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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

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Open-file Map
88-752

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GEOLOGY 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

DESCRIPTION OF ROCK UNITS

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.

AROMAS SANDS (PLEISTOCENE)--

Qa — Undivided nonmarine deposits

Qad — Dune sands, divided locally

Qaf — Fluvial silt, clay, and gravel intercalated with dune sand, divided locally

QTn — NONMARINE DEPOSITS (LOWER PLEISTOCENE AND PLIOCENE)--Sand and silt deposited by fluvial processes.

UNITS SOUTHWEST OF SAN ANDREAS FAULT

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

Tm — MONTEREY FORMATION (MIDDLE MIOCENE)--Not exposed at the surface southwest of the San Andreas fault in Loma Prieta quadrangle, but 55 feet of siliceous shale assigned to the Monterey Formation were penetrated in Bean Hill Ltd. no. 1 Hihn well (see structure section B-B"). In exposures in the Laurel quadrangle to the west, the Monterey is a thin- to medium-bedded olive-gray to light-gray subsiliceous organic mudstone. Formation yields benthic foraminifers and mollusks diagnostic of neritic depths and of a middle Miocene age.

Tlo

LOMPICO SANDSTONE (MIDDLE MIOCENE)--Not exposed at the surface southwest of the San Andreas fault in Loma Prieta quadrangle, but 230 feet of sandstone assigned to the Lompico Sandstone were penetrated in Bean Hill Ltd. no. 1 Hihn well (structure section B-B". At the surface in Laurel quadrangle, the Lompico Sandstone consists of yellowish-gray thick-bedded to massive calcareous arkosic sandstone. Formation contains benthic foraminifers and mollusks diagnostic of neritic depths and of a middle Miocene age.

Tla

LAMBERT SHALE (LOWER MIOCENE)--Thin- to medium-bedded and faintly laminated olive-gray organic mudstone present only in the subsurface of Loma Prieta quadrangle (see structure sections). Formation grades upward to thin-bedded sandy siltstone with thin to thick interbeds of micaceous fine-to medium-grained arkosic sandstone. In Laurel quadrangle to the west, Lambert Shale is as much as 1,800 feet thick and yields bathyal foraminifers diagnostic of the Saucesian Stage (early Miocene).

VAQUEROS SANDSTONE AND BASALT (LOWER MIOCENE AND OLIGOCENE)--

Tv

Yellowish-gray thick-bedded to massive arkosic sandstone deposited at neritic to bathyal depths.

Tba

Basalt, penetrated in the subsurface, in Union Oil Co. Teresa Hihn no. 1 well (section A-A"), probably correlative with flows that crop out in the western part of the Laurel quadrangle and along Zayante Canyon in Felton quadrangle, where they are as much as 200 feet thick (Clark, 1981) and have been dated by potassium-argon methods at 23.1 ± 0.7 Ma (Turner, 1970).

Tz

ZAYANTE SANDSTONE (LOWER MIOCENE AND OLIGOCENE)--Tongues of poorly sorted, reddish muddy sandstone, greenish sandy siltstone, and cobble conglomerate with abundant granitic detritus, probably nonmarine, locally interbedded with Vaqueros Sandstone.

SAN LORENZO FORMATION (OLIGOCENE AND UPPER EOCENE)--

Tsl

Shale and sandstone, undivided

Tsr

Rices Mudstone Member - nodular light-gray mudstone, grading downward into fine-grained arkosic and slightly glauconitic sandstone. Unit contains bathyal foraminifers 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 foraminifers 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 foraminifers 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.

ROCKS WITHIN SAN ANDREAS FAULT ZONE

db

MAFIC INTRUSIVE ROCKS OF HIGHLAND WAY AND EUREKA CANYON ROAD (JURASSIC?)--Fine- to medium-grained locally titaniferous, intrusive diabase, basalt, and gabbro, in tectonic contact along the San Andreas fault zone with shale and sandstone of

Highland Way. Much of rock is a breccia consisting of cumulate gabbro and diabase inclusions enclosed in a fine-grained olivine-augite-basalt matrix. Chilled intrusive contacts occur locally within the intrusive body. Rock is metamorphosed to prehnite-pumpellyite grade, with much of olivine and clinopyroxene altered to chlorite. Rock is cut by late anastomosing veinlets of quartz and plagioclase. Age of unit is unknown because of faulted contacts, but it may correlate with rocks of the Jurassic Coast Range ophiolite northeast of the fault.

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

Tme

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. Disseminated grains of glauconite (1 to 3 percent) are common in coarse sandstone and a highly glauconitic sandstone marker bed occurs in upper part of unit. Carbonaceous shales locally are fetid, and in places occur with thin (3 to 4 cm-thick) carbonate interbeds and also thin, laminated black chert horizons. Benthic foraminifers and nannofossil assemblages indicate that the lower part of the unit is early Eocene (Penutian, CP-11) and was deposited in a middle bathyal setting (K. McDougall and D. Bukry, written commun., 1988). Shale collected from the upper part of the section (from along the ridge northwest of Gamecock Canyon) yielded benthic foraminifers, nannofossils, and fish remains indicative of middle to late Eocene, and Oligocene or early Miocene (Zemorrian or Saucesian) ages and middle to upper bathyal depths. One benthic Miocene fauna from this same area is indicative of an upper-slope setting (R.L. Pierce written commun., 1971; and K. McDougall and D. Bukry, written commun., 1988). The top of this unit is not exposed.

Te_2 MARINE SANDSTONE AND SHALE (EOCENE)--Massive to thin-bedded, coarse- to fine-grained, yellow-orange to white weathering, quartzo-feldspathic sandstone, silty sandstone, and silty dark-brown to greenish-brown, brown to gray weathering mudstone. Basal beds consist of thick bedded quartzo-feldspathic sandstone (0.5 to 3 m thick) locally with calcareous cement, disseminated glauconite pellets, rounded pebbles of black chert, quartz, mafic igneous rocks, and sparse angular clasts of sheared serpentinite. The basal sandstone is overlain by thick-bedded quartzo-feldspathic, biotite-bearing sandstone (1/2 to 2 m thick), which is rhythmically interbedded with brown, silty, buff-weathering mudstone. The upper part of the unit consists of thick-bedded to massive, medium- to coarse-grained, yellow to white-weathering, friable to moderately lithified, quartzo-feldspathic sandstone. Locally, the upper part of this unit also includes minor brown, platy, silty, semi-siliceous mudstone (Te_{2a}). Where thick-bedded to massive, the upper sandstone exhibits cavernous and spheroidal weathering and traction-related sedimentary structures. The age of this unit is probably middle to late Eocene, based on the early Eocene age of underlying mottled mudstone and sandstone of Mount Chual and on the occurrence of _Parvamussium_ c.f. _P. stanfordensis_ in silty siliceous mudstone partings near the top of the unit at one locality (C.L. Powell, written commun., 1988). Contacts with the underlying rocks and with the overlying shale and sandstone of Highland Way are faulted. Unit is here correlated with similar cavernous weathering quartzo-feldspathic sandstone north of the map area in Santa Teresa Hills. The correlative rocks in Santa Teresa Hills were originally assigned a Late Cretaceous age (Bailey and Everhart, 1964), but were recently re-assigned to the Eocene (Short, 1986; Blondeau and Brabb, 1983). The unit may also correlate in part, with rocks near Searsville Lake and along Westridge Road in Palo Alto 15' quadrangle mapped as Eocene Butano(?) Sandstone (Dibblee, 1966; Page and Tabor, 1967) assigned to the middle Eocene _Discoaster bifax_ subzone of Bukry et al. (1977).

Te_1 MOTTLED MARINE MUDSTONE AND SANDSTONE OF MOUNT CHUAL (LOWER EOCENE)--Thin bedded olive-green to greenish-gray, or mottled reddish-brown and green mudstone; brown to white, thin- to thick-bedded quartzo-feldspathic, locally glauconitic sandstone (Te_{lss}); and minor conglomerate. Basal conglomerate exposed only locally, consists of up to 8 m of unsorted subrounded to subangular clasts of red radiolarian chert, quartz-veined green and brown metachert, graphitic quartzite, mafic igneous rocks, serpentinite, quartz-veined metasandstone, foraminifer-bearing limestone and rare clasts of quartz-lawsonite schist. Conglomerate clasts are set in a gritty matrix of mafic igneous and chert detritus cemented with bioclastic carbonate. Some limestone clasts contain calcareous algae and planktic and large foraminifers of Eocene age (planktic foraminifer zones P7-P8) (W.V. Sliter, written commun., 1988). Calcareous algal material, worm tubes, and oyster fragments from conglomerate matrix suggest shallow-water deposition or transport from a shallow-water setting. Based on stratigraphic position and age, conglomerate horizon is correlated here with shallow-water limestone containing Discocyclina sp. of early Eocene age in Santa Teresa Hills north of the map area (Blondeau and Brabb, 1983). A laminated glauconite sandstone and glauconitic quartz-grit up to about 2 m thick overlies, or occurs locally in place of the conglomerate. Also, a breccia composed of angular chips of mottled red and green mudstone locally occurs above, or in place of the glauconitic sandstone and the conglomerate. As much as 210 m of olive green- to red and green-mottled chloritic mudstone and minor thin-bedded biotitic feldspathic sandstone overlie the conglomerate, glauconitic sandstone and (or) the mudstone-chip breccia. This mudstone unit characteristically contains abundant benthic and planktic foraminifers, nannofossils, echinoid spines, and fish debris indicative of an early Eocene (Penutian, CP-11) age, and a lower bathyal to abyssal (2000 m or greater) depositional setting (K. McDougall and D. Bukry, written commun., 1988). In addition, species transported from higher slope and shelf settings are also present. This mottled mudstone is correlative with lithologically identical units of the same age in Santa Teresa Hills (Blondeau and Brabb, 1983; Bukry et al., 1977; Short, 1986), possibly with rocks of similar age near Stanford University (Graham and Classen, 1955; Page and Tabor, 1967), with rocks exposed southeast of the Calaveras fault along the west side of the Diablo Range near Paicines (Bolado Park Formation of Karr, 1962), with the Lucia Mudstone of the Santa Lucia Range west of King City, and with the basal Juncal Formation of the San Rafael Mountains north of Santa Barbara (Bukry and others, 1977). The upper part of the mudstone unit locally includes thick-bedded to massive channel-shaped deposits of medium- to coarse-grained quartzo-feldspathic sandstone with disseminated glauconite and locally, rounded pebbles of quartz and dark chert.

SANDSTONE, SHALE, AND CONGLOMERATE OF SIERRA AZUL (UPPER CRETACEOUS)--

Kus

Feldspathic to arkosic lithic wacke and dark green to black, hard, silty, locally concretionery argillite. Sandstone is orange-brown weathering, gray to green, biotitic, thin to thick bedded, fine- to medium-grained and locally conglomeratic. Sandstone and argillite are mostly rhythmically interbedded, exhibiting thinning upward bedding cycles, load features, plane-laminations at tops of beds, and rarely, graded beds. Upper part of section is largely massive, medium- to fine-grained sandstone and dark-green to black, hard, silty to micaceous argillite, locally with spheroidal sandy to shaly carbonate concretions and lenses. These rocks in places contain ammonites, gastropods, _Dentalium_ sp., _Penticrinus_ sp., fish parts, and rare crabs (_Archaepus_ sp.) of probable late Campanian age, and also probably transported in part, from a near shore depositional setting (W. Elder, written commun., 1988). The uppermost beds of the unit include a progradational(?) thickening-upward cycle of 25 cm- to 1 m-thick beds of feldspathic sandstone that locally exhibit trough-shaped cross-bedding. In many places formation is veined extensively with quartz ± calcite ± laumontite.

Kuc

Conglomerate, unsorted, polymict, rounded, pebbly to bouldery, aerially extensive, and up to 153 m thick in lower and middle parts of formation. Conglomerate is also present locally in less extensive thinner lenses. Clast counts (Simoni, 1974) show that the conglomerate consists predominently of clasts of intermediate to silicic (andesite, dacite, rhyolite), porphyritic volcanic extrusive and hypabyssal intrusive rocks most of which are recycled (55 percent). These volcanic clasts are followed in order of abundance by clasts of granitic rocks, including aplite (16 percent), mafic igneous rocks, including basalt and diabase (13 percent), and minor slate or phyllite (6 percent), sandstone (5 percent), vein quartz (3 percent), and quartzite (1 percent). Locally, the conglomerate is a calcite-cemented intraformational breccia mixed with abundant fragments of bivalves, Dentalium sp., and Membranipora sp., of late Campanian to early Maastrichtian age. Brecciation probably occurred during transport from a near-shore depositional setting (W. Elder, written commun., 1988).

KJs

SHALE AND SANDSTONE (LOWER CRETACEOUS(?) AND UPPER JURASSIC)--Thin-bedded, dark-green to black shale and minor interbedded cherty, locally pebbly, arkosic and lithic wacke. Unit is present only locally, and is highly sheared. A thin quartz-veined greenish-gray, tan-weathering radiolarian-bearing tuff interbed occurs locally in the lower part of shale. Tabular to nodular, dark-gray to brown, calcareous concretions occur locally. Calcareous interbeds and shales locally contain rare Ammonites and pelecypods (mostly Buchia), which indicate a Tithonian age for this unit within Loma Prieta quadrangle. Buchia species of Tithonian to Valanginian age occur in same unit to southeast near Mount Madonna (McLaughlin, 1973).

COAST RANGE OPHIOLITE (MIDDLE TO UPPER JURASSIC)--

Jo

Undivided ophiolitic rocks shown in structure sections.

Jovb

Laharic breccia and flow banded tuff, andesitic to dacitic. Coarsening-upward, unsorted, gray to white pyroclastic breccia in upper part consists of angular clasts up to boulder size, of glassy, albite- and quartz-phenocryst-rich flow rock in a dark aphanitic tuff matrix, grading downward to centimeter-size clasts at base. Breccia is underlain abruptly by fine-grained flow-banded tuff which displays grading, and plane-laminar and cross-laminar structure. Loading, and convolute features are present about 2 m above the contact of tuff with underlying mafic volcanic flows. Thin, light-gray to reddish-black radiolarian chert beds 1 to 6 cm thick, probably of Late Jurassic age, occur between 2 and 5 m above depositional base. Rocks of this unit have been subjected to extensive sodic and saussuritic alteration and are converted to keratophyre and quartz keratophyre. In addition, these rocks are locally overprinted by a later episode of potassic hydrothermal alteration.

Jov

Spilitic pillow flows, flow breccias, and tuff, disconformable beneath laharic breccia unit and locally cut by diabase sills.

Jodi

Diorite dikes and sills south of, and within the Sargent fault zone, faulted below shale and sandstone of Late Jurassic age, and above undated diabase; exhibit saussuritic alteration to epidote group assemblages.

Jodb

Diabase sills, fine- to coarse-grained and saussuritic. Diabase is faulted beneath flow rocks on north side of the Sargent fault, but south of the fault diabase underlies dioritic rocks and overlies cumulate gabbro.

Jog

Gabbro cumulates, with pyroxene-feldspar segregation layering, and prominent uralitic and saussuritic alteration. Unit is locally gradational into ultramafic cumulates, but in most places it is faulted above and below. Elsewhere, Pb-U dates from zircon indicate these rocks to be 163 to 169 Ma (Hopson and others, 1986).

Jou

Ultramafic cumulates, exhibiting residual interstitial plagioclase and segregation layering. Ultramafic rocks range from peridotite to norite. Rocks are locally cut by rodingitic dikes, or enclose sheared dikes or segregations of gabbro or diabase. Ultramafic cumulates are partially serpentinized and faulted along upper and lower contacts.

Jos

Partially to completely serpentinized, sheared ultramafic rocks, locally enclosing minor sheared intrusives or segregations of cumulate clinopyroxene and hornblende gabbro, and commonly altered to rodingite assemblages. Along Croy Ridge, serpentinite within Berrocal fault zone locally is altered to silica carbonate rock.

myl

MYLONITE (MIDDLE CRETACEOUS OR YOUNGER)--Mylonitic rocks occuring locally at the base of the Coast Range ophiolite. At Loma Prieta, mylonite occurs along the low-angle fault that has emplaced ophiolitic rocks over marine sandstone of Eocene age. This mylonite is derived largely from cataclasis and recrystallization of coarse- to fine-grained, tuffaceous metaclastic rocks, and flow-banded tuff and laharic breccia of the Coast Range ophiolite. Elsewhere, near the north-central boundary of the quadrangle, minor phyllitic mylonite locally occurs along the Berrocal fault zone, at the contact between ophiolitic rocks and the Franciscan Complex. Based on the age of rocks in the upper and lower plates of the thrust fault at the base of the Coast Range ophiolite at Loma Prieta, the mylonite there may be Eocene or younger (perhaps Miocene(?)), provided that the mylonite formed as the result of emplacement of the ophiolite above Eocene rocks. However, the mylonite could be much older (perhaps middle Cretaceous?) if it formed during earlier emplacement of the Coast Range ophiolite above rocks of the Franciscan Complex, and was displaced vertically along the younger Sargent and Berrocal fault zones.

UNITS NORTHEAST OF THE BERROCAL FAULT

Tmm

MONTEREY SHALE (MIDDLE MIOCENE)--Flaggy, yellowish-white weathering, hard brown mudstone, porcelanite, and cherty porcelanite. Mudstone and porcelaneous rocks commonly contain molds of foraminifers and minor fish parts, but no dateable rocks have been found in this unit in Loma Prieta quadrangle. Unit occurs only in a small (about .02 km^2) area in northeastern corner of quadrangle but is more extensive in adjacent Mount Madonna quadrangle. Age is probably middle Miocene (CN3 or CN4) based on nannofossils and benthic foraminifers from lithologically identical rocks in Los Altos Hills southeast of Foothill College (D. Bukry, written commun., 1988), and on benthic foraminifers and pelecypods from identical correlative rocks southwest of intersection of Sanders and Old Watsonville Roads, in Mount Madonna quadrangle (McLaughlin, 1973). These rocks are lithologic and age equivalents of the Monterey formation of Bailey and Everhart (1964); and the Monterey Shale of McLaughlin and others (1971) and Dibblee and Brabb (1980).

Tmt

TEMBLOR SANDSTONE (MIDDLE MIOCENE)--Brown to buff weathering, friable to compact, massive to thick bedded, subfeldspathic to arkosic sandstone; includes minor mudstone and unsorted calcite-cemented conglomerate in lower part of unit. Basal conglomerate contains both angular first-cycle clasts and recycled rounded clasts derived from the Franciscan Complex (radiolarian chert, metachert, metasandstone, and mafic igneous rocks) and from early Tertiary to Jurassic rocks of the Loma Prieta-Sierra Azul area (rounded quartz pebbles, arkosic wacke, sandy limestone containing Eocene foraminifers, including *Discocyclina* sp., and serpentinite) (Osbun, 1975; Blondeau and Brabb, 1983; McLaughlin, 1973). Fragmental, reef-like fossil accumulations including oysters, barnacles, bryozoa, sparse shark teeth, and pectens, are abundant locally (Bailey and Everhart, 1964; Osbun, 1975; McLaughlin, 1973). Unit exhibits prominent cavernous weathering in massive to thick-bedded exposures southeast of Croy Road, in Section 4, T10S, R2E, at eastern boundary of quadrangle, where it unconformably overlies the Franciscan Complex and serpentinite of the Coast Range ophiolite. Age is early to middle Miocene, probably Saucesian or younger, based on megafossils in the basal conglomerate, and on benthic foraminifers from mudstone partings in correlative sandstone in adjacent Mount Madonna quadrangle (McLaughlin, 1973). Unit therefore is correlative with Temblor Sandstone of McLaughlin and others (1971); and Temblor Formation of Dibblee and Brabb (1980); and Temblor formation of Bailey and Everhart (1964).

CENTRAL BELT OF THE FRANCISCAN COMPLEX (LOWER EOCENE? TO UPPER JURASSIC)--

fsr

Melange. Sheared rocks, composed chiefly of a mixture of hard, resistant blocks of different lithologies and metamorphic grades, enclosed in a less resistant matrix of black scaly argillite, tuffaceous volcanic rock, and chert-rich lithic sandstone. Melange is considered to have formed from deformation in time interval between formation of oldest components in melange (Jurassic) and the time of unconformable deposition of early Eocene rocks on melange in Santa Teresa Hills quadrangle to north (Short, 1986). Individual blocks and large intact terranes enclosed by melange are mapped separately as follows:

fs_1

Sandstone--Arkosic to feldspathic, biotite-bearing wacke, medium to fine-grained; containing up to 10 percent rock fragments consisting (in decreasing abundance) of intermediate to mafic, porphyritic to glassy volcanic rocks; felsite and chert; quartzite; and schist and phyllite. Sandstone contains up to 1 percent detrital accessory minerals, including white mica, epidote and (or) clinozoisite, tourmaline, and zircon. Sandstone is metamorphosed to pumpellyite-grade, and locally it overlies basalt.

fl

Limestone--Whitish-gray to reddish-brown weathering, dark-gray to brown, or reddish-pink foraminiferal limestone, locally with black, greenish-gray, or red lenses of chert and mafic tuff. Limestone is either depositionally or structurally intercalated within basaltic flows and flow breccia. Unit is here assigned to the Calera-type limestone present in the New Almaden area to the north and in the Permanente limestone quarry near Stevens Creek, 25 kilometers to the northwest (Bailey and Everhart, 1964; Dibblee, 1966). The limestone is traceable as part of a discontinuous belt southeastward to the Sargent oil field in the San Juan Bautista 15' quadrangle (Allen, 1946).

Foraminifers from limestone blocks near the north center of the quadrangle boundary in Sec. 25, T9S, R1E, are of Late Aptian age (W.V. Sliter, written commun., 1988). In nearby areas outside the quadrangle foraminifer faunas in the limestone range from Early Cretaceous (Aptian) to Late Cretaceous (Turonian) age (Sliter, 1984; Tarduno and others, 1985).

fb

Basalt flows, flow breccia, and tuff--Unit consists predominantly of flow breccia within quadrangle. Breccia is locally calcite-cemented and veined with quartz and epidote. A thin lens of tan, cherty tuff was mapped in one area. Basaltic rocks are here considered to be Aptian or older within Loma Prieta quadrangle, based on structural relationship to limestone.

fc

Chert--Red, green, and white radiolarian chert, occurs locally as blocks in melange.

fm

Glaucophane schist, eclogite, and amphibolite-grade metamorphic rocks--Occur as sparse blocks in melange, mapped only locally near northeastern corner of quadrangle.

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CREDITS FOR PALEONTOLOGIC DATA

Mesozoic invertebrate fossils	-	W. Elder,[1] D. L. Jones[2]
Mesozoic foraminifers	-	W. V. Sliter[1]
Mesozoic radiolaria	-	B. Murchey[1]
Tertiary foraminifers		
Benthic -	-	K. McDougall[1] and R. L. Pierce (deceased)[1]
Planktic -	-	R. Z. Poore[1]
Planktic and Benthic in thin section	-	W. V. Sliter[1]
Tertiary nannofossils	-	D. Bukry[1]
Tertiary fish scales	-	R. L. Pierce (deceased)[1]

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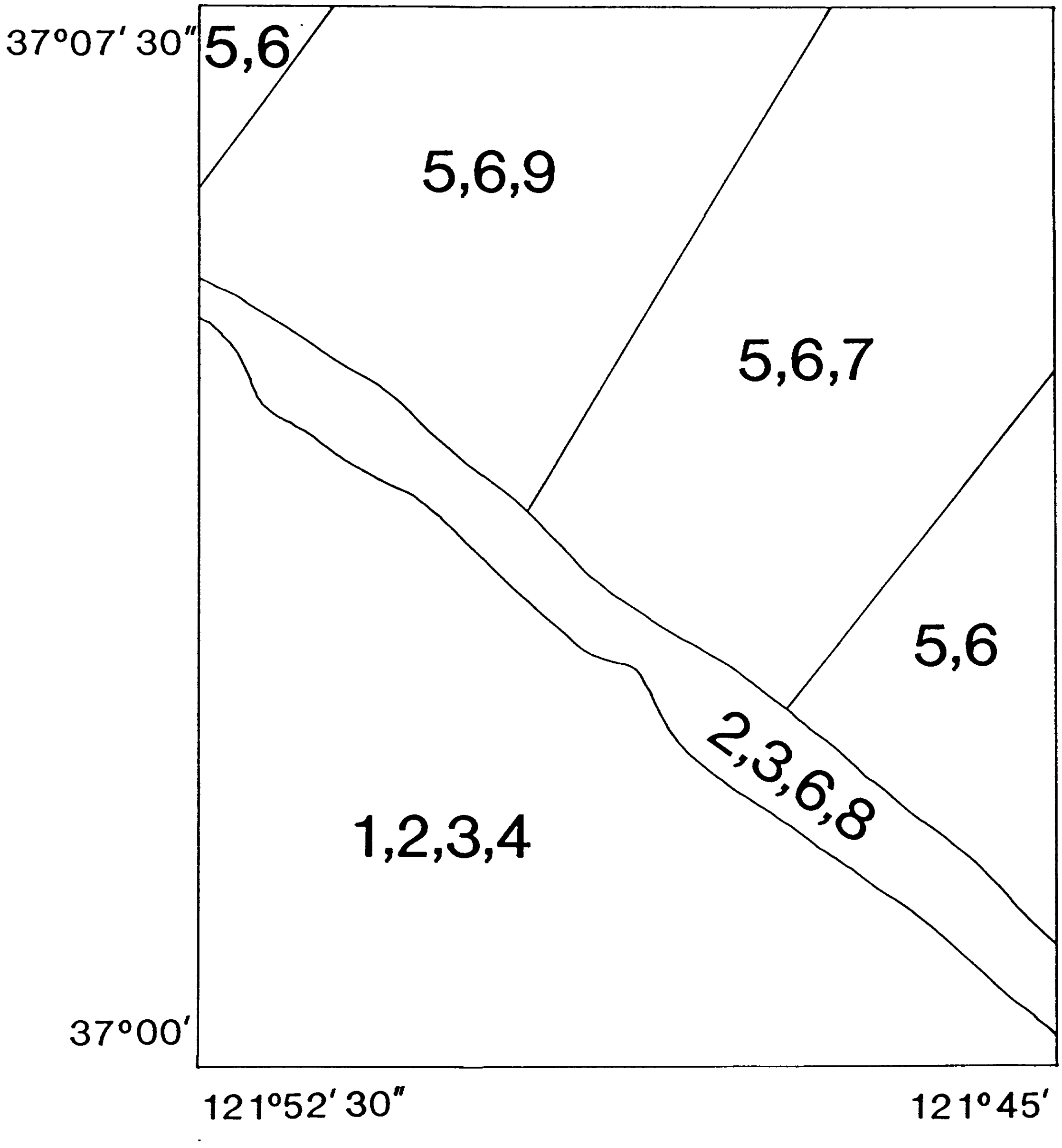
FIGURE 1. INDEX TO SOURCES OF DATA USED IN MAP COMPILATION



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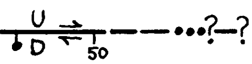
MAP SYMBOLS

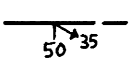
Contact, dashed where approximate, dotted where concealed



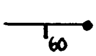
Fault, dashed where approximate, dotted where concealed, queried where uncertain. Ball and bar denote down-thrown block, or U and D denote up and down-thrown blocks. Direction and amount of dip of fault plane shown locally. Horizontal arrows denote relative horizontal movement


Fault at low-angle to bedding, interpreted as low-angle normal fault, double-bars on down-dropped side


Thrust fault, barbs on upper plate

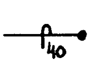


Direction and amount of dip of fault, and plunge of lineation on fault plane

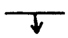


Bedding, ball denotes that facing direction is known from sedimentary structures

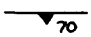

Vertical bedding, ball denotes facing direction, as determined from sedimentary structures



Overturned bedding, ball denotes that facing direction is known from sedimentary structures

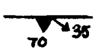


Bedding, strike and dip direction determined from air photo interpretation



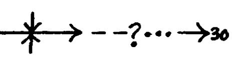
Shear foliation

Vertical shear foliation

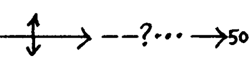


Shear foliation, showing plunge of lineation on shear surface

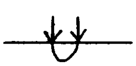
Folds



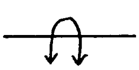
Synclinal axis, showing direction and amount of plunge, dashed where approximate, dotted where concealed, queried where uncertain



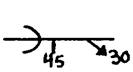
Anticlinal axis, showing direction and amount of plunge, dashed where approximate, dotted where concealed, queried where uncertain



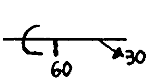
Overturned syncline



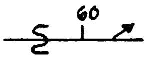
Overturned anticline



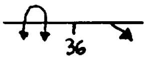
Outcrop-scale anticlinal fold, showing dip of axial plane, and amount and direction of plunge



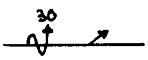
Outcrop-scale synclinal fold, showing dip of axial plane, and amount and direction of plunge



Isoclinal folds showing dip of axial planes and plunge direction



Outcrop-scale overturned anticline, showing dip of axial plane and plunge direction



Overturned isoclinal folds, showing dip of axial planes and plunge direction

Drill hole

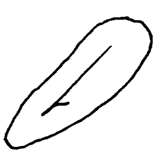
Mine adit

Mineral prospect

ooooooo Conglomeratic marker bed

g...g...g...g Glauconitic marker bed

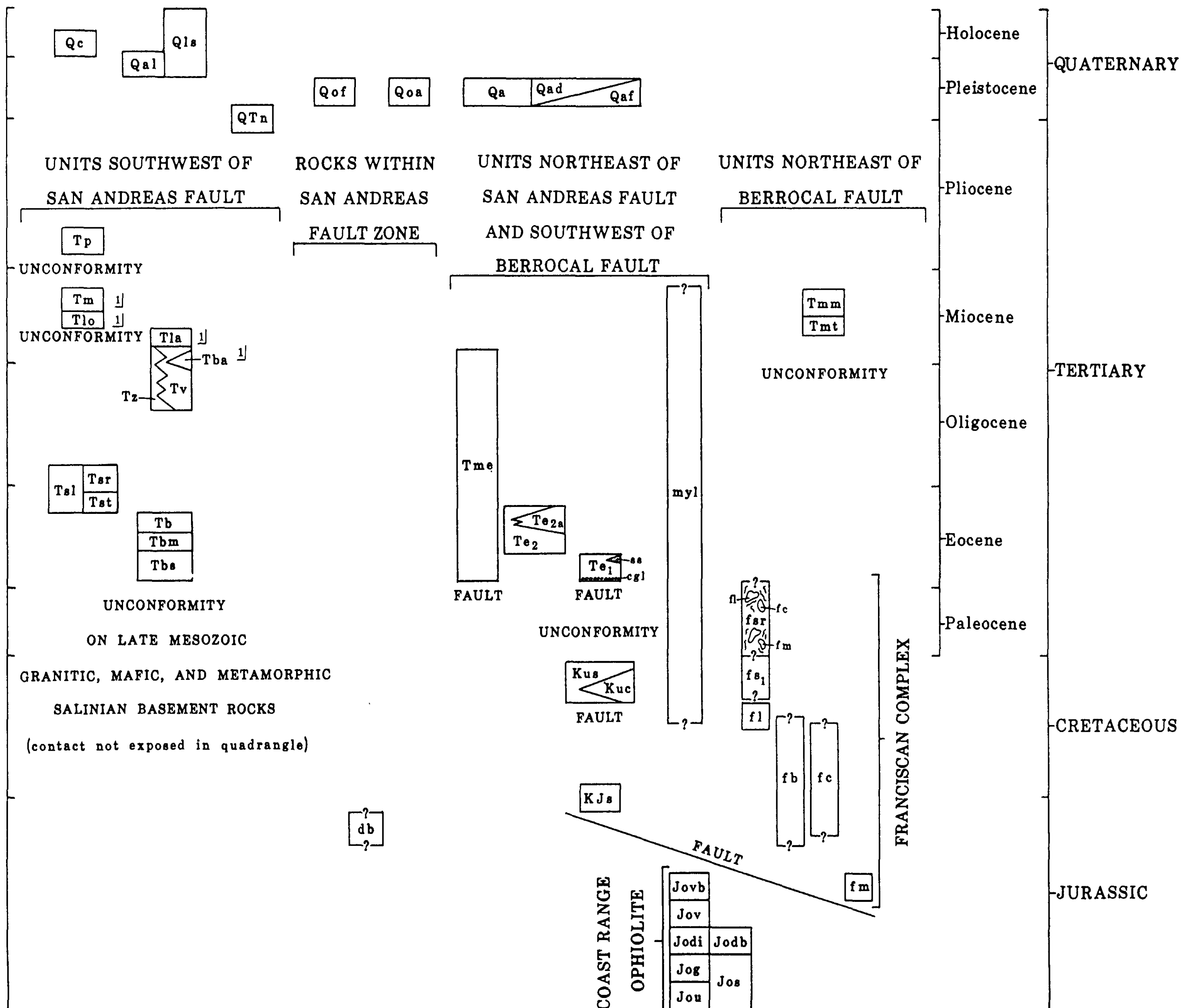
Closed depression



Landslide, arrows indicate direction of movement

Topographic escarpment, line above barbs denotes top of escarpment

CORRELATION OF MAP UNITS



1/ Present only in subsurface in quadrangle