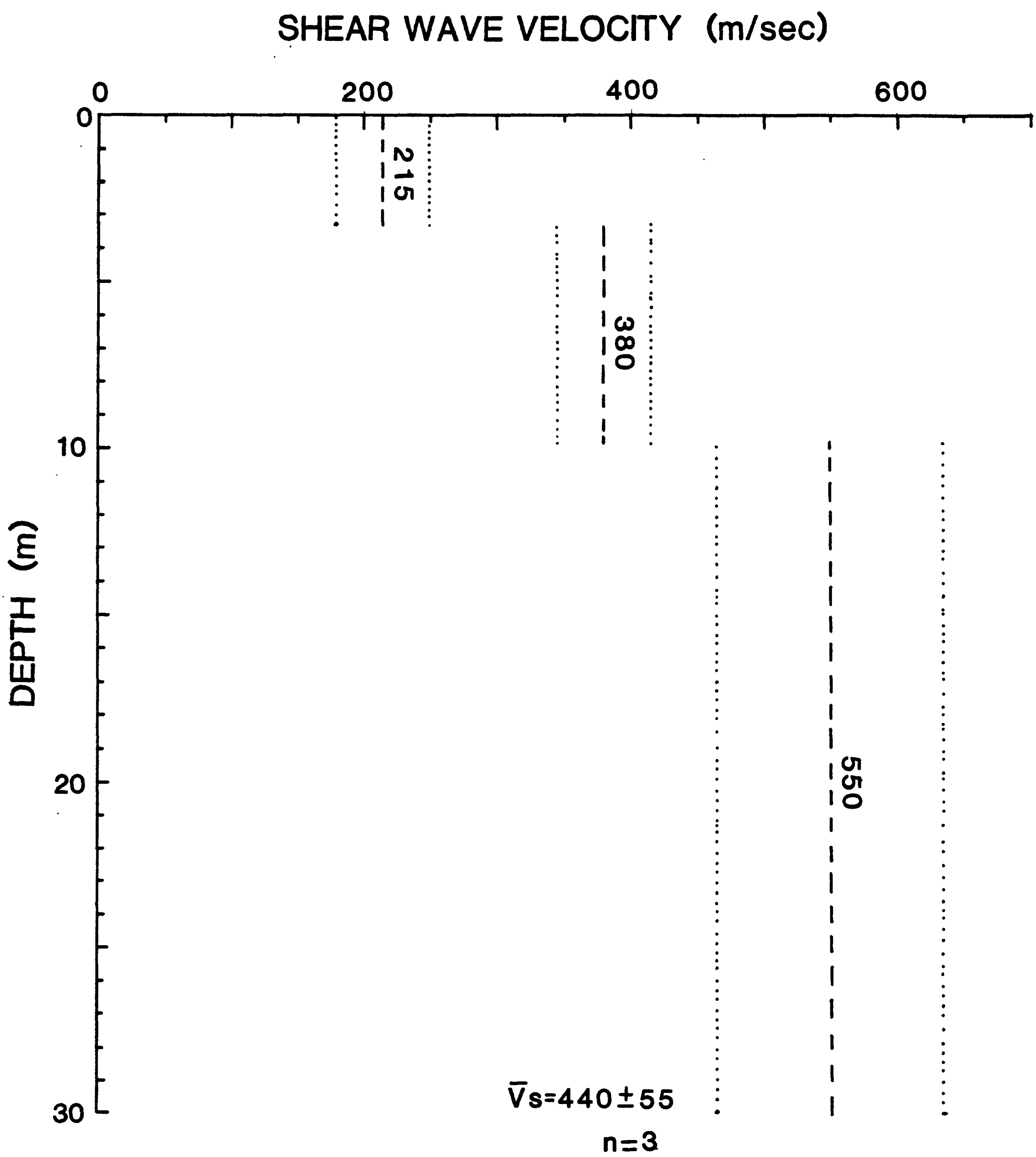


Geologic unit: Sandstone and shale of the Franciscan assemblage

Estimated velocity profile for sites:

BELMONT 2-STORY BLDG
LEXINGTON DAM ABUTMENT
PIEDMONT JR. HIGH SCHOOL
POINT BONITA
S.F.-CLIFF HOUSE
S.F.-DIAMOND HEIGHTS
S.F.-PACIFIC HEIGHTS
S.F.-RINCON HILL
S.F.-TELEGRAPH HILL

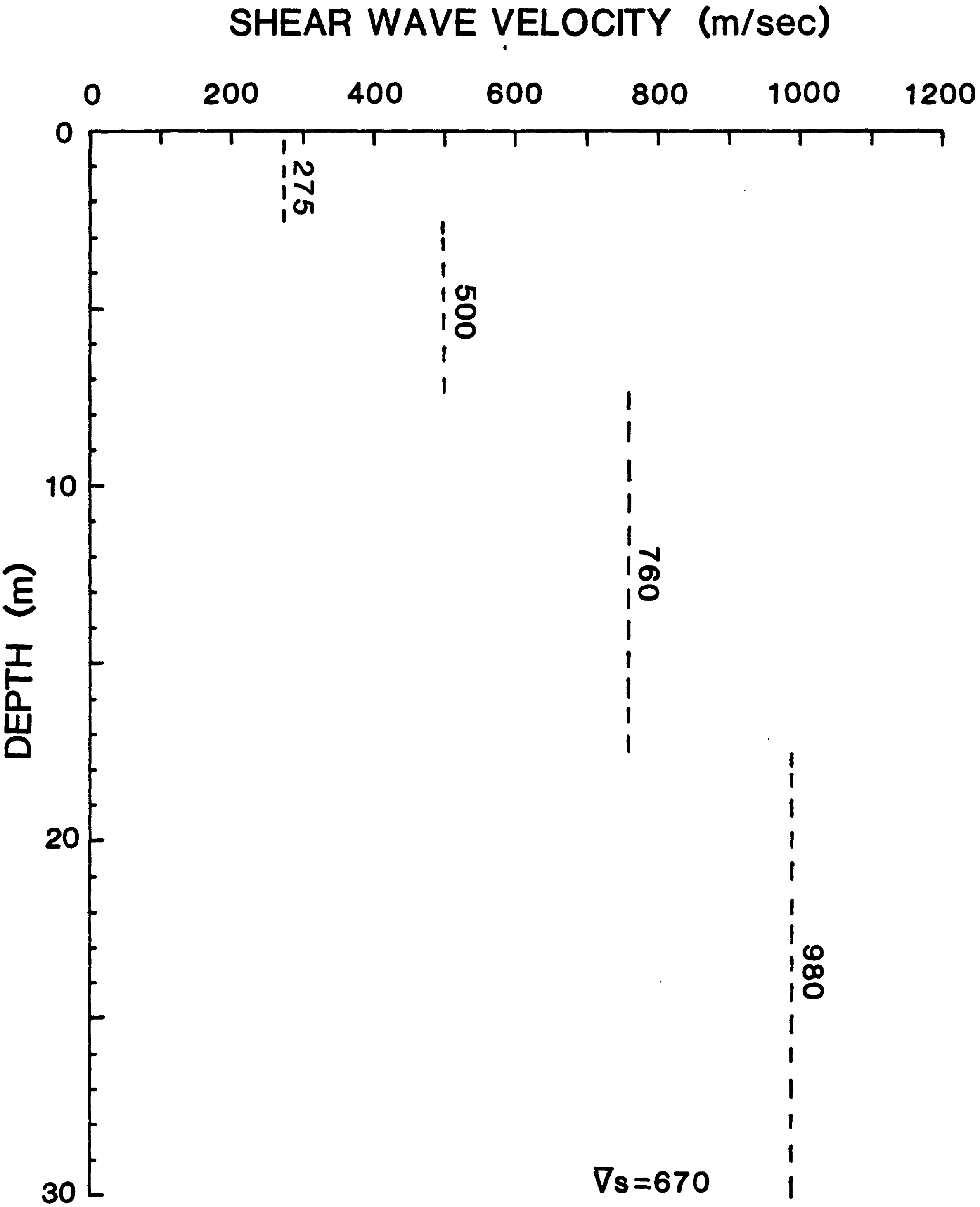
Figure 71



Geologic unit: Santa Clara Formation

Sites: RICHMOND
SARATOGA

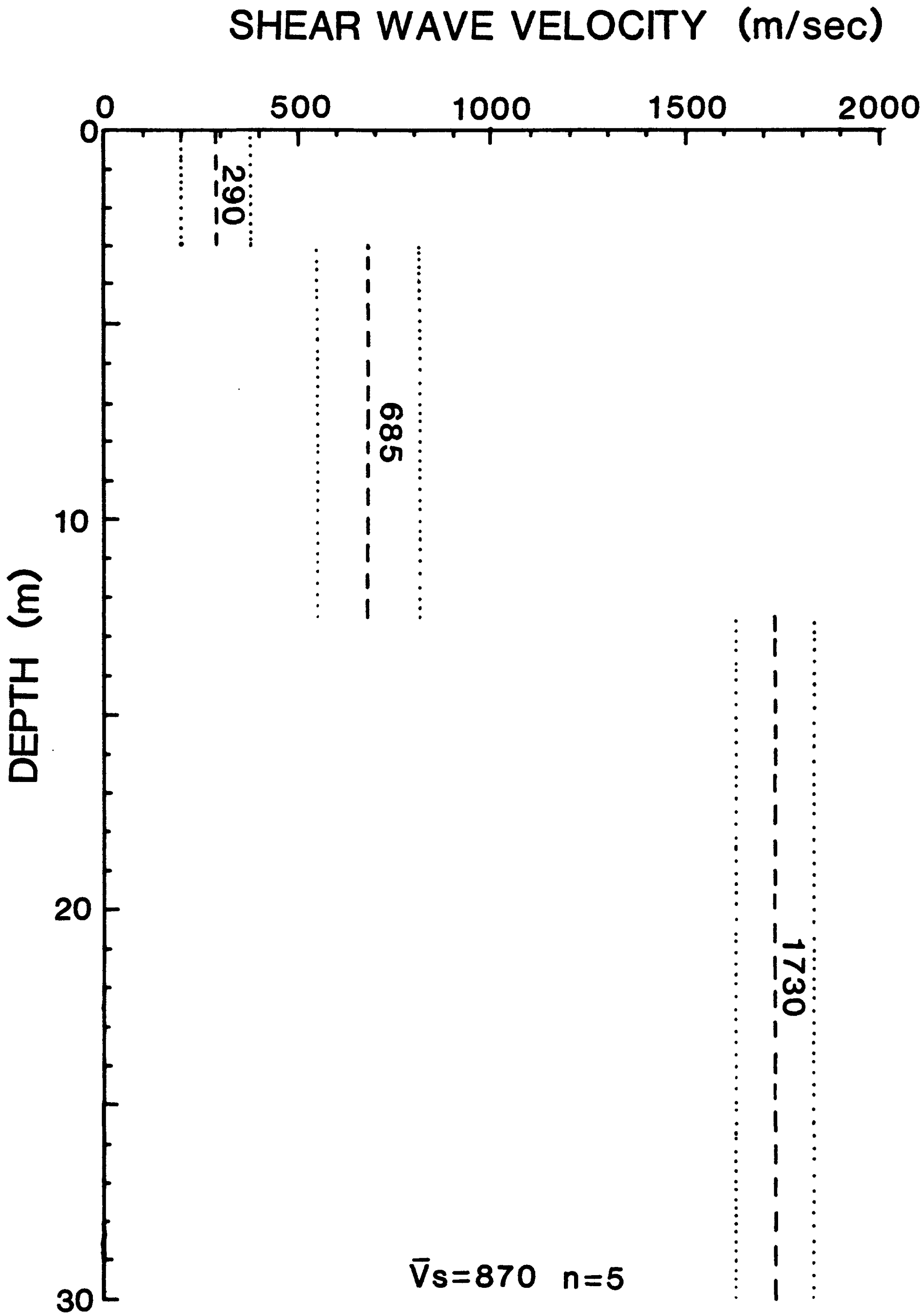
Figure 72



Geologic unit: Metasedimentary rocks (schist)

Estimated velocity profile for site: SANTA CRUZ

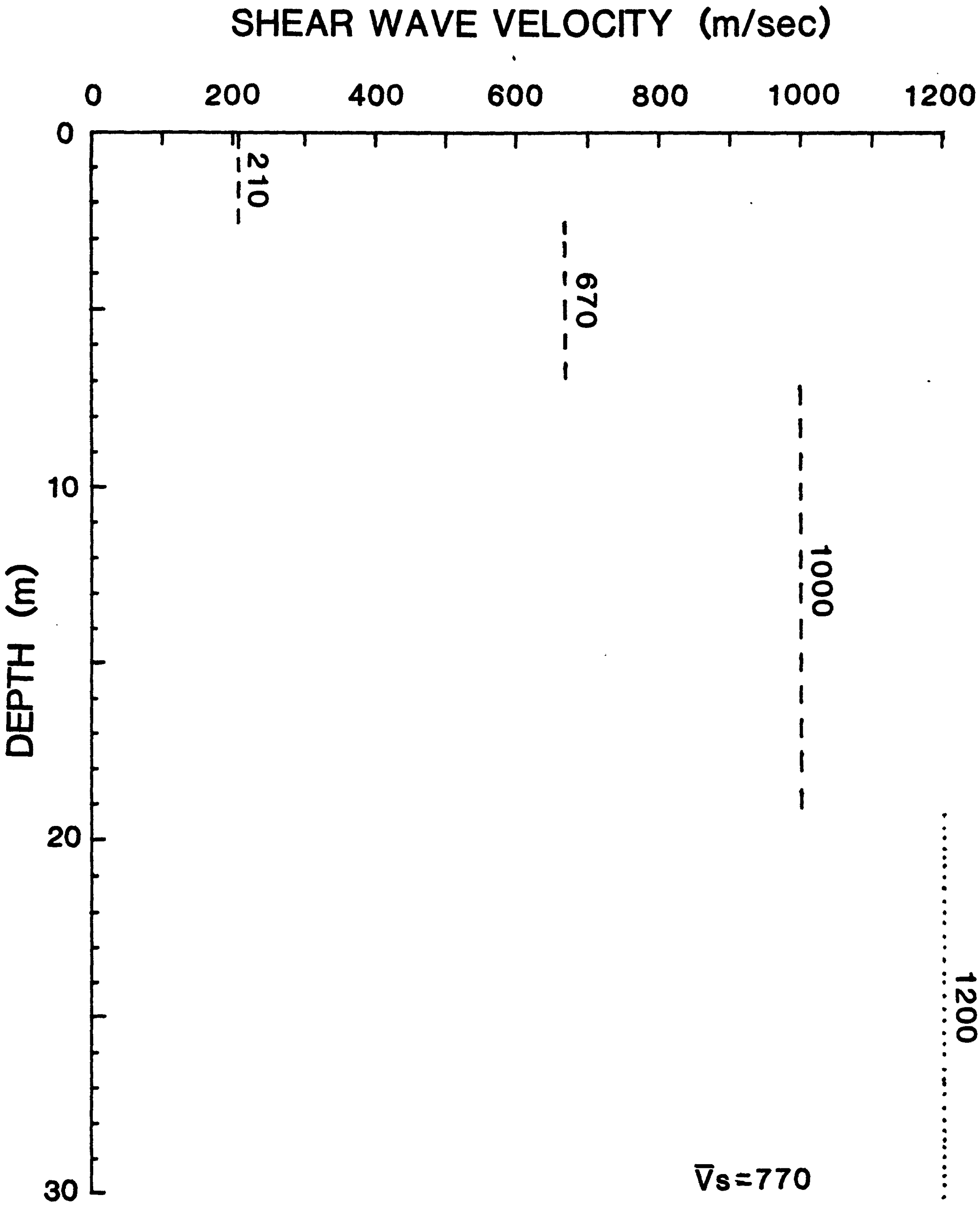
Figure 73



Geologic unit: Granodiorite

Estimated velocity profile for sites: HOLLISTER SAGO
MONTEREY CITY HALL
SAGO SOUTH

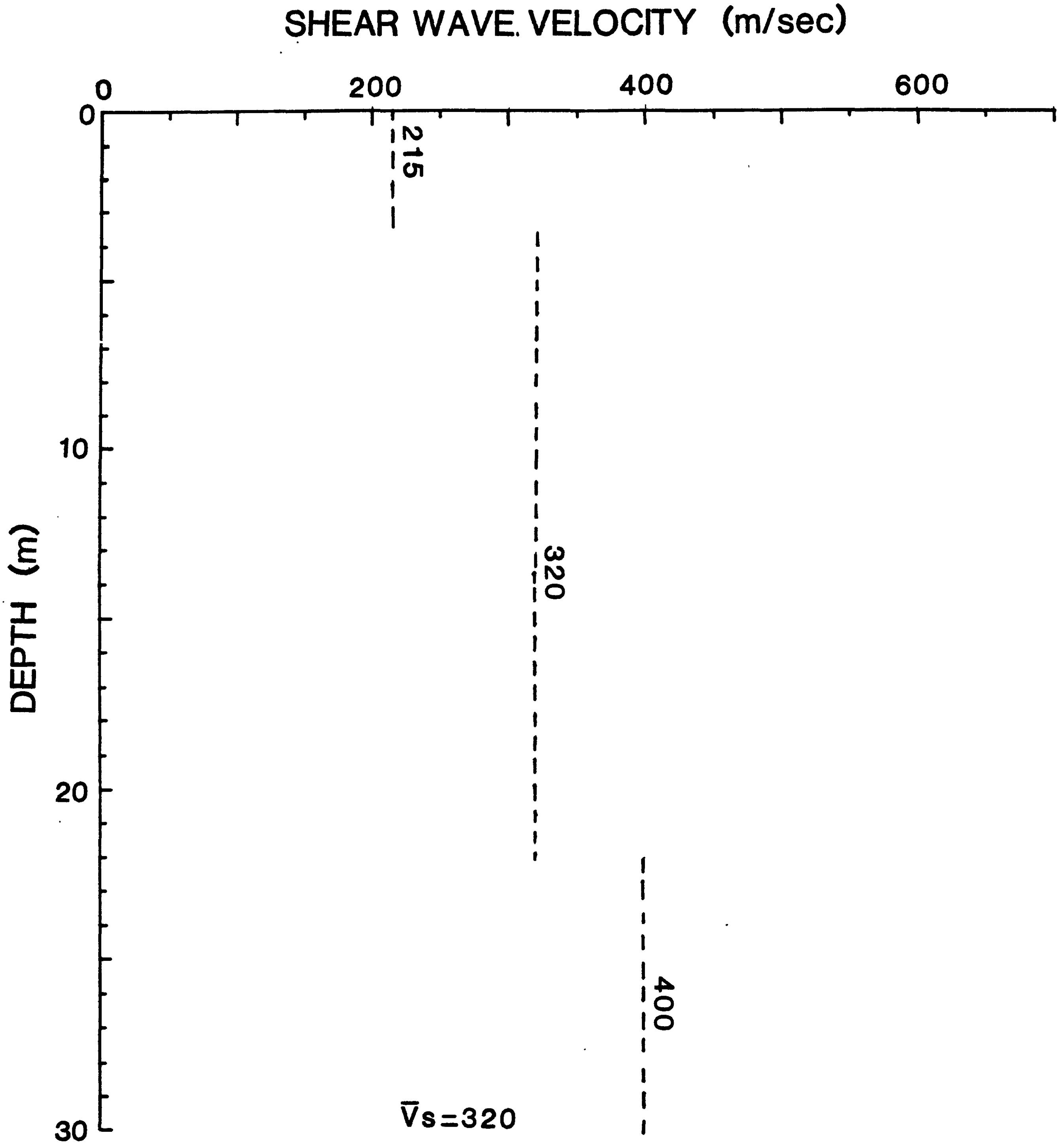
Figure 74



Geologic unit: Chert of Franciscan assemblage

Estimated velocity profile for sites: CHERRY FLAT
1295 SHAFTER

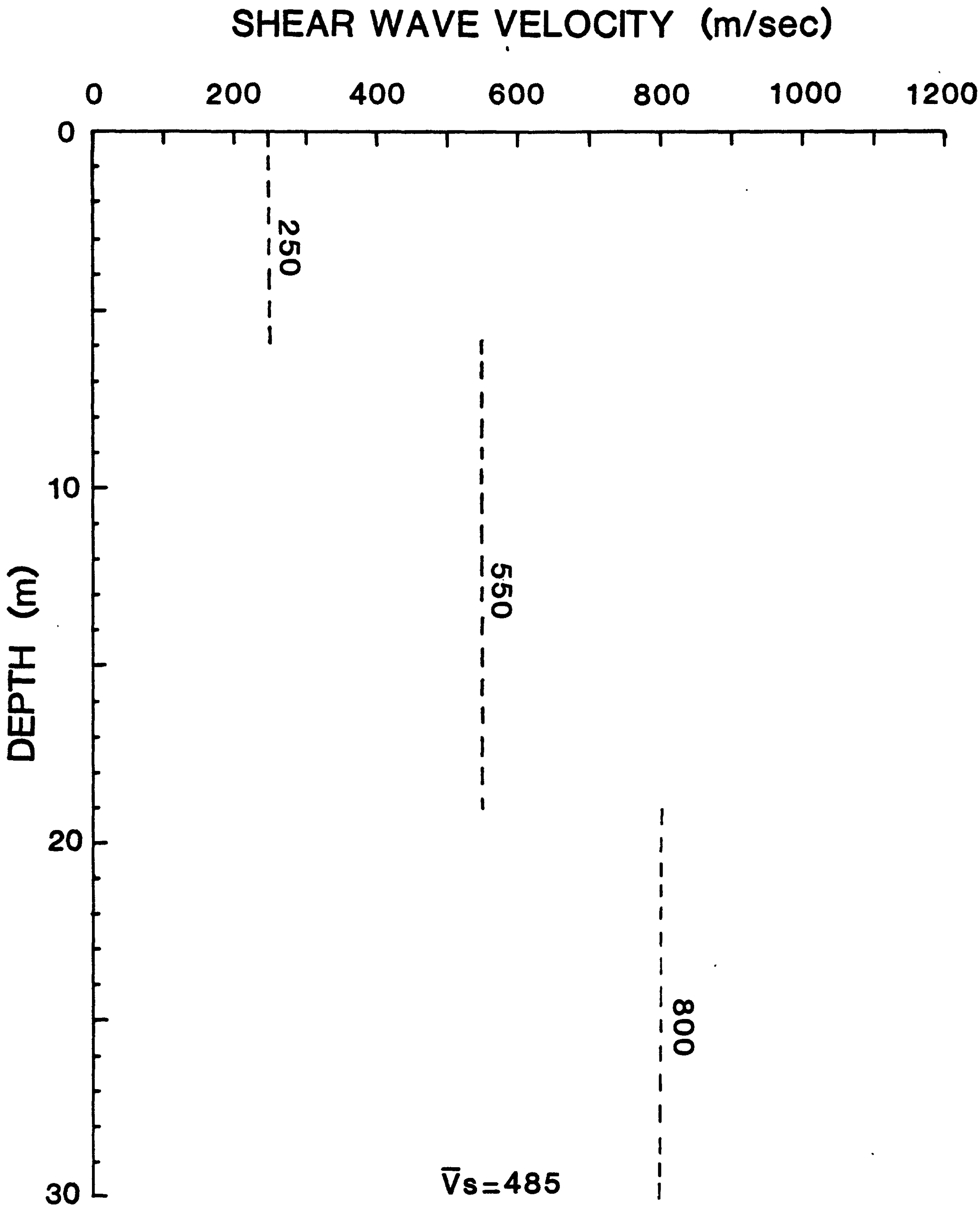
Figure 75



Geologic unit: Santa Clara Formation/Unnamed Miocene sandstone

Estimated velocity profile for site: SLAC

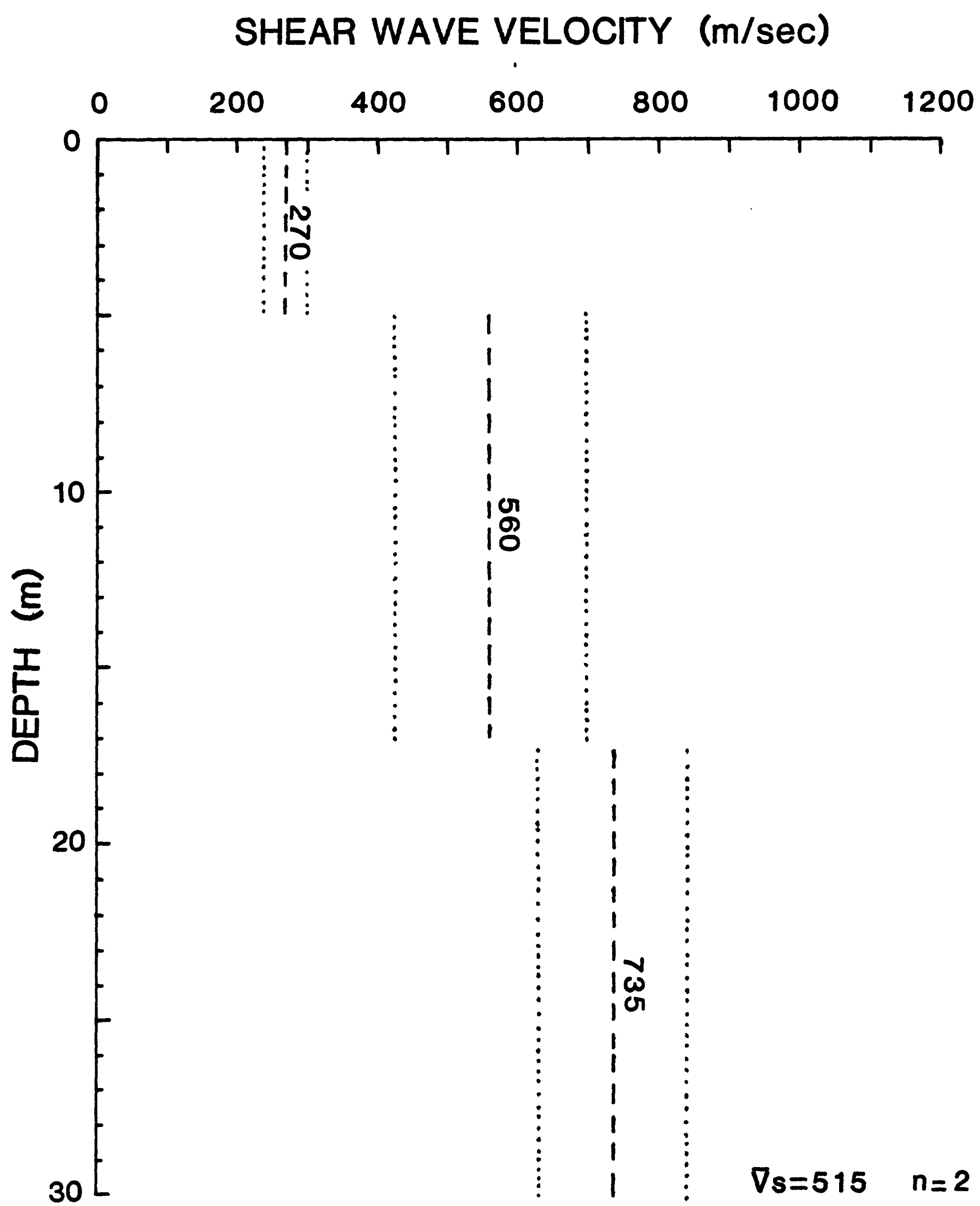
Figure 76



Geologic unit: Butano(?) Sandstone

Estimated velocity profile for site: WOODSIDE

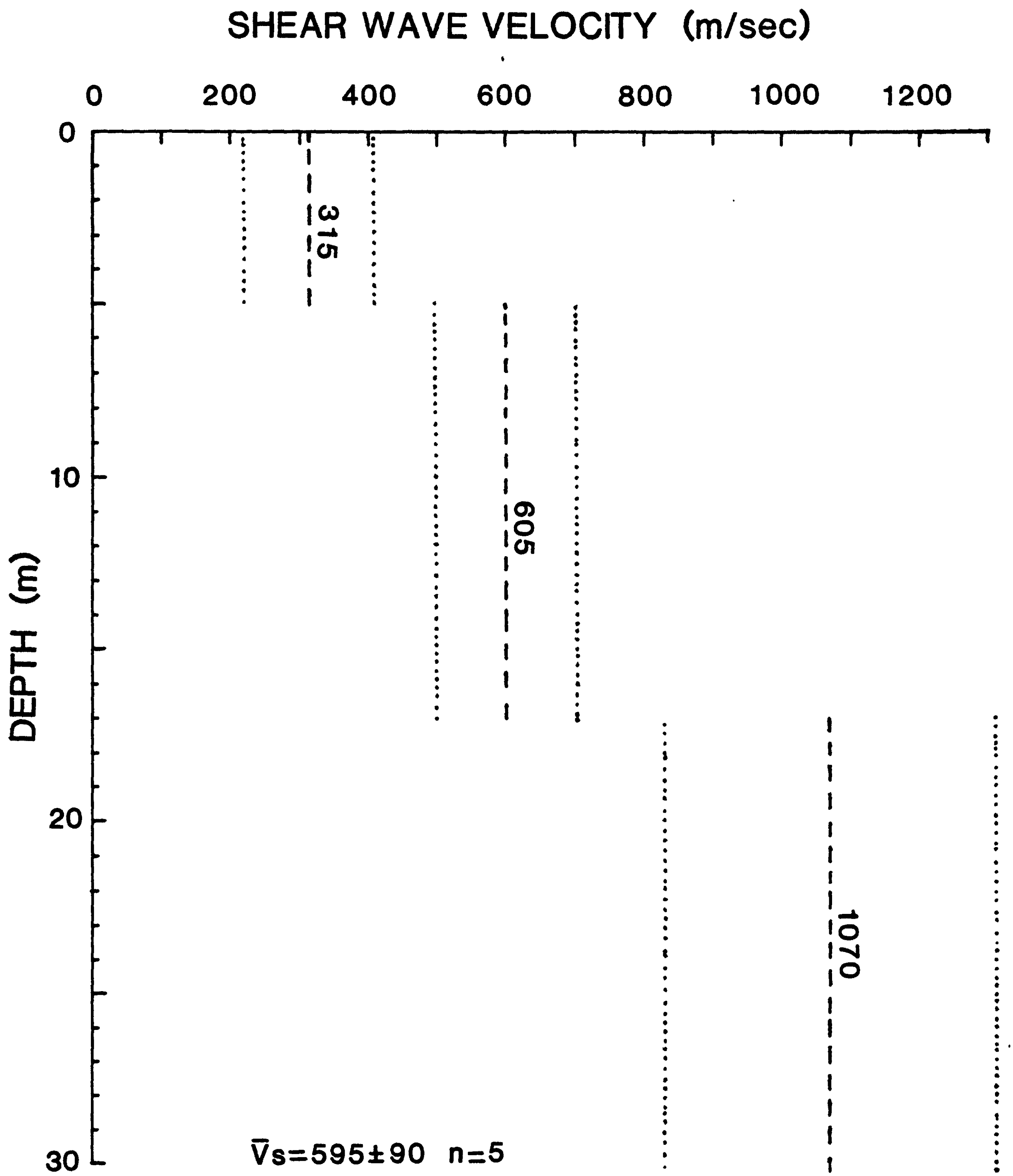
Figure 77



Geologic unit: Serpentinite

Estimated velocity profile for sites:
GOLDEN GATE BRIDGE
PRESIDIO

Figure 78

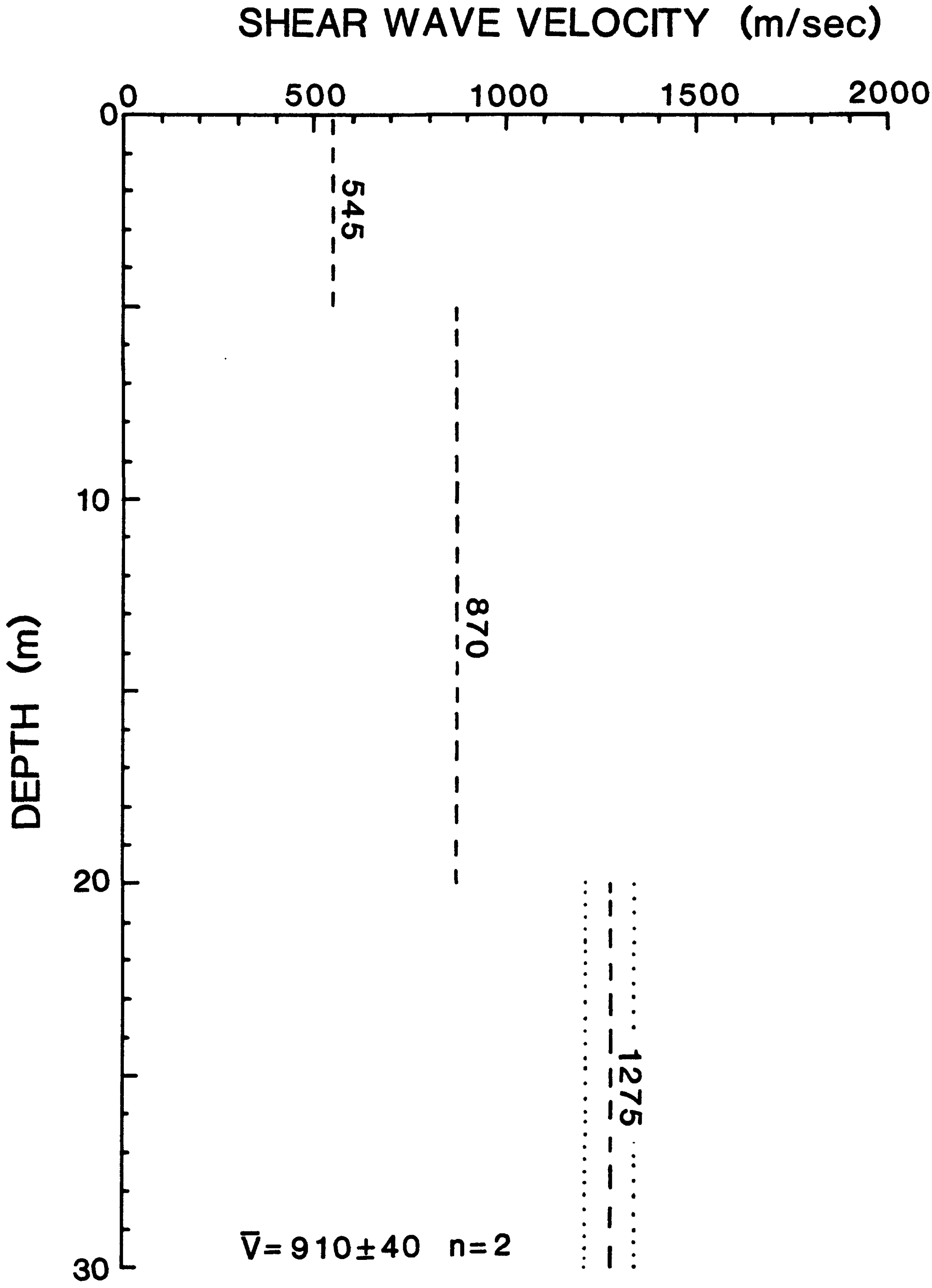


Geologic unit: Miocene sandstone
(Neroly Sandstone, Cierbo Sandstone)
Estimated velocity profile for sites:

LLNL SITE 300

PATERSON PASS ROAD

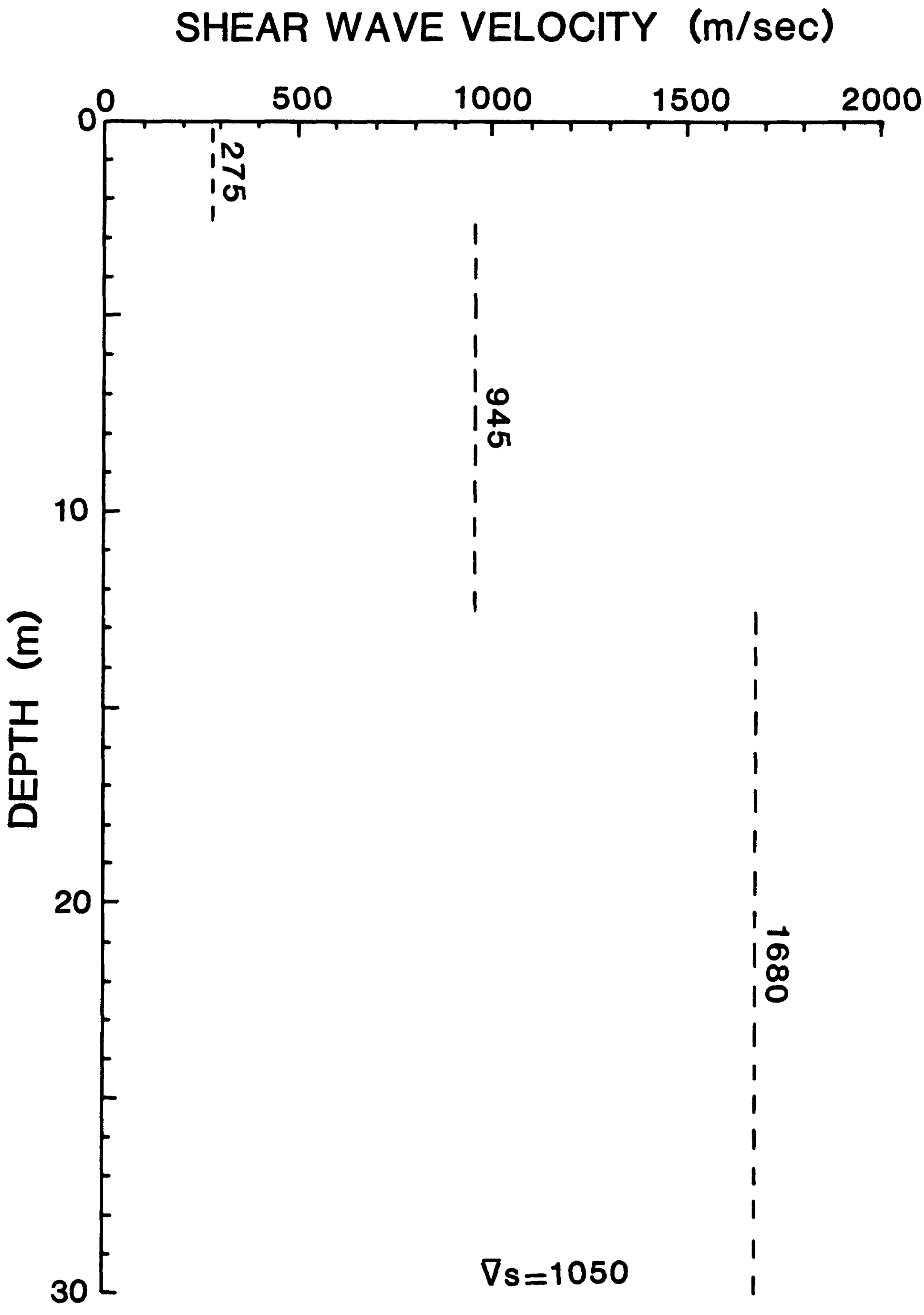
Figure 79



Geologic unit : Sandstone at San Bruno Mountain

Estimated velocity profile for site:
SO. SAN FRANCISCO-SIERRA POINT

Figure 80

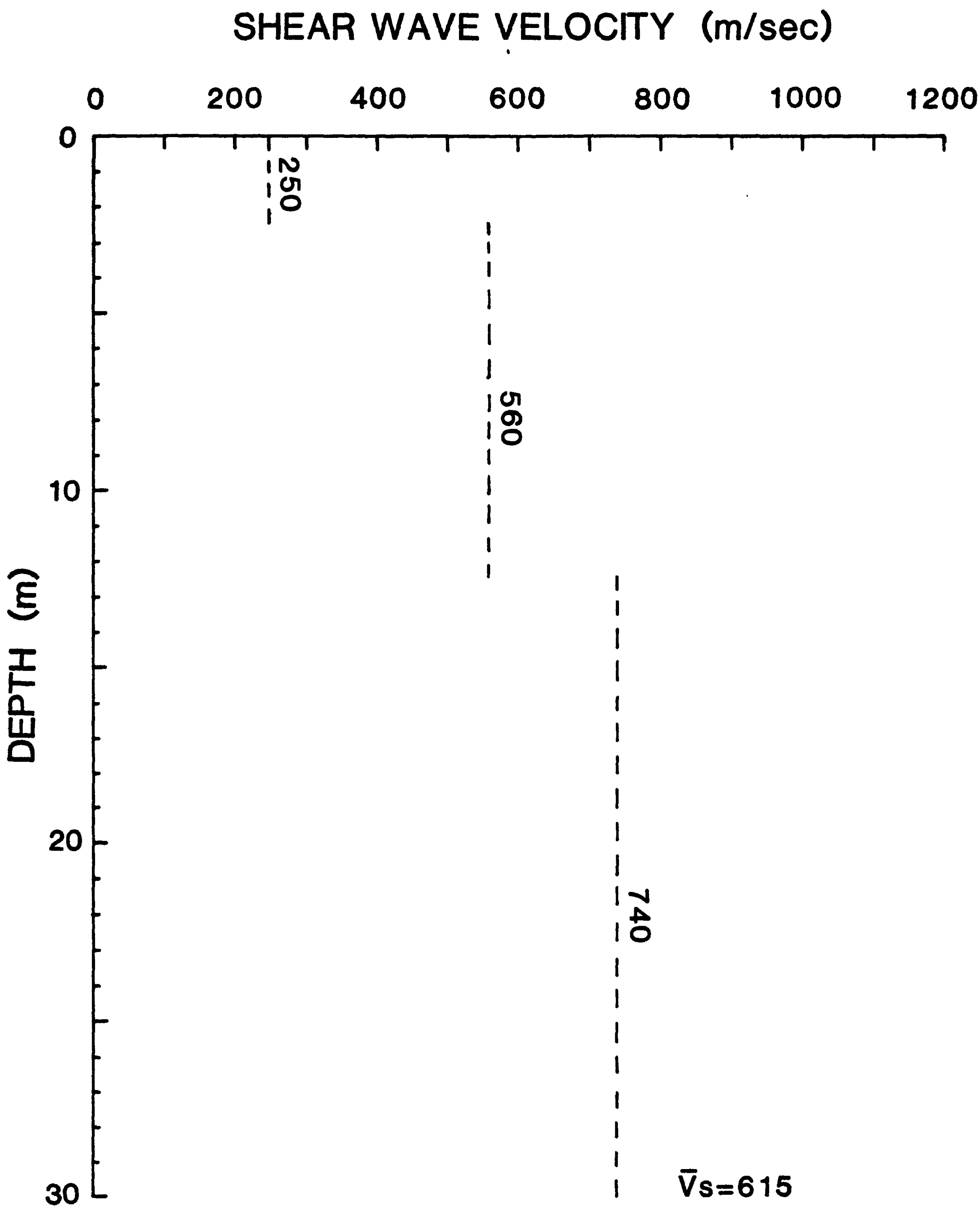


Geologic unit: Miocene rhyolite

Estimated velocity profile for site:

BEAR VALLEY #7 PINNACLES

Figure 81

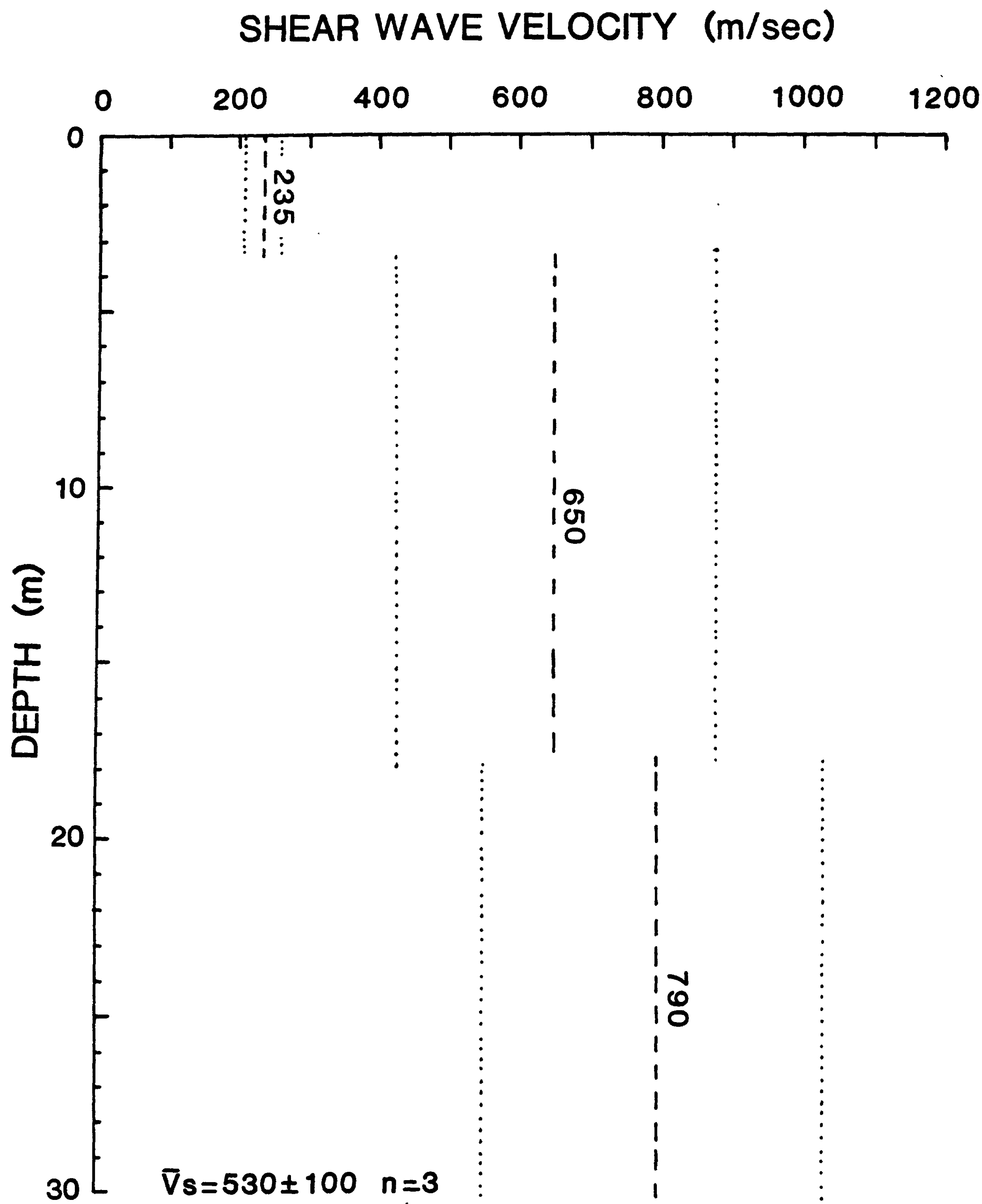


Geologic unit: Claremont shale

Estimated velocity profile for site:

BERKELEY-STRAWBERRY CANYON

Figure 82

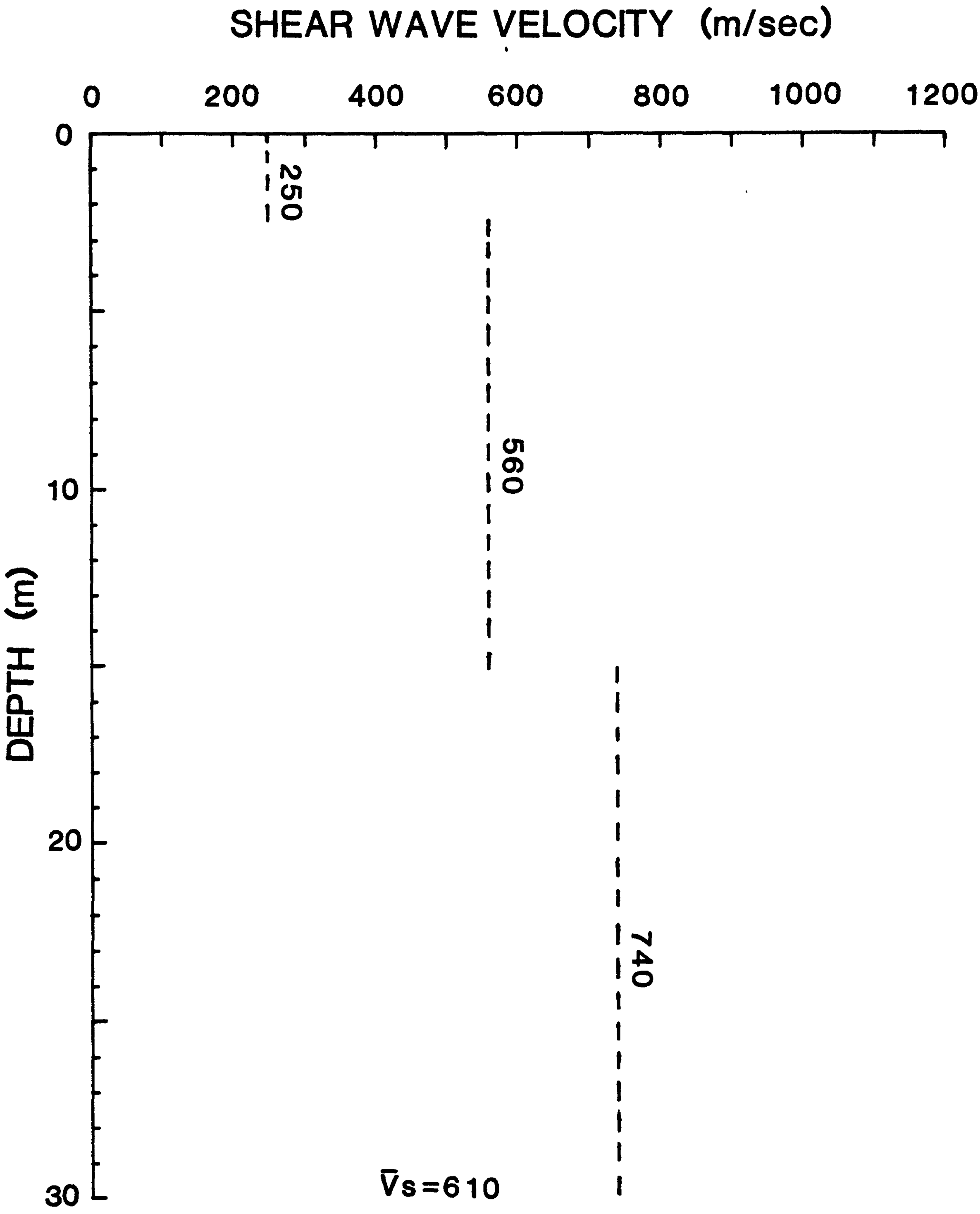


Geologic unit: Sheared rocks of Franciscan assemblage

Estimated velocity profile for site:

BERKELEY MEMORIAL STADIUM

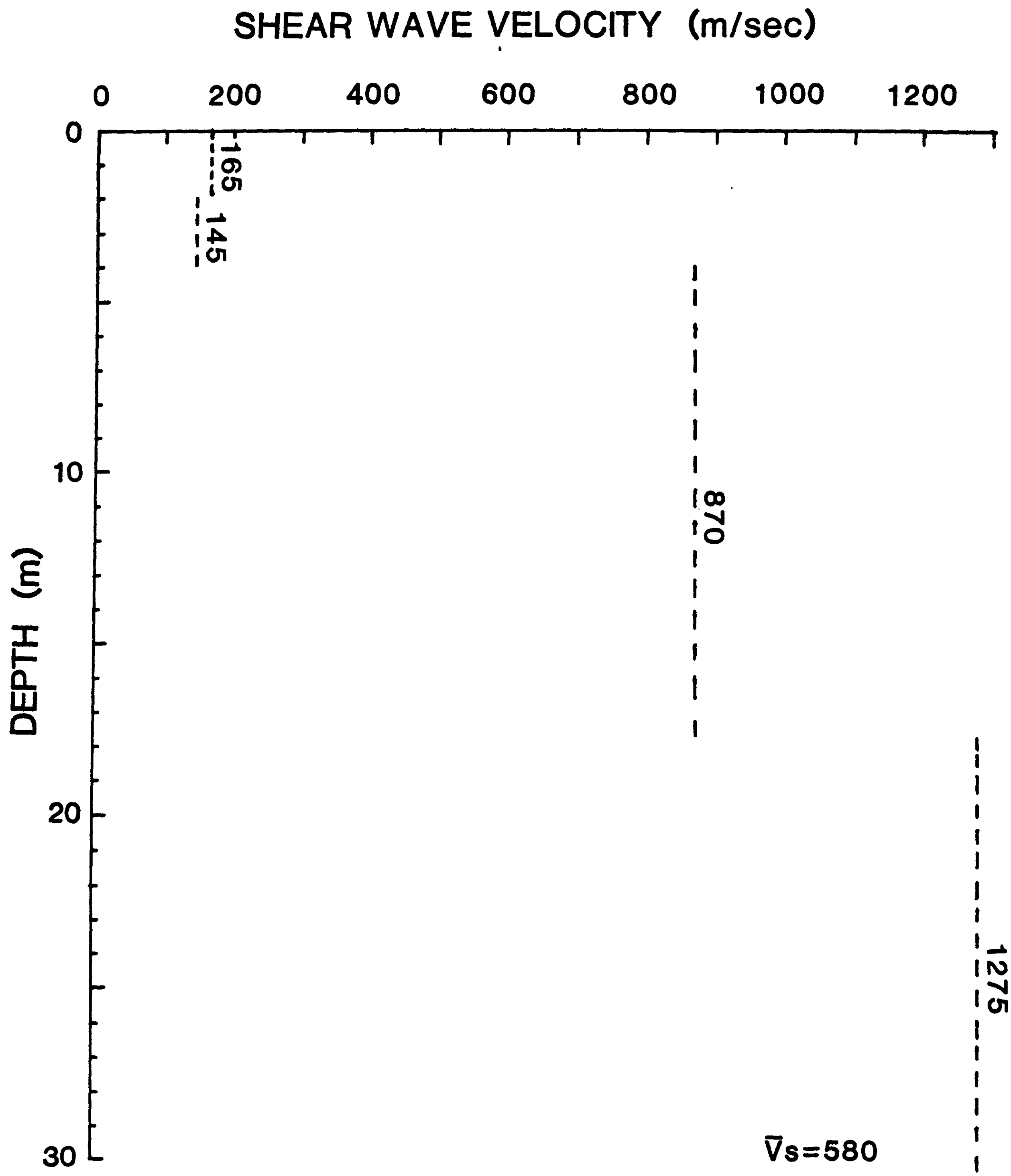
Figure 83



Geologic unit: Upper Cretaceous shale

Estimated velocity profile for site:
LAWRENCE BERKELEY LAB

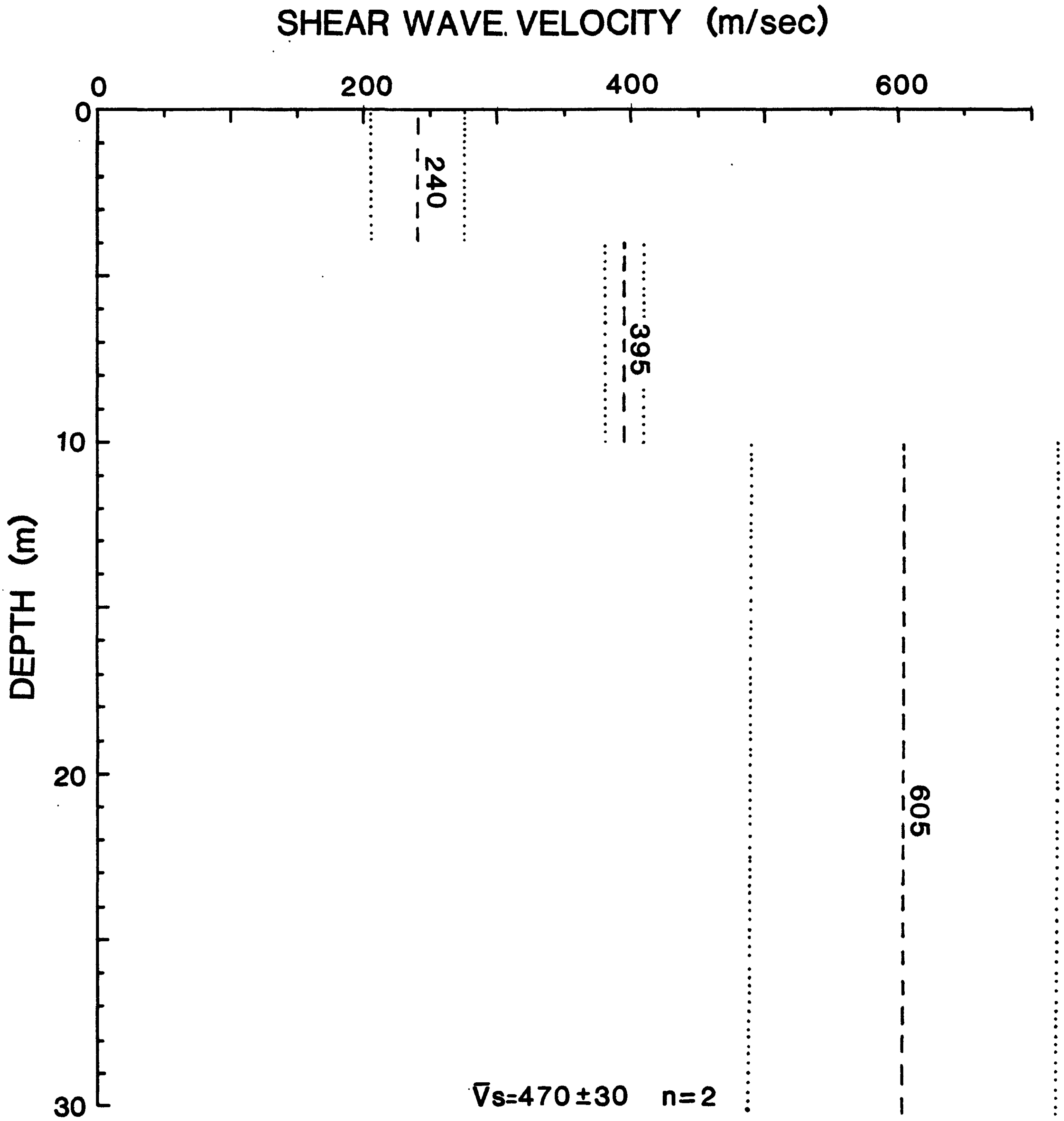
Figure 84



Geologic unit: Artifical fill/Holocene bay mud
Panoche Formation (Cretaceous shale&sandstone)

Estimated velocity profile for site: MARE ISLAND

Figure 85

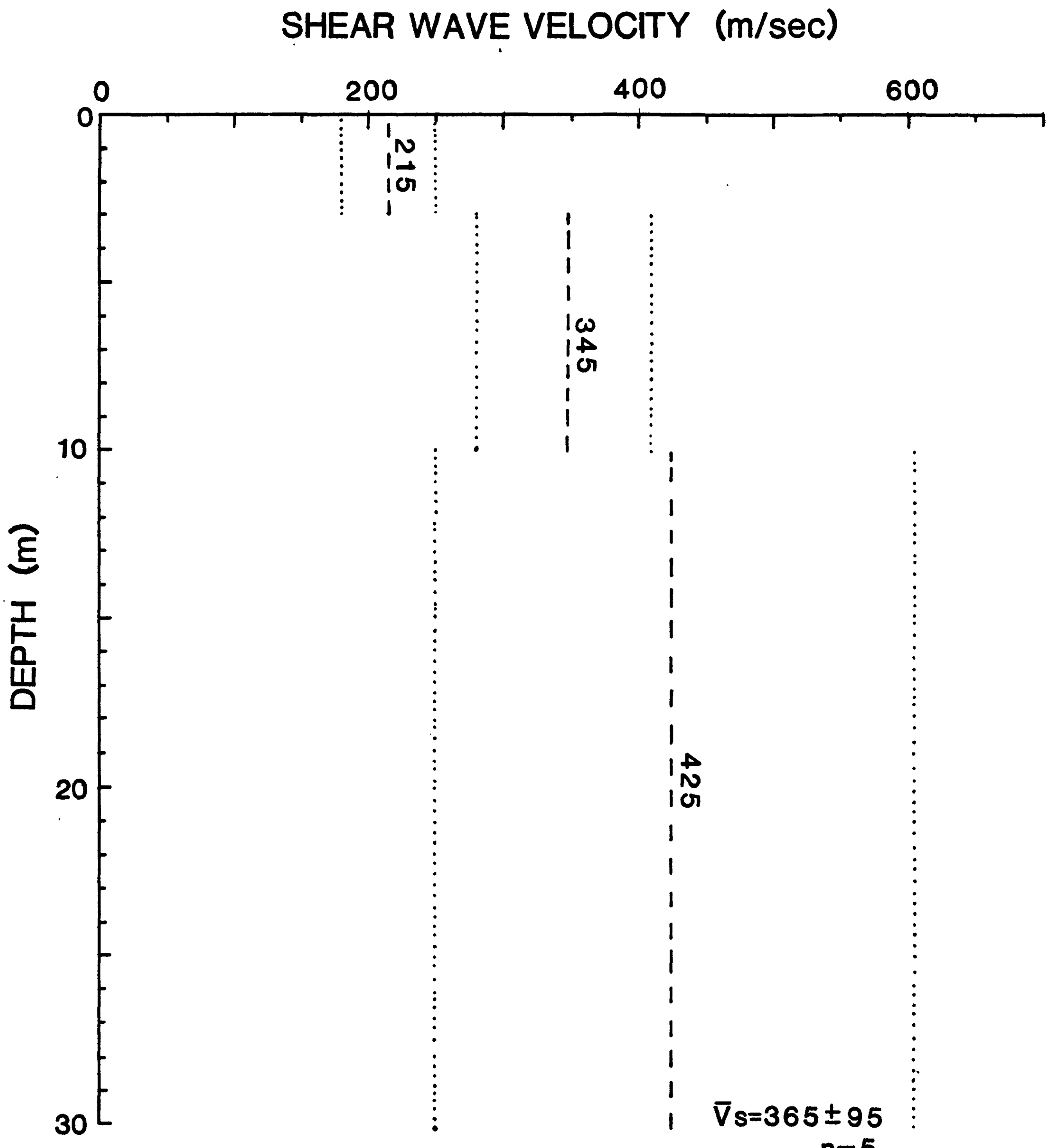


Geologic unit: Late Pleistocene coarse-grained alluvium

Estimated velocity profile for site:

SARATOGA-WEST VALLEY COLLEGE

Figure 86

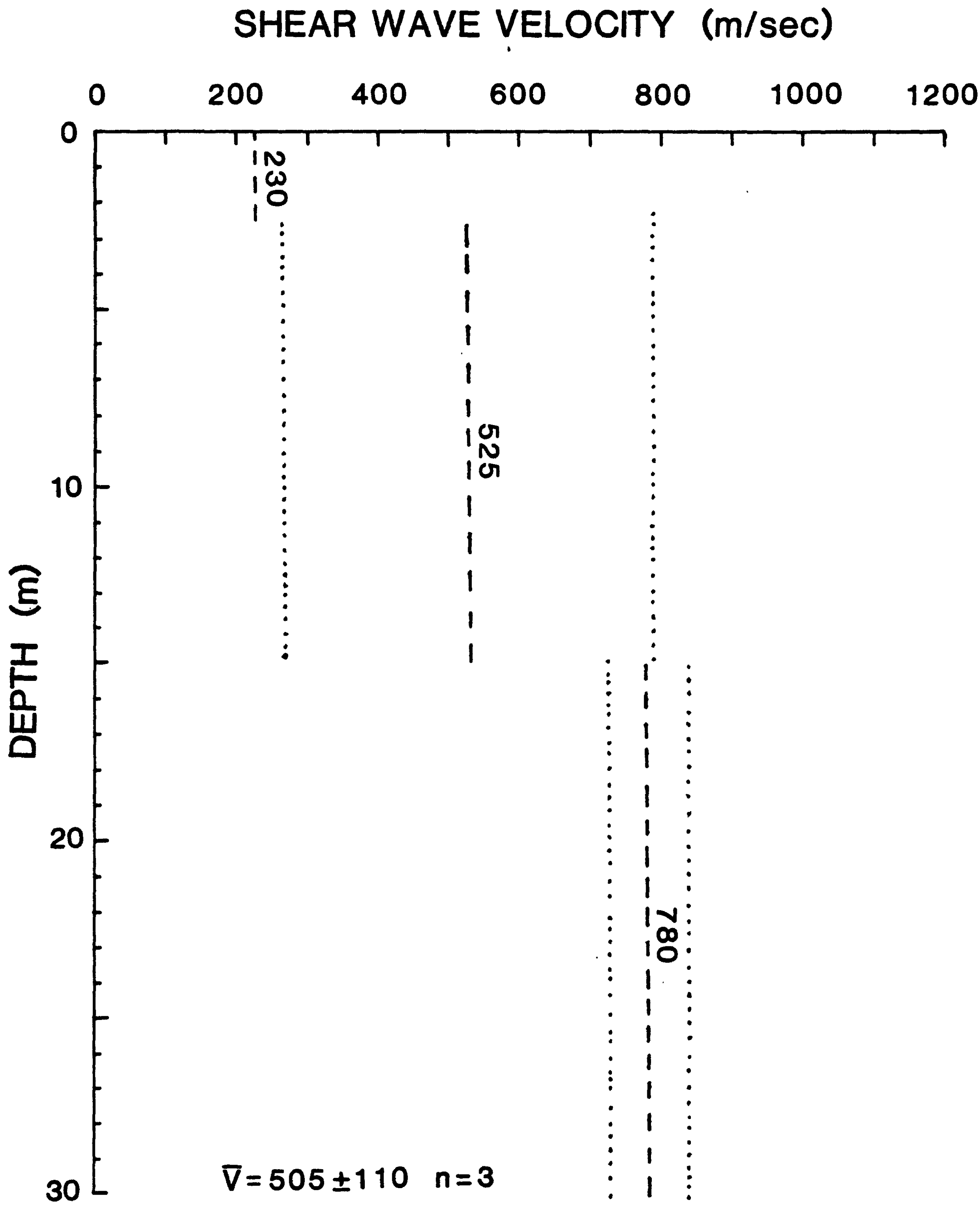


Geologic unit: Late Pleistocene alluvium

Estimated velocity profile for sites:

ANDERSON DAM DOWNSTREAM
HALLS VALLEY
HAYWARD BART
LLNL EAST GATE
LLNL NW CORNER
SANDIA NATIONAL LAB
SAN JOSE-SANTA TERESA
SUNOL

Figure 87

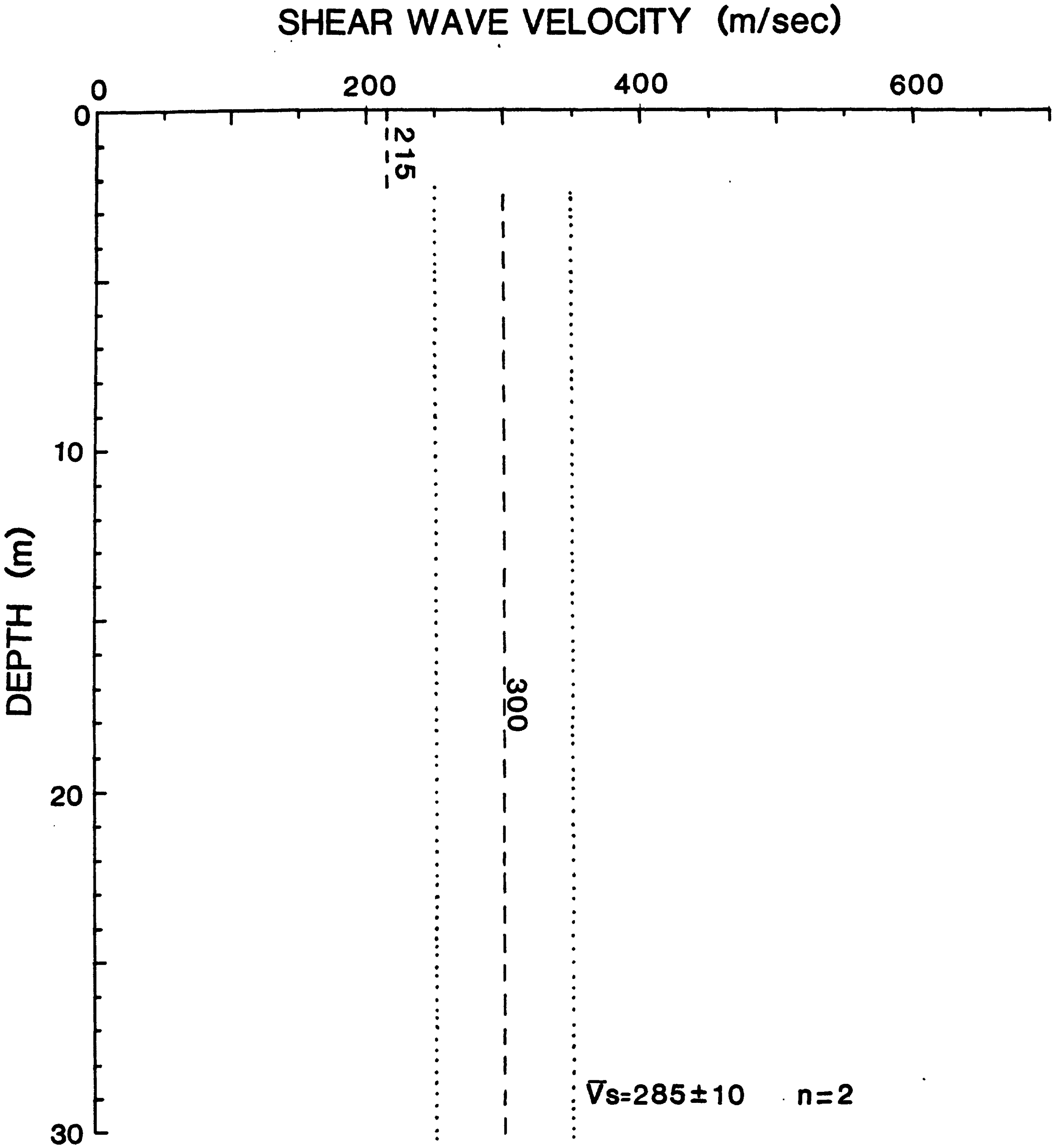


Geologic unit: Late Pleistocene very coarse-grained alluvium

Estimated velocity profile for site:

COYOTE LAKE DOWNSTREAM

Figure 88

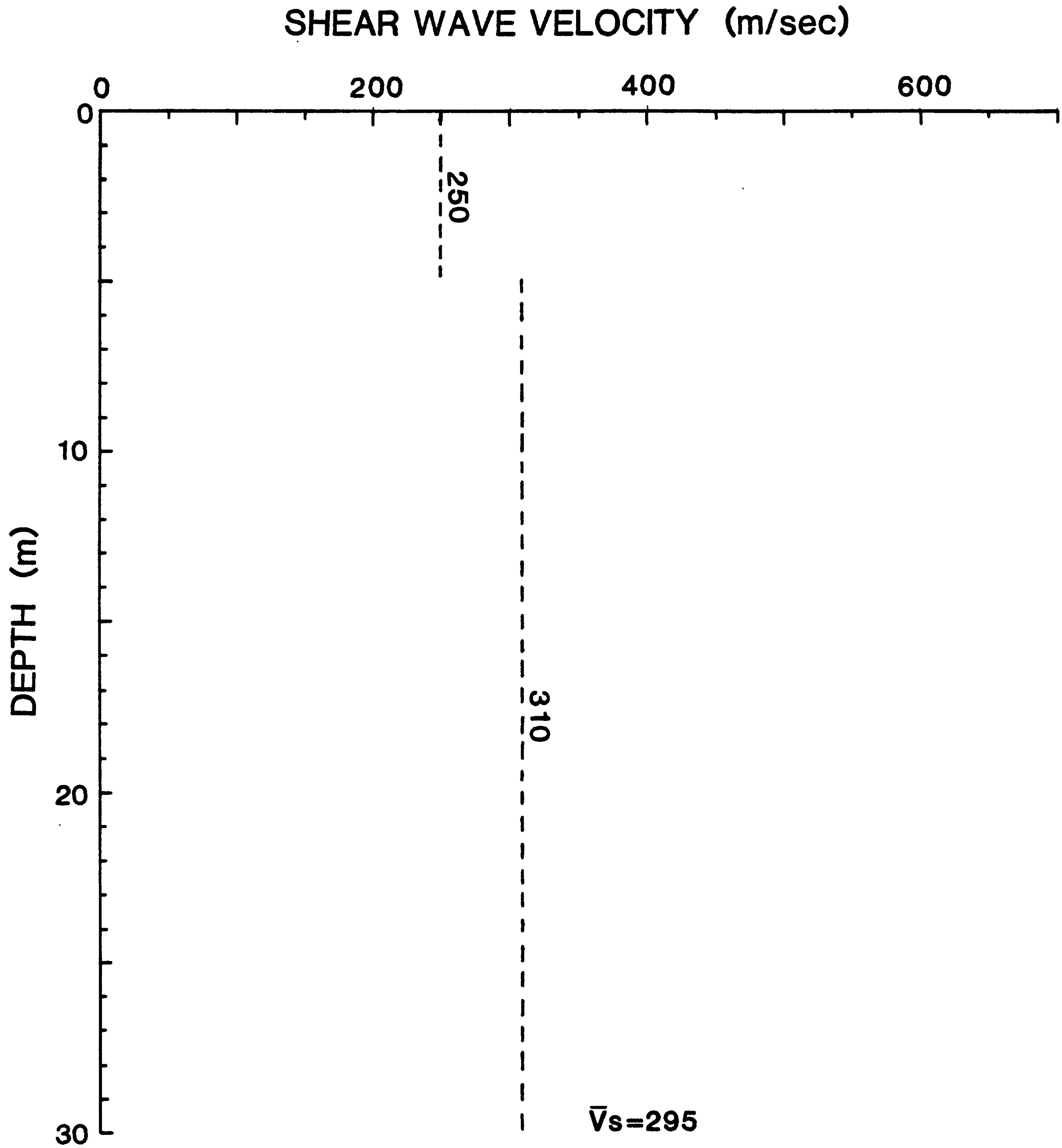


Geologic unit: Late Pleistocene fine-grained alluvium

Estimated velocity profile for sites:

BERKELEY 2-STORY HOSPITAL
FREMONT
FREMONT-MISSION SAN JOSE

Figure 89

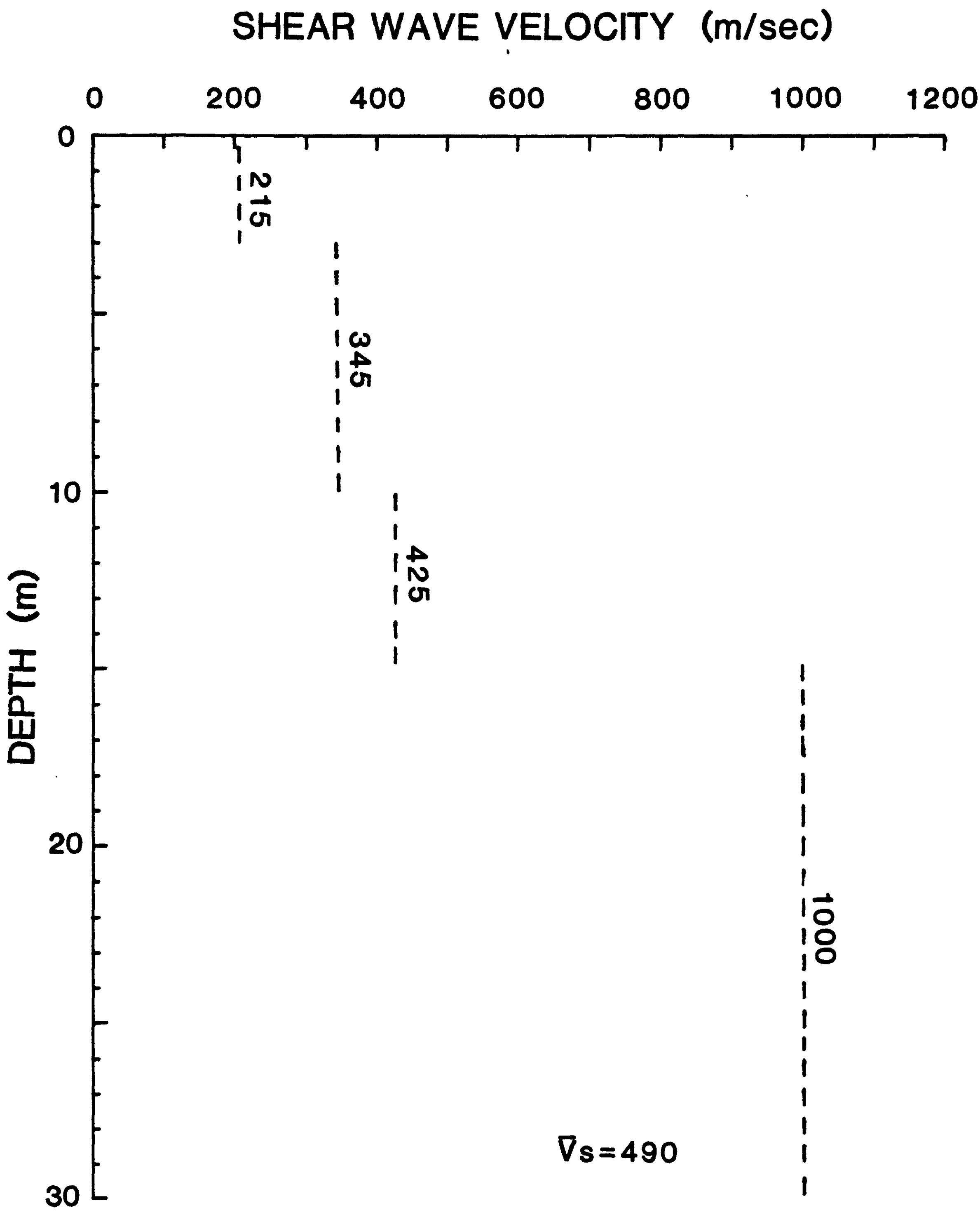


Geologic unit: **Merritt Sand**

Estimated velocity profile for site:

OAKLAND 2-STORY OFFICE BUILDING

Figure 90

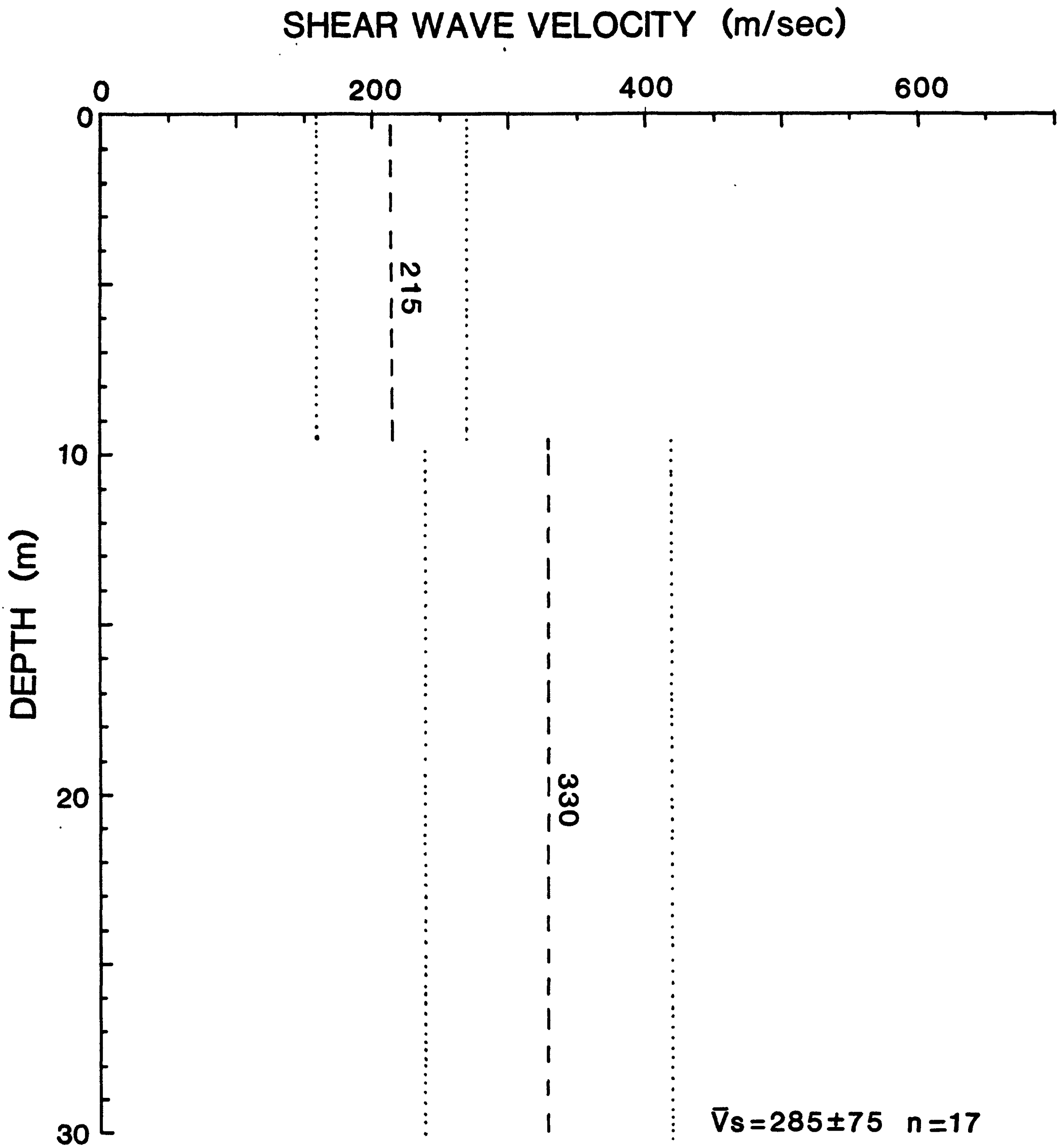


Geologic unit: Late Pleistocene alluvium/
Sandstone of Franciscan assemblage

Estimated velocity profile for site:

BIG SUR

Figure 91

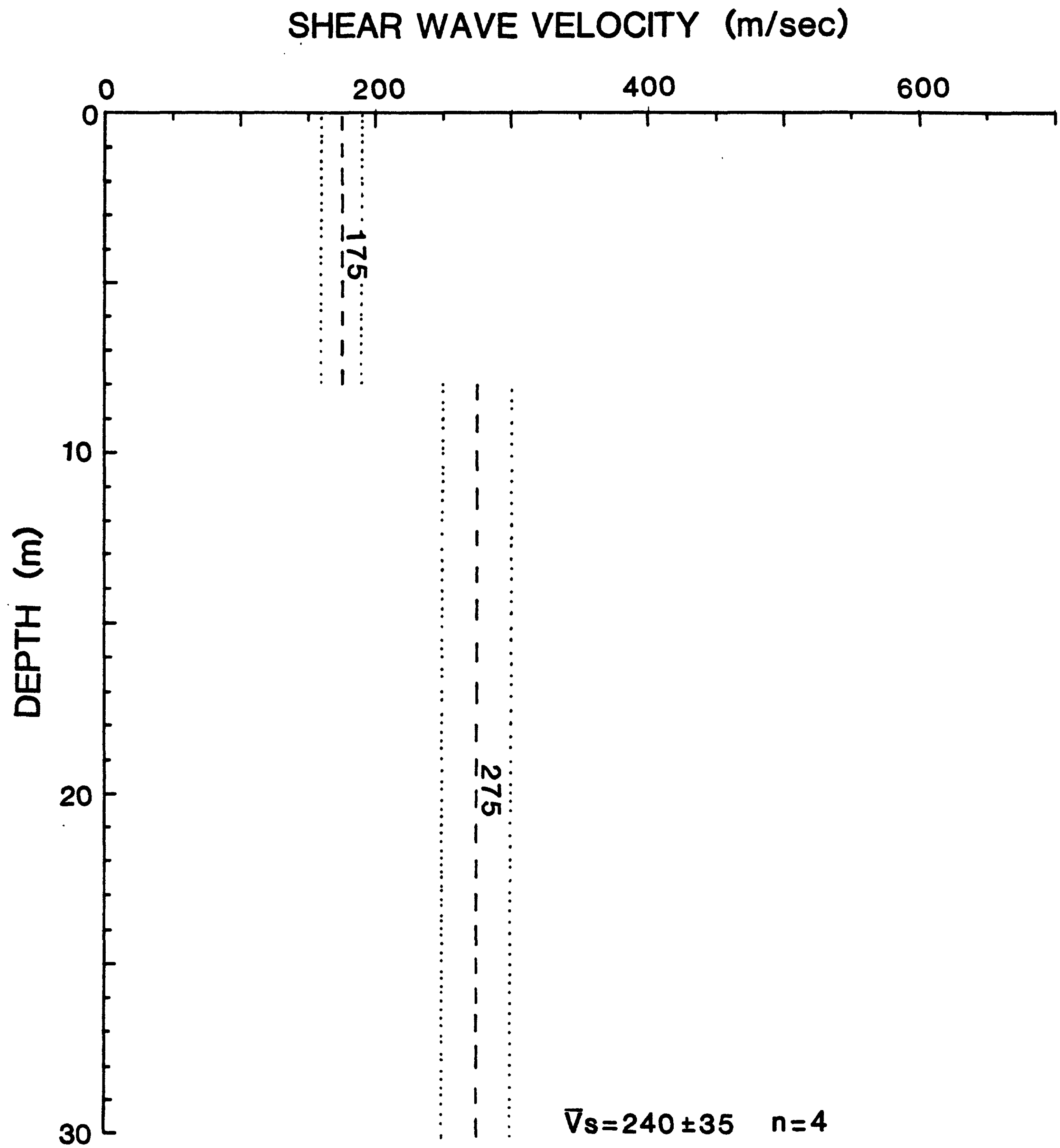


Geologic unit: Holocene alluvium

Estimated velocity profile for sites:

BEAR VALLEY #5 CALLENS
GREENFIELD
LOS BANOS
BEAR VALLEY #12 WILLIAMS
BITTERWATER
SALINAS
CAPITOLA
TRACY SEWAGE PLANT

Figure 92



Geologic unit: Holocene fine-grained alluvium

Estimated velocity profile for sites:

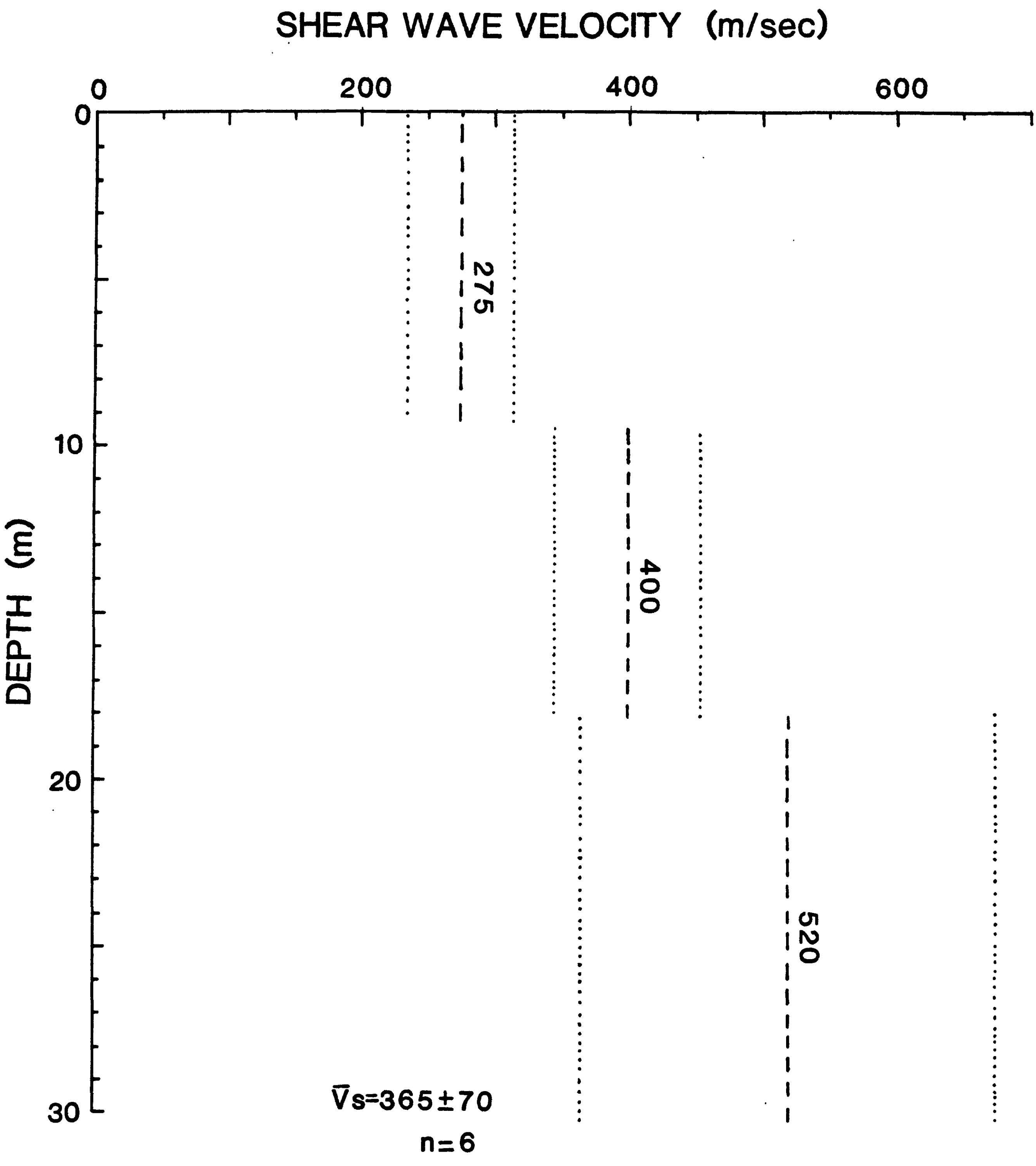
AGNEW

DUBLIN FIRESTATION

MILPITAS 2-STORY BLDG

SUNNYVALE-COLTON AVE

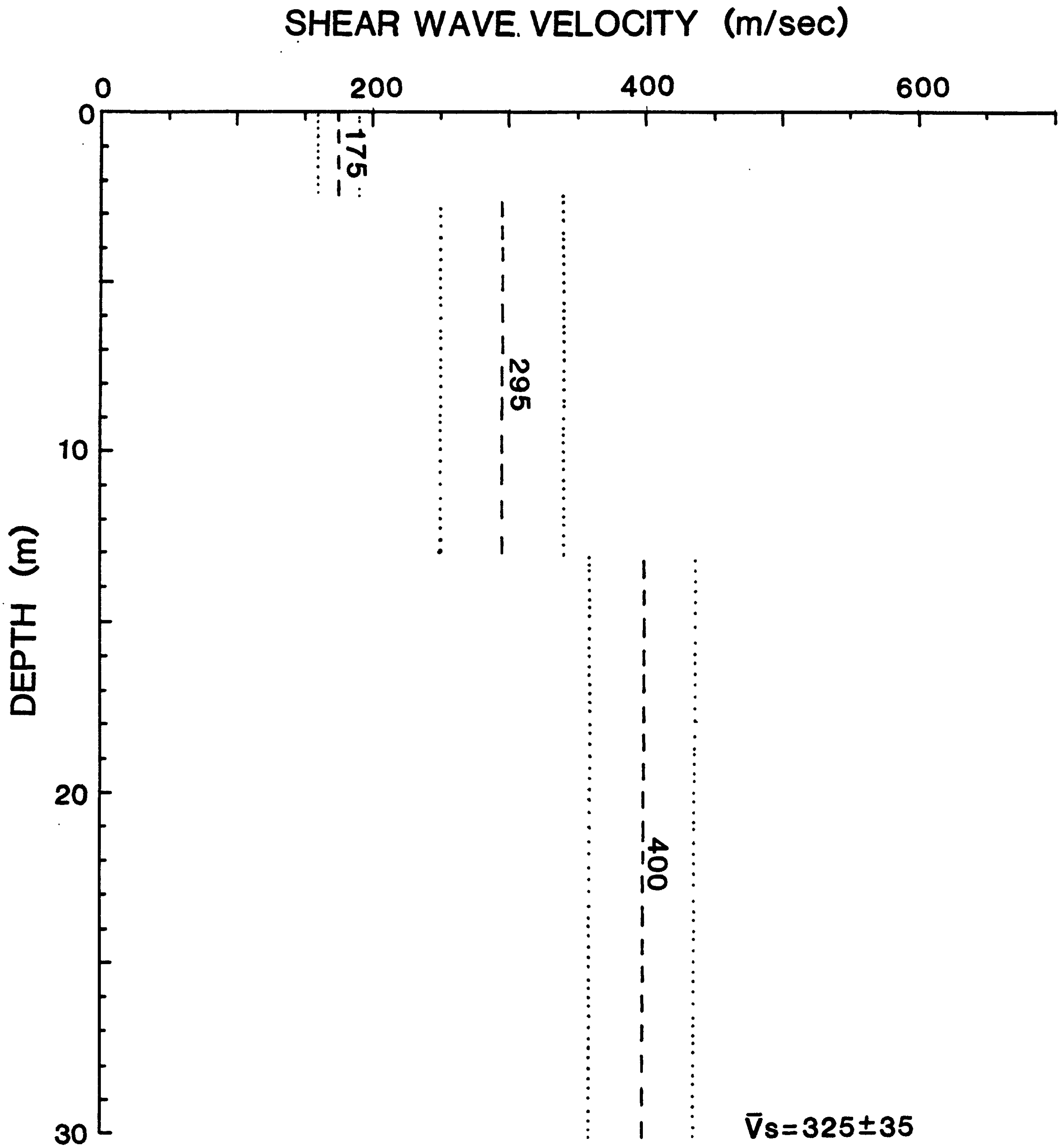
Figure 93



Geologic unit: Holocene coarse-grained alluvium
Estimated velocity profile for sites:

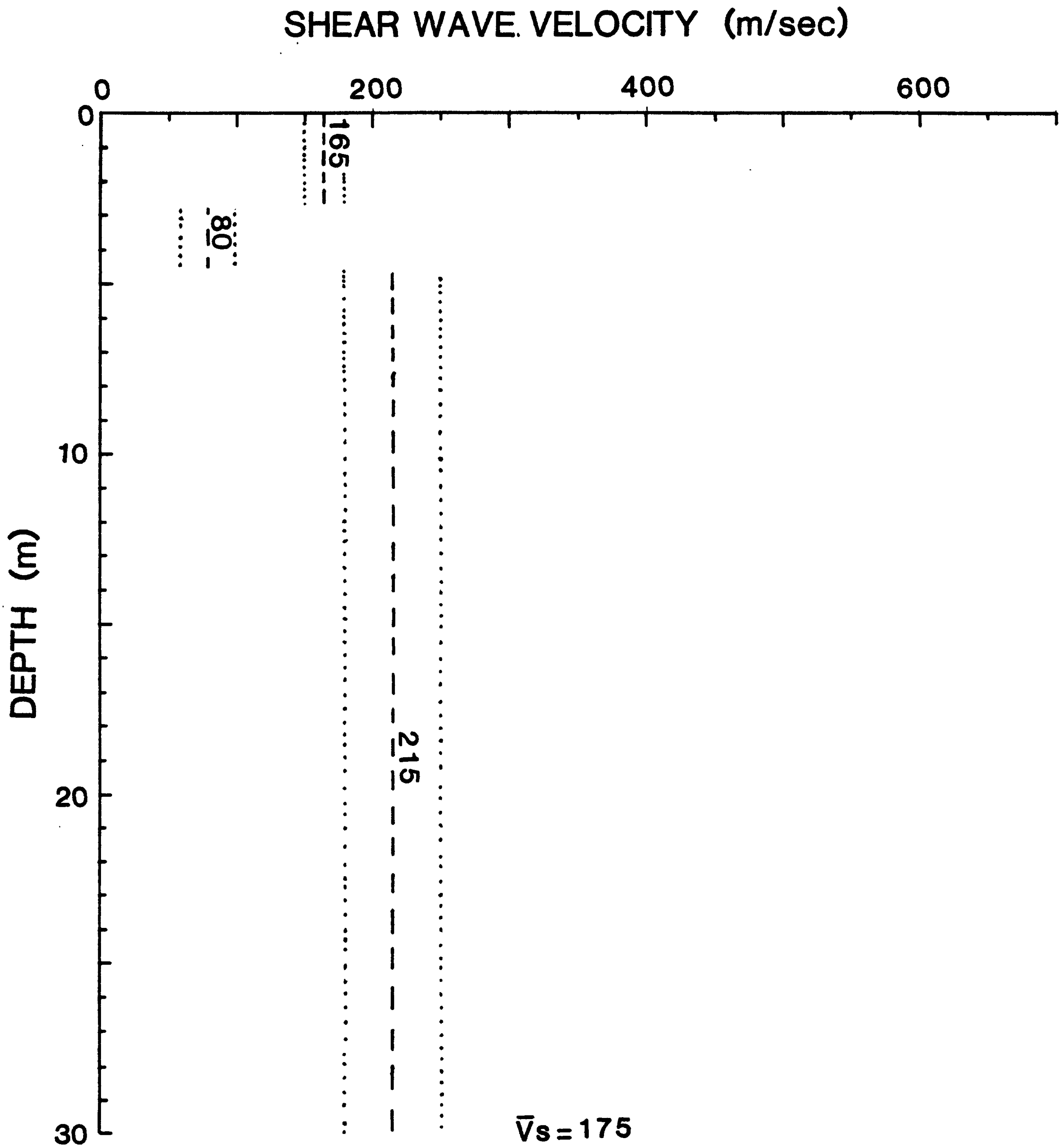
CALAVERAS RESERVOIR
GILROY OLD FIREHOUSE
OLEMA

Figure 94



Geologic unit:
Holocene fine-grained alluvium/Pliocene sandstone&mudstone
Estimated velocity profile for site:
LIVERMORE - FAGUNDES

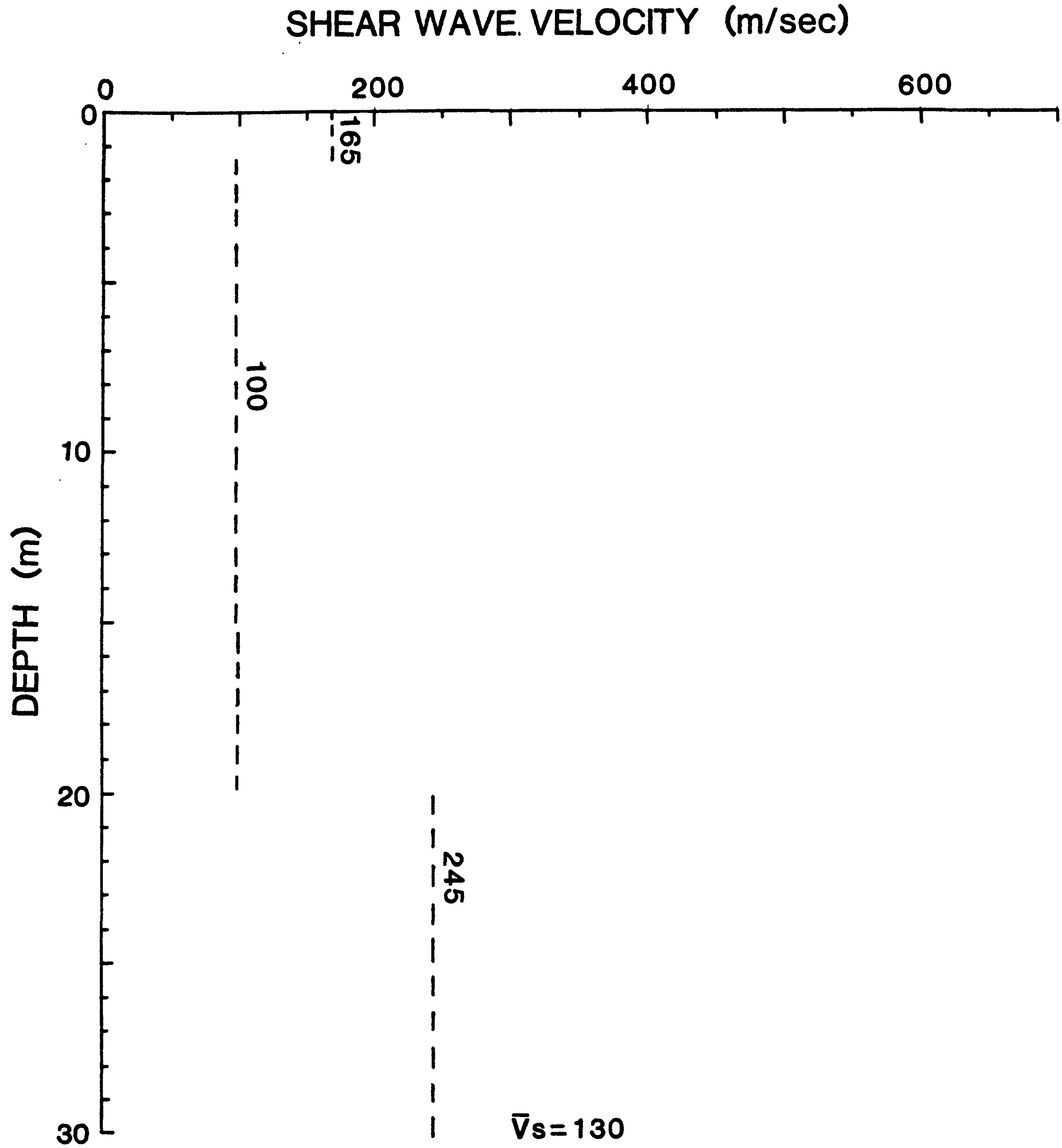
Figure 95



Geologic unit: Artifical fill/Holocene bay mud

Estimated velocity profile for site: PALO ALTO 2-STORY BUILDING

Figure 96

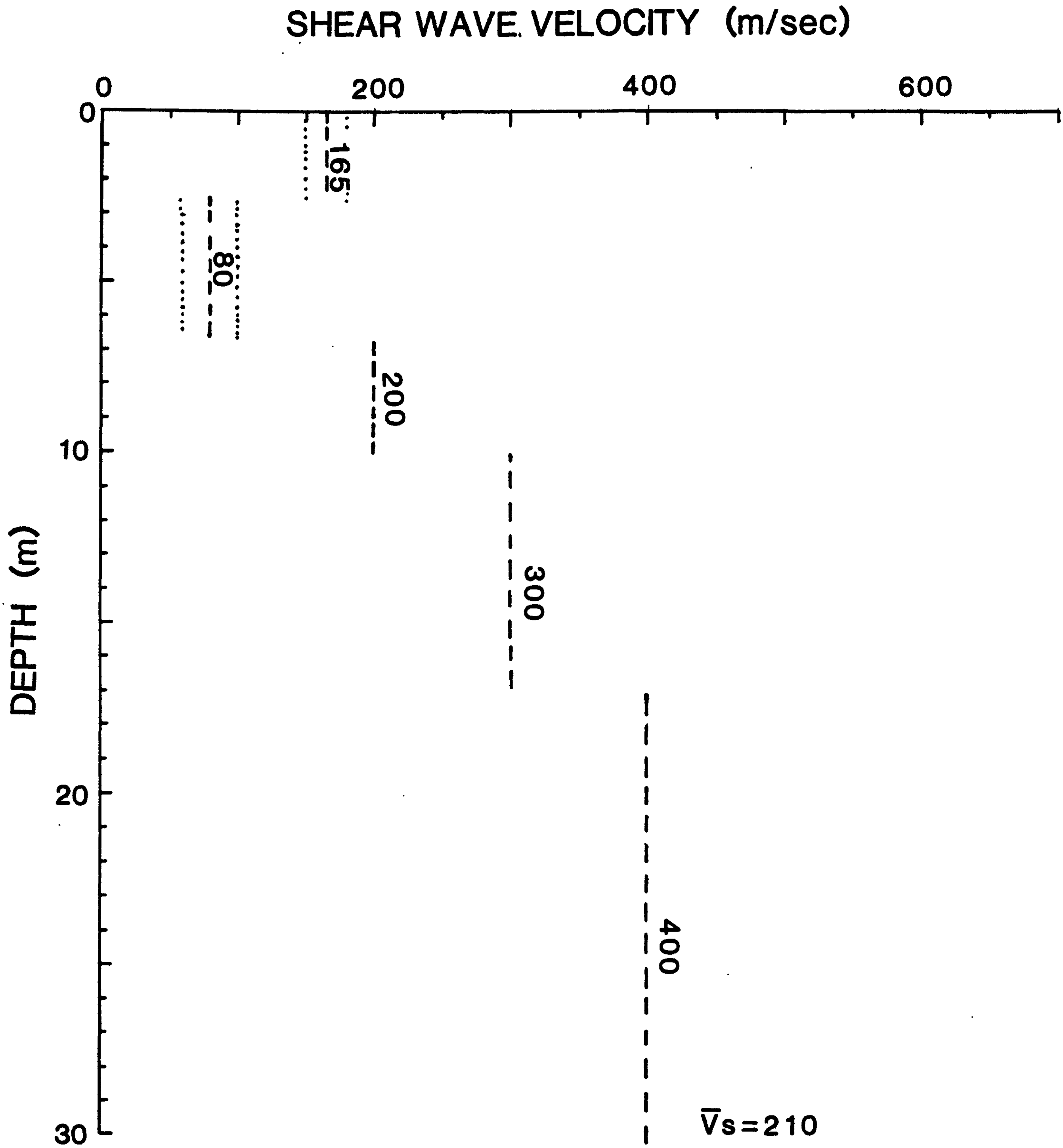


Geologic unit: Artifical fill/Holocene bay mud

Estimated velocity profile for site:

FOSTER CITY-MENHADEN COURT

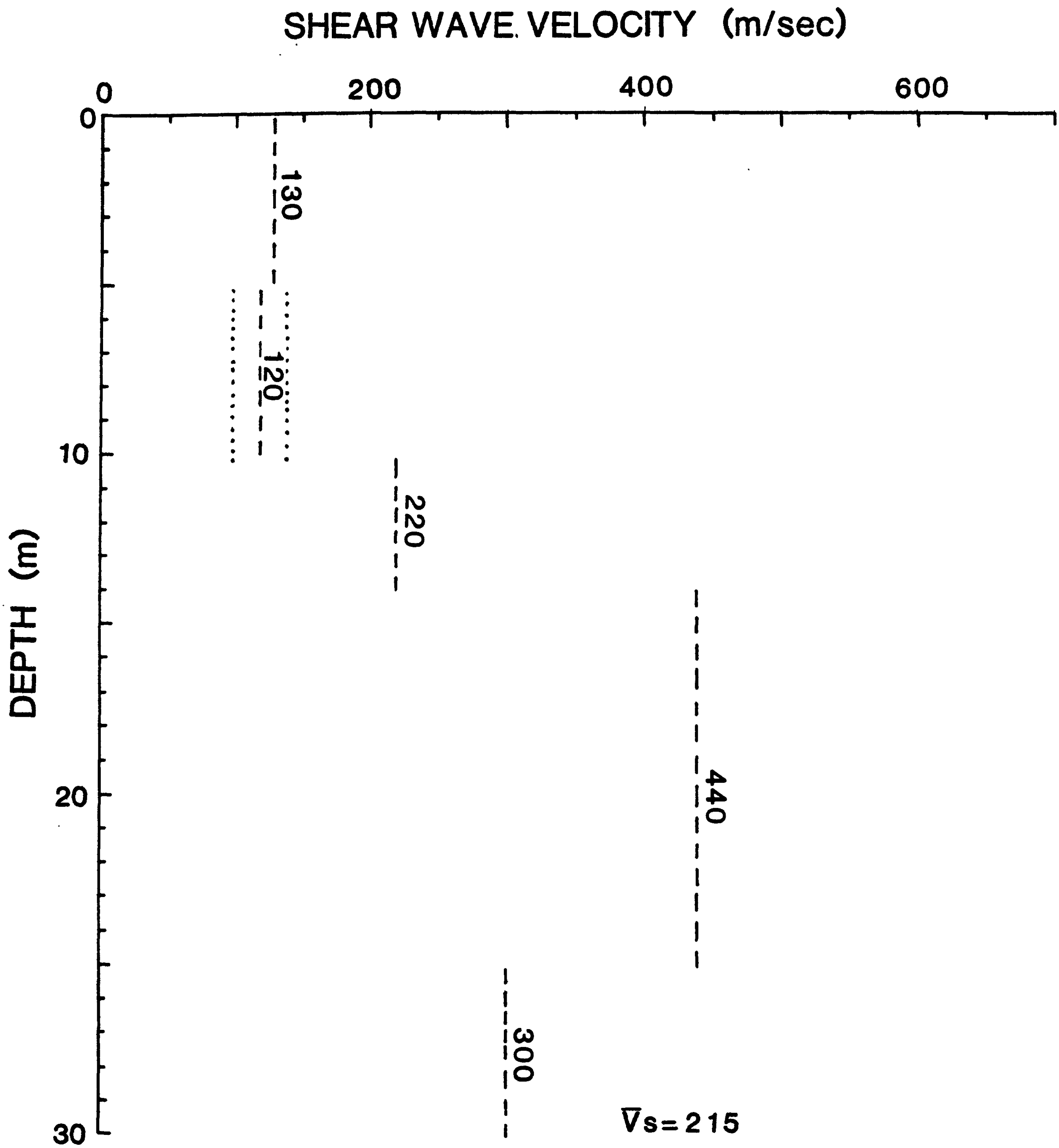
Figure 97



Geologic unit: Artifical fill/Holocene bay mud

Estimated velocity profile for site: S.F. INTERNATIONAL AIRPORT

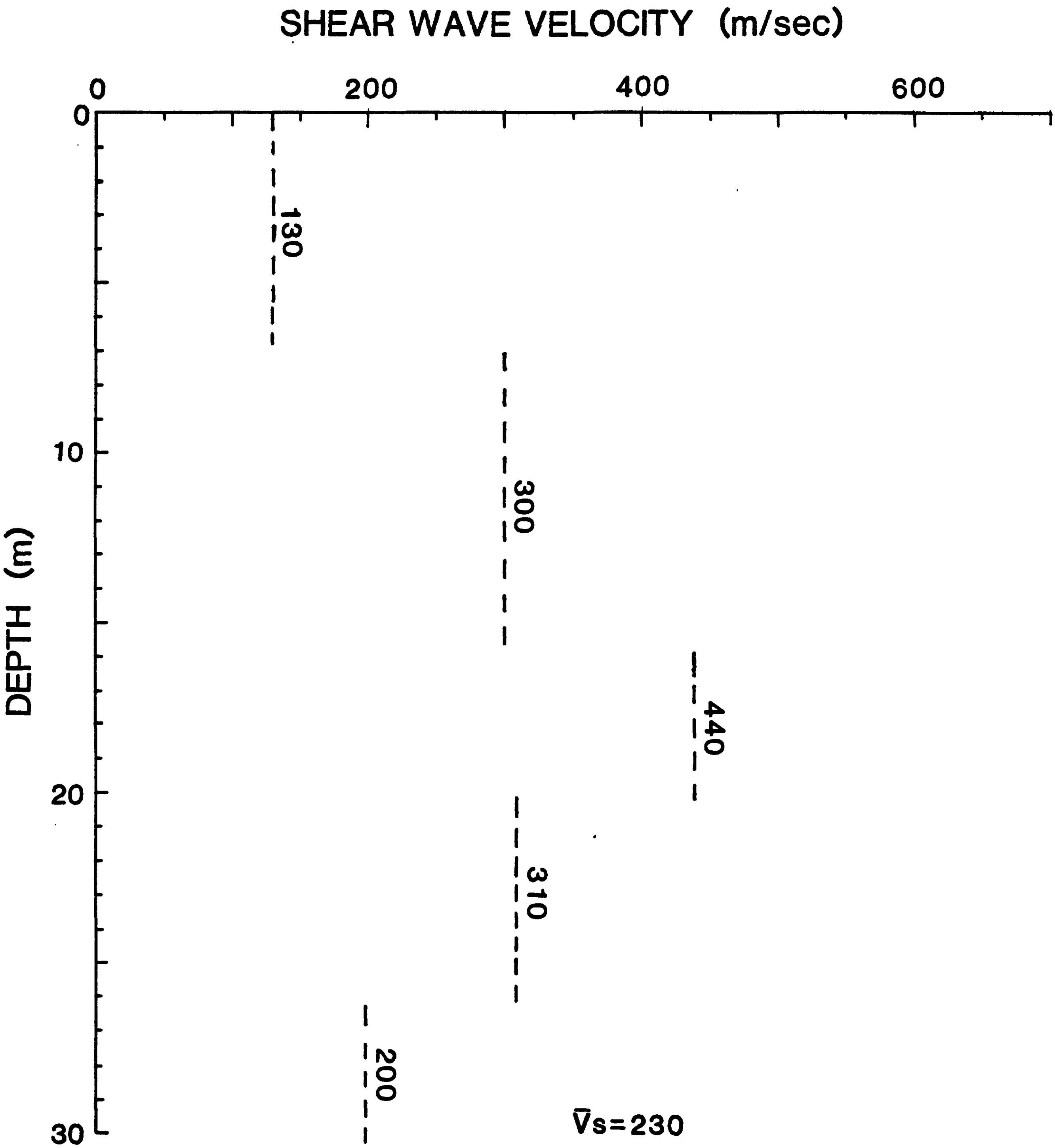
Figure 98



Geologic unit: Artifical fill/Holocene bay mud

Estimated velocity profile for site: ALAMEDA NAVAL AIR STATION

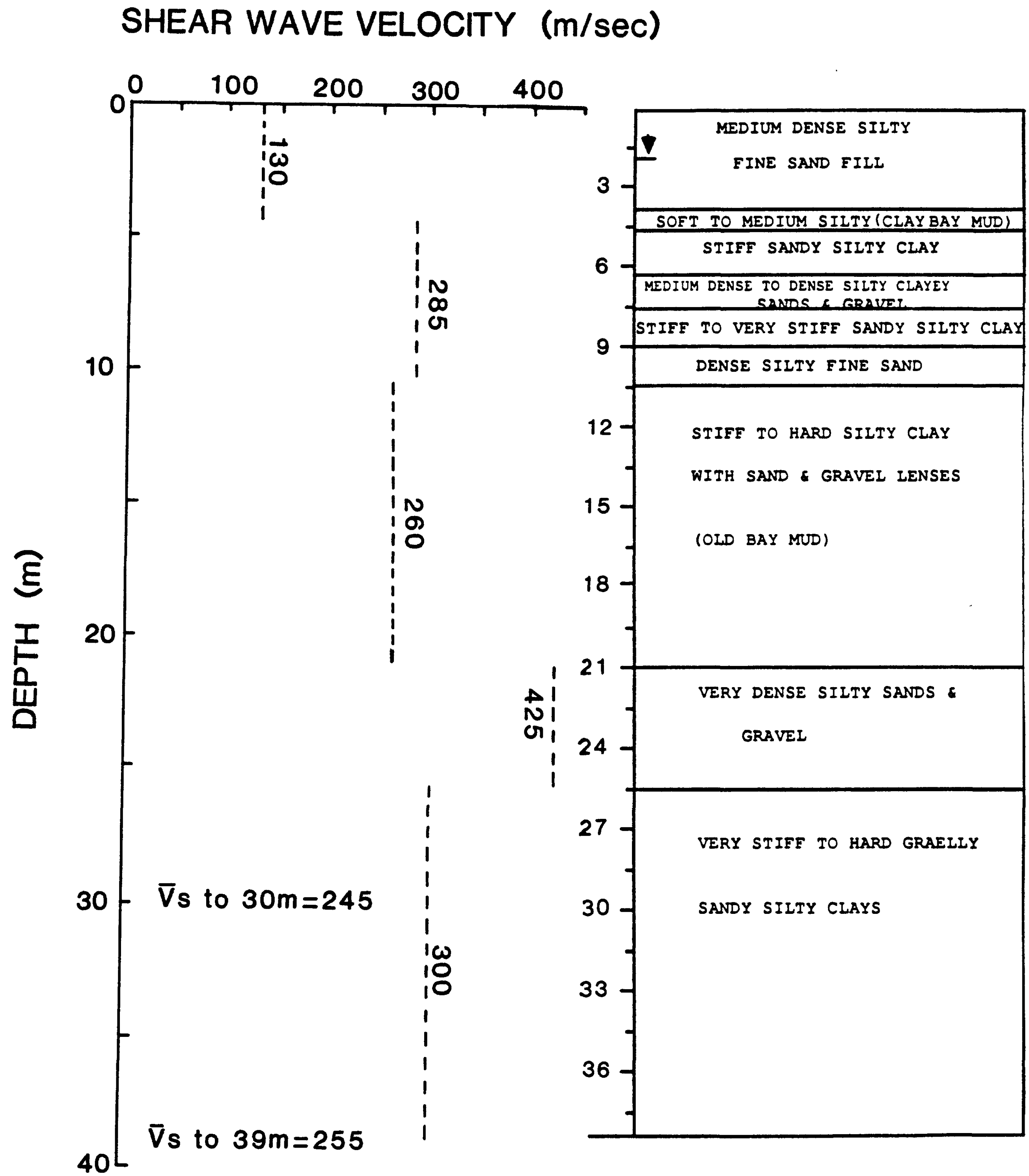
Figure 99



Geologic unit: Artifical fill/ Holocene bay mud

Estimated velocity profile for site: OAKLAND OUTER HARBOR

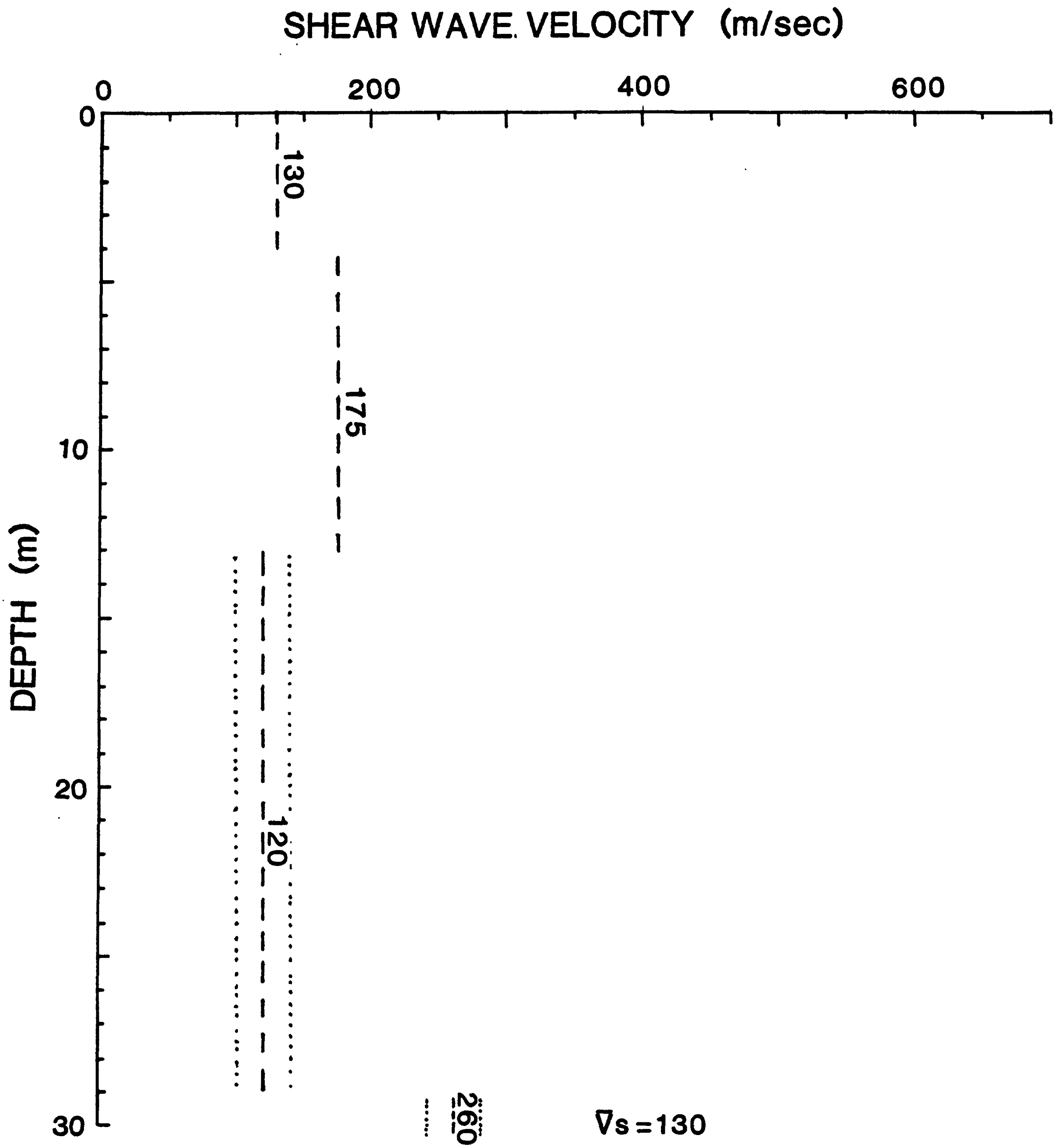
Figure 100



Geologic unit: Artifical fill/ Holocene bay mud

Estimated velocity profile for site: EMERYVILLE

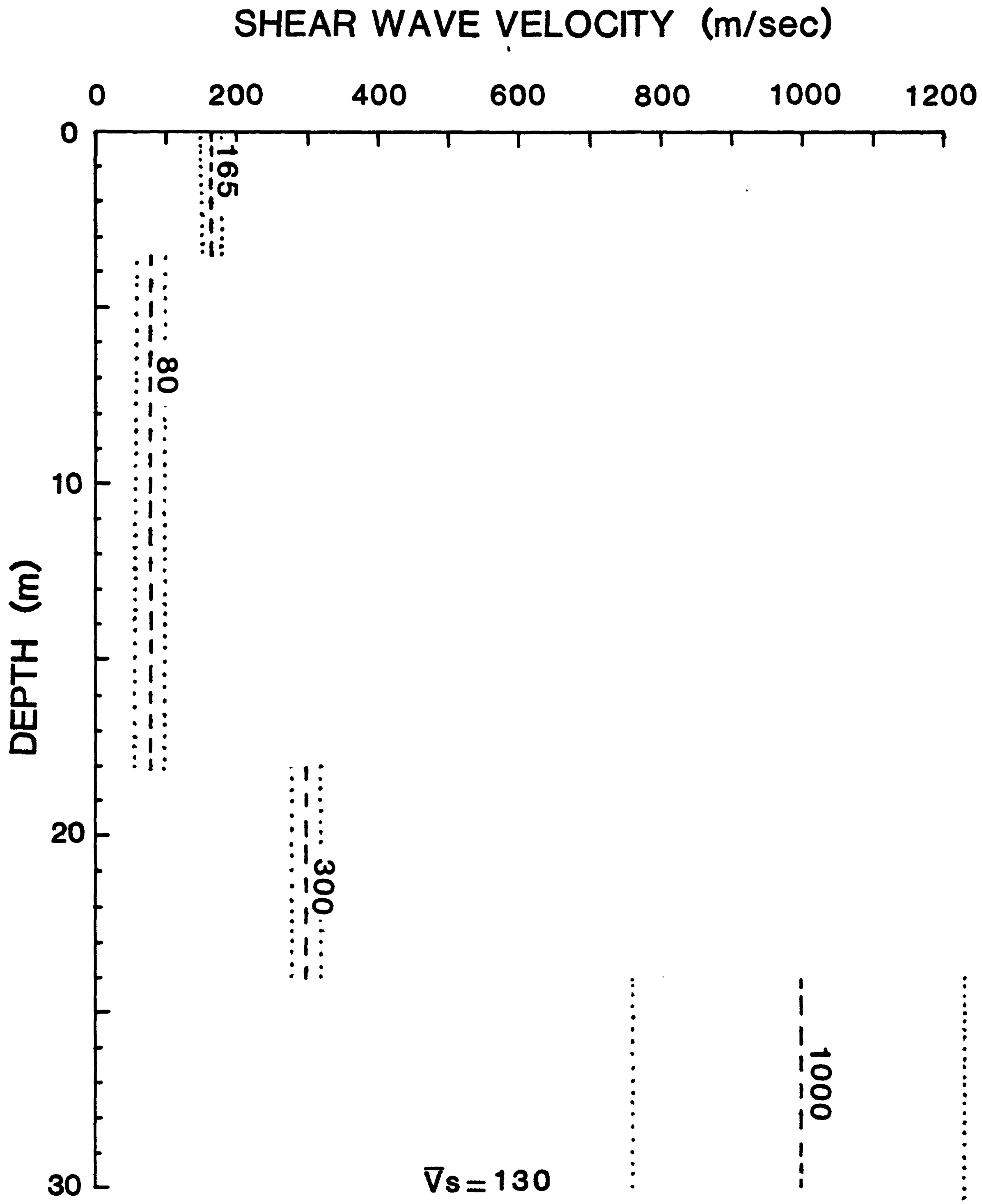
Figure 101



Geologic unit: Artifical fill/Holocene bay mud

Estimated velocity profile for site: TREASURE ISLAND

Figure 102

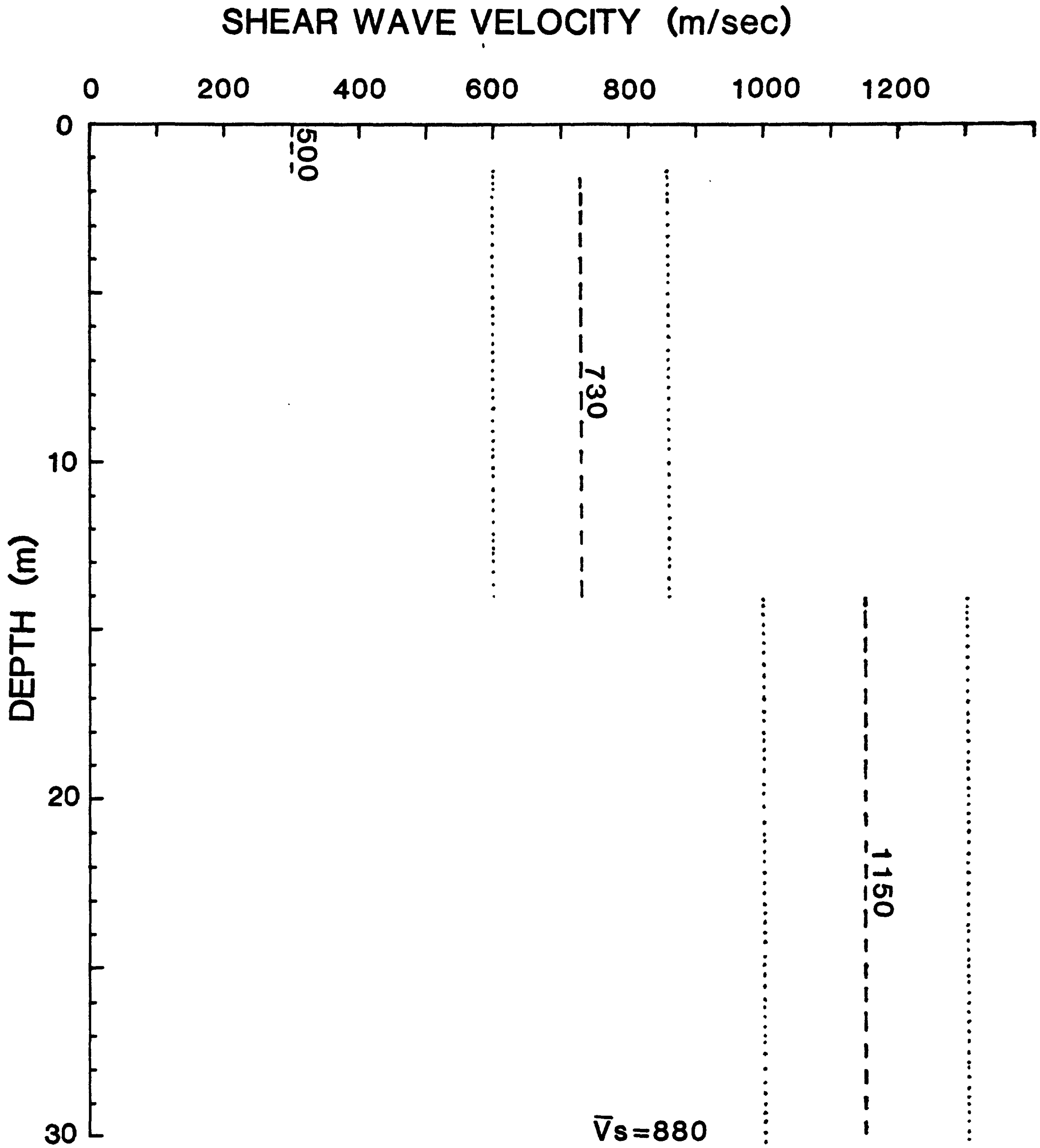


Geologic unit: Artificial fill/Holocene bay mud

Estimated velocity profile for site:

LARKSPUR FERRY TERMINAL

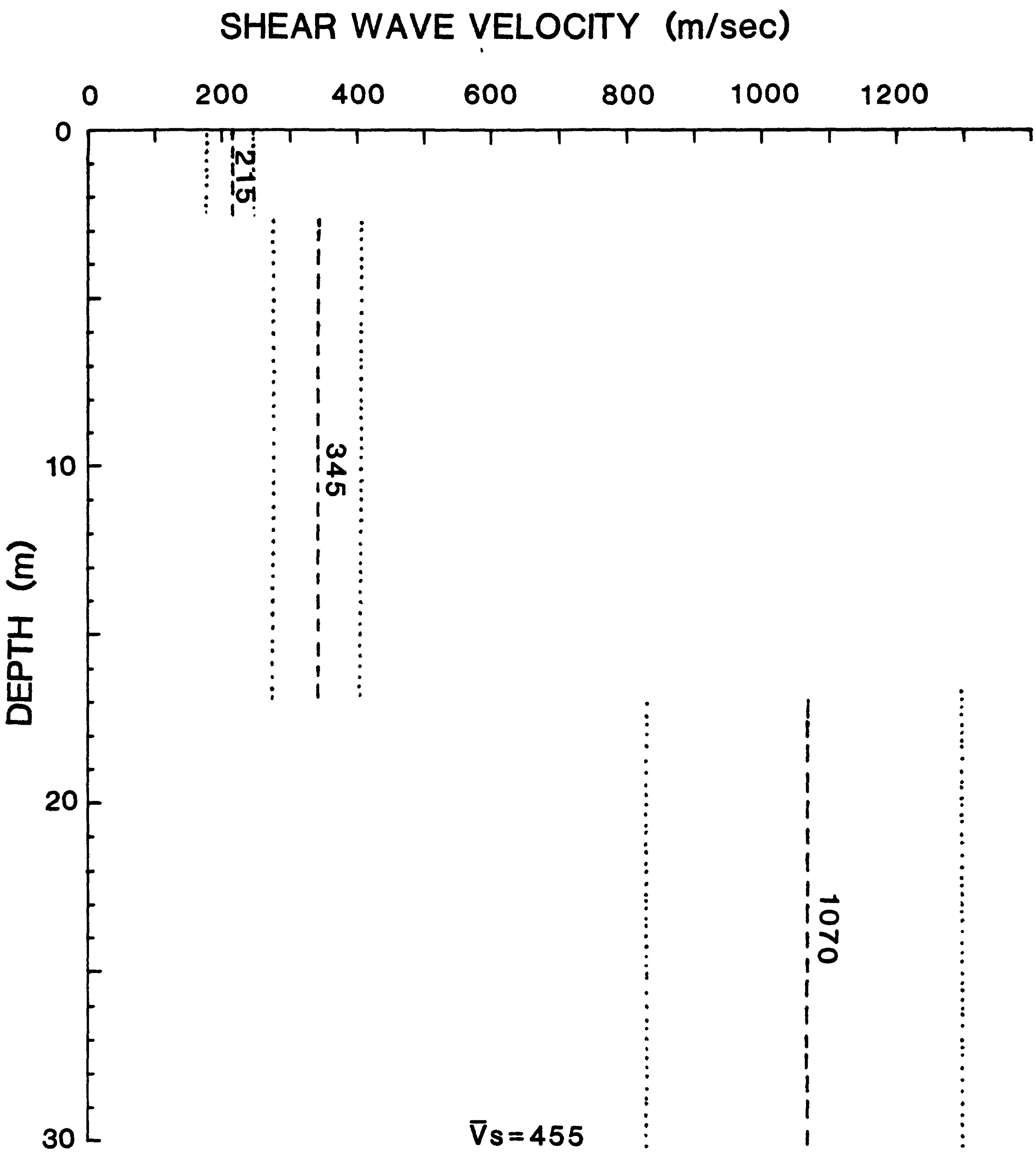
Figure 103



Geologic unit: Sandstone and shale of the Franciscan assemblage

Estimated velocity profile for site: YERBA BUENA ISLAND

Figure 104

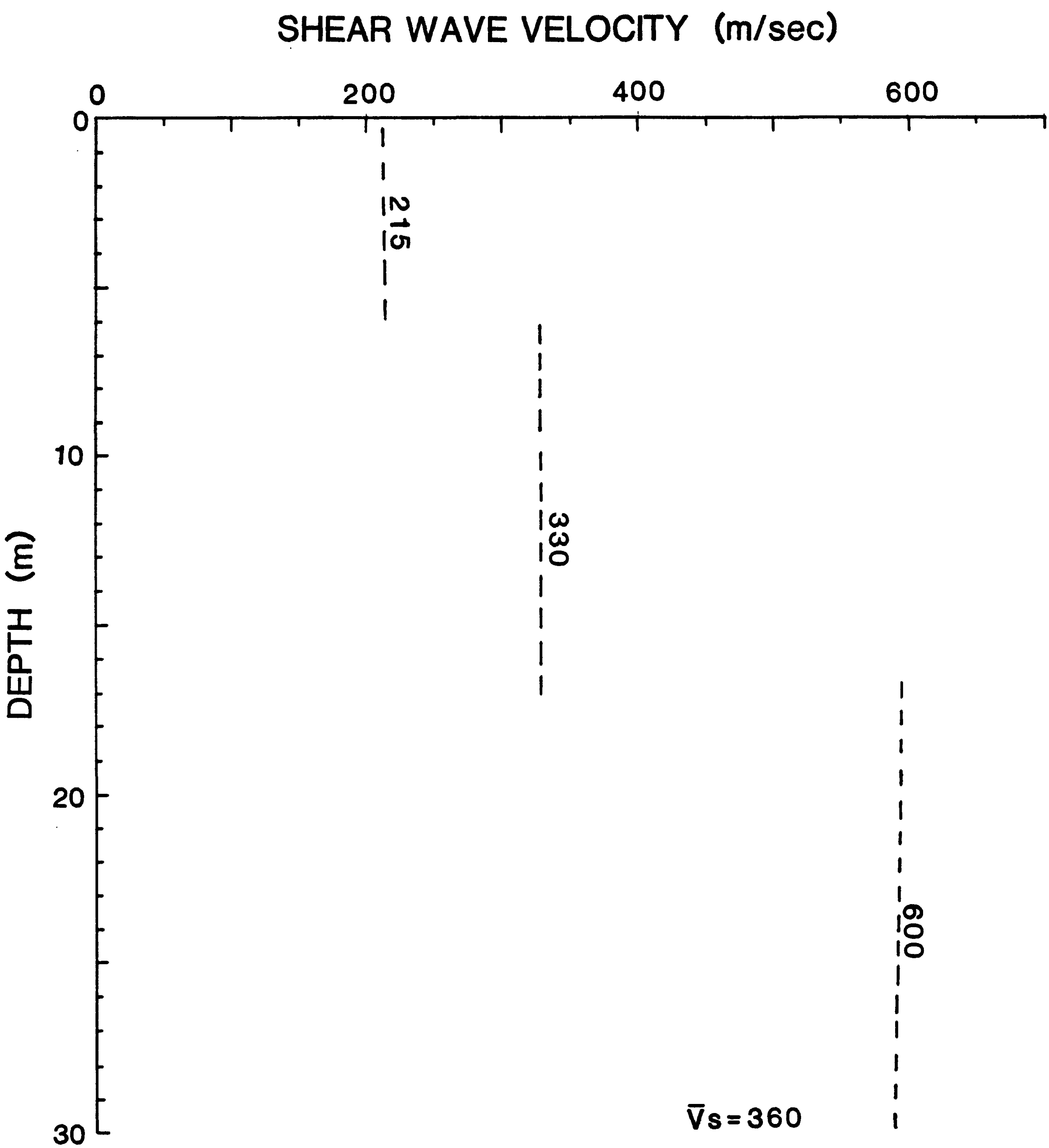


Geologic unit: Late Pleistocene alluvium
Unnamed marine sedimentary rocks

Estimated velocity profile for site:

GILROY #7-MANTELLI RANCH

Figure 105

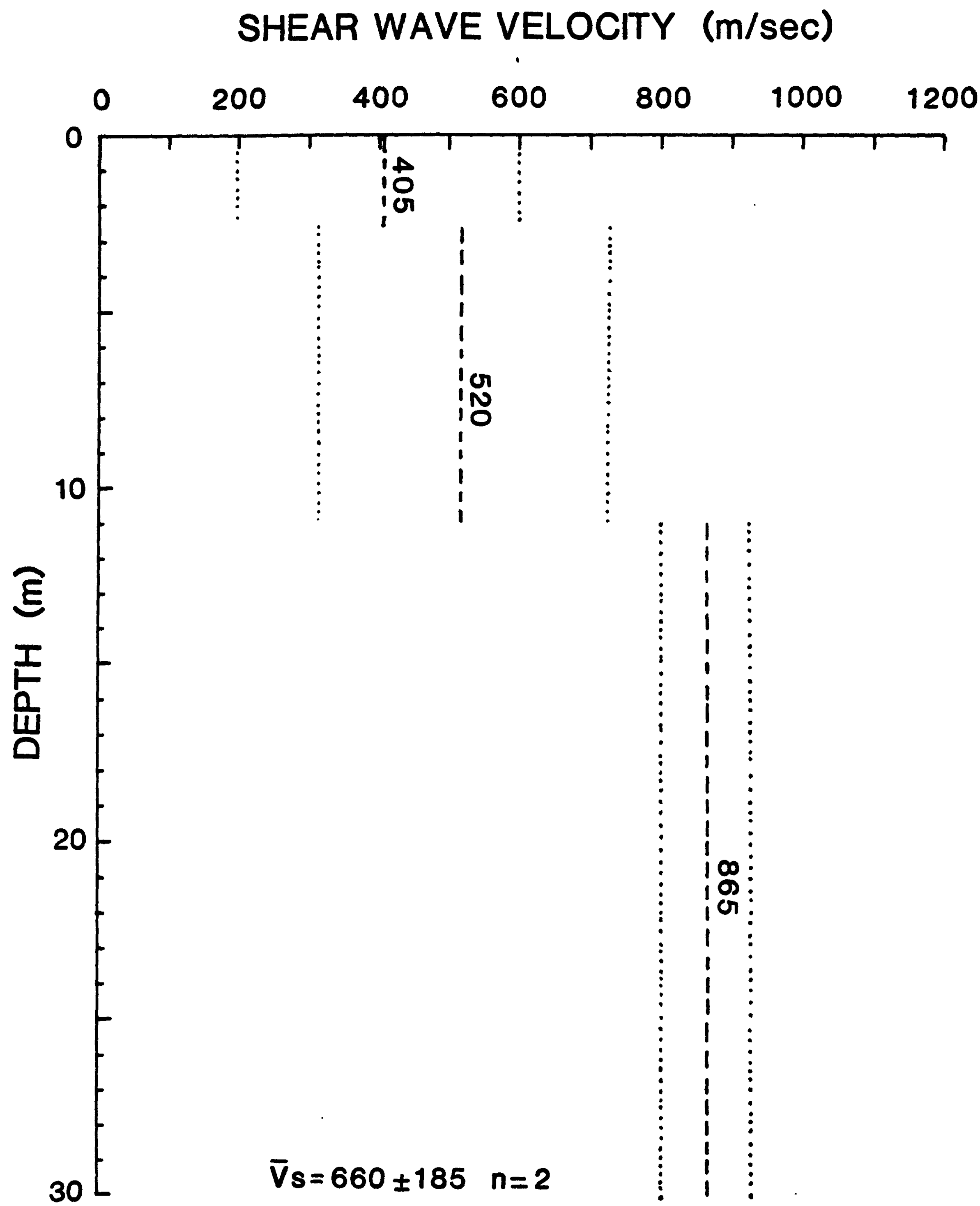


Geologic unit: Holocene and Late Pleistocene alluvium
Miocene sandstone,shale and conglomerate

Estimated velocity profile for site:

BEAR VALLEY #10 WEBB

Figure 106

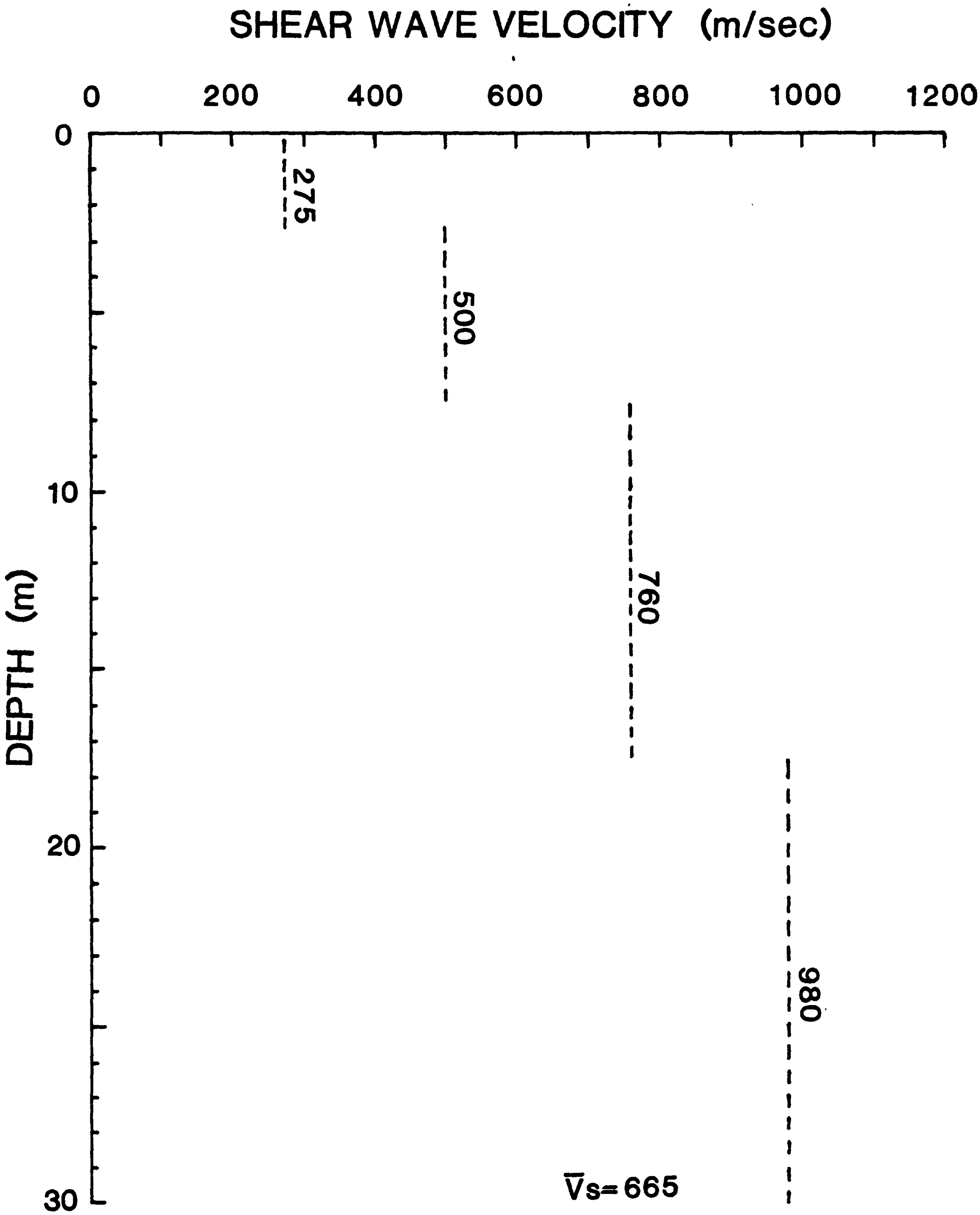


Geologic unit: Leona Rhyolite

Estimated velocity profile for site:

HAYWARD CITY HALL FF-N

Figure 107



Geologic unit: Gabbro-Diorite

Estimated velocity profile for site:

HAYWARD CITY HALL FF-S

Figure 108