DIVISION OF MINES
Ian Campbell, Chief

STATE OF CALIFORNIA
Edmund G. Brown, Governor

DEPARTMENT OF NATURAL RESOURCES
DeWitt Nelson, Director

EXPLANATORY DATA

SANTA CRUZ SHEET

GEOLOGIC MAP OF CALIFORNIA

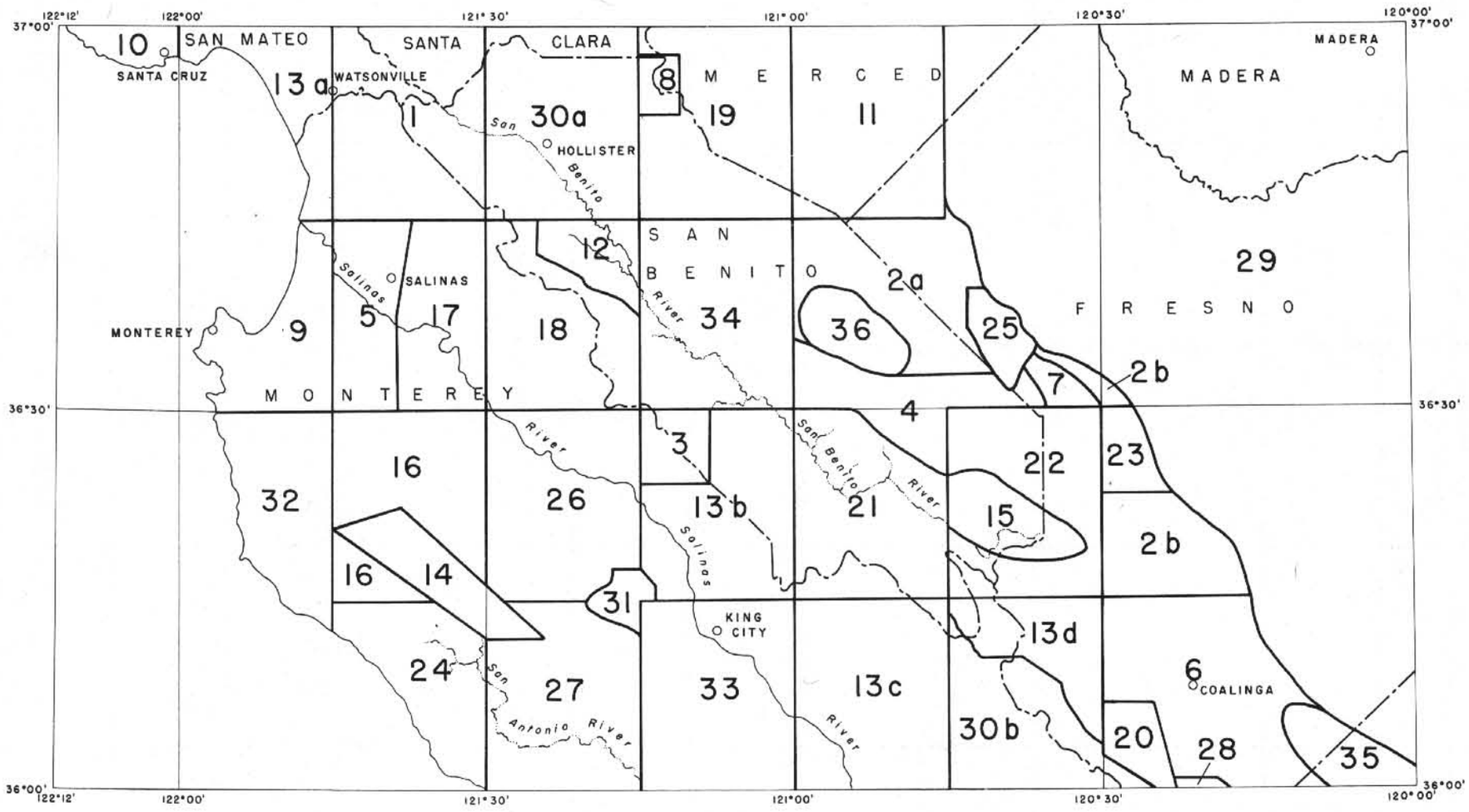
OLAF P. JENKINS EDITION

Compiled by Charles W. Jennings and Rudolph G. Strand, 1958

Third printing, 1971

INDEX TO GEOLOGIC MAPPING

USED IN COMPILATION OF THE SANTA CRUZ SHEET



*1. Allen, John E., 1946, Geology of the San Juan Bautista quadrangle, California, California Div. Mines Bull. 133, 112 pp., Pl. 1: Geologic map of the San Juan Bautista quadrangle, California, scale 1: 62,500.

*2a. Anderson, R., and Pack, R. W., 1915, Geology and oil resources of the west border of the San Joaquin Valley north of Coalinga, California: U. S. Geol. Survey Bull. 603, 220 pp., Pl. 1: Geologic map of the western border of San Joaquin Valley, California between the Coalinga oil field and Livermore Pass, scale 1: 125,000. (Glaucophane Ridge area modified by John T. Alfors, Geologic map of a portion of Panoche Valley quadrangle, California, scale approx. 8 inches = 1 mile, University of California, Berkeley, unpublished Ph.D. thesis in progress).

2b. Anderson, R., and Pack, R. W., 1915, Geology and oil resources of the west border of the San Joaquin Valley north of Coalinga, California: U. S. Geol. Survey Bull. 603, 220 pp., Pl. 1: Geologic map of the western border of San Joaquin Valley, California between the Coalinga oil field and Livermore Pass, scale 1: 125,000. (Modified in part by Standard Oil Co. of Calif.)

3. Andrews, P., 1936, Geology of the Pinnacles National Monument: Univ. California, Dept. Geol. Sci., Bull., vol. 24, no. 1, pp. 1-38, Map 1: The Pinnacles National Monument, areal geology and sections, scale approx. 2 inches = 1 mile.

4. Anonymous, Vallecitos area, scale 2½ inches = 1 mile, unpublished.

5. Anonymous, Santa Cruz area areal geology from Halfmoon Bay to Carmel and San Andreas fault to coast, scale 1 inch = 1 mile, unpublished.

*6. Arnold, R., and Anderson, R., 1910, Geology and oil resources of the Coalinga district, California: U. S. Geol. Survey Bull. 398, 354 pp., Pl. 1: Geologic and structural map of the Coalinga district, California, scale 1: 125,000 (Modified in part by Standard Oil Co. of Calif.).

7. Atwill, E. R., 1935, Oligocene Tumey formation of California: Am. Assoc. Petroleum Geologists Bull., vol. 19, no. 8, pp. 1192-1204, Fig. 2: Map showing surface geology of area between Tumey Gulch on northwest and Cantua Creek on southeast, scale approx. ½ inch = 1 mile.

8. Bailey, E. H., and Myers, W. B., 1942, Quicksilver and antimony deposits of the Stayton district, California: U. S. Geol. Survey Bull. 931-Q, pp. 405-434, Pl. 64: Geologic map and sections of the Stayton mining district, California, scale 1: 12,000.

9. Bowen, O. E., Geologic map of the Monterey quadrangle, California, scale 1: 24,000, California Div. Mines, unpublished work in progress (1958). Also: Beal, C. H., The Geology of the Monterey quadrangle; scale 1: 62,500, Stanford University, unpublished M. A. thesis, 1915; Anonymous, Santa Cruz area areal geology from Halfmoon Bay to Carmel and San Andreas fault to coast, scale 1 inch = 1 mile, unpublished.

*10. Branner, J. C., Newsom, J. F., and Arnold, R., 1909, Description of the Santa Cruz quadrangle, California: U. S. Geol. Survey Geol. Atlas of the U. S., Santa Cruz folio no. 163, 11 pp., Pl. 2: Areal geology, scale 1: 125,000.

11. Briggs, L. I., Jr., 1953, Geology of the Ortigalita Peak quadrangle, California: California Div. Mines Bull. 167, 61 pp., Pl. 1: Geologic map of the Ortigalita Peak quadrangle, California, scale 1: 62,500. (Great Valley units compiled by R. G. Strand, California Div. Mines, unpublished, 1958, from U. S. Soil Survey mapping.)

*12. Dempster, R. E., Geology of the northeastern part of the Gonzales quadrangle, California, scale 1: 62,500, University of California, Berkeley, unpublished M.A. thesis, 1949.

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13b. Dibblee, Thomas W., Jr., Geologic map of part of the Metz quadrangle, scale 1: 62,500, unpublished.

13c. Dibblee, Thomas W., Jr., Geologic map of the San Ardo quadrangle, scale 1: 62,500, unpublished.

13d. Dibblee, Thomas W., Jr., Geologic map of the northeast part of the Priest Valley quadrangle, scale 1: 62,500, unpublished.

14. Dickinson, W. R., Tertiary stratigraphy and structure west of the Arroyo Seco, Monterey County, scale approx. 1: 24,000, Stanford University, unpublished M.S. thesis, 1956.

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18. Jennings, C. W., and Strand, R. G., Geologic reconnaissance map of part of Gonzales quadrangle, California, scale 1: 62,500, California Div. Mines, unpublished (1958). (Qc units adapted from unpublished mapping by T. W. Dibblee).

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Mielenz, R. C. The geology of the southwestern part of San Benito County, California, scale 1: 62,500, University of California, Berkeley, unpublished Ph.D. thesis, 1939.

*22. Payne, M. B., Geology of the New Idria quadrangle, California, scale 1: 62,500, California Div. Mines, unpublished work in progress (1958). (Modified in part by other mapping; see item 4).

23. Pratt, W. L., Geology of the northwest quarter of the Joaquin Rocks quadrangle, scale 1: 62,500, University of California, Berkeley, unpublished, M.A. thesis, 1949.

24. Reiche, P. C., 1937, Geology of the Lucia quadrangle, California: Univ. California, Dept. Geol. Sci., Bull., vol. 24, no. 7, pp. 115-168, Map: Geologic map of the Lucia quadrangle, scale 1: 62,500.

25. Schoellhamer, J. E., and Kinney, D. M., 1953, Geology of portions of Tumey and Panoche Hills, Fresno County, California: U. S. Geol. Survey Oil and Gas Inv. Map OM 128, scale approx. 1: 24,000.

*26. Schombel, L. F., 1943, Soledad quadrangle: California Div. Mines Bull. 118, pp. 467-470, Fig. 194: Geologic map Soledad quadrangle, scale approx. 1: 125,000.

27. Stanford Geological Survey, (R. R. Compton in charge), Geologic map of Junipero Serra quadrangle, California, scale 1: 62,500, Stanford University, unpublished, 1957.

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*30a. Taliaferro, N. L., 1948, Geologic map of the Hollister quadrangle, California: California Div. Mines Bull. 143, Pl. 1 (no text), scale 1: 62,500.

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Stanford Geological Survey, (R. L. Rose in charge), Geologic map of the Priest Valley area, Fresno and Monterey Counties, California, scale 1: 24,000, Stanford University, unpublished maps, 1956 and 1957.

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33. Weidman, R. M., Geology of the King City quadrangle, California, scale 1: 24,000, University of California, Berkeley, unpublished Ph.D. thesis, 1958.

34. Wilson, I. F., 1943, Geology of the San Benito quadrangle, California: California Div. Mines Rept. 39, pp. 183-270, Pl. 3: Geologic map of the San Benito quadrangle, California, scale 1: 62,500.

35. Woodring, W. P., Stewart, R., and Richards, R. W., 1940, Geology of the Kettleman Hills oil field, California: U. S. Geol. Survey Prof. Paper 195, 170 pp., Pl. 3: Geologic map of the Kettleman Hills, California and generalized stratigraphic sections of exposed formations by W. P. Woodring and R. Stewart assisted by J. C. Miller and G. F. Taylor, scale 1: 31,680.

*36. Yates, R. G., and Hilpert, L. S., 1945, Quicksilver deposits of central San Benito and northwestern Fresno counties, California: California Div. Mines Rept. 41, pp. 11-35, Pl. 1: Geologic map of west end of Panoche Valley, San Benito County, California, scale approx. 2 inches = 1 mile.

* Modified by Thomas W. Dibblee, Jr. from unpublished mapping.

For a complete list of published geologic maps of this area see Division of Mines Special Report 52.

STRATIGRAPHIC NOMENCLATURE—SANTA CRUZ SHEET

LEGEND SANTA CRUZ SHEET			DATA FROM SELECTED PUBLISHED SOURCES USED TO COMPILE THE SANTA CRUZ SHEET Numbers Refer to Index on Reverse Side of Sheet											
AGE	STATE MAP SYMBOL	STATE MAP UNIT	Allen 1	Andrews 3	Briggs 11	Fiedler 16	Leith 19	Reiche 24	Schoellhamer and Kinney 25	Taliaferro 30a	Thorup and Kleinpell 31	Trask 32	Wilson 34	Woodring, Stewart and Richards 35
CENOZOIC / QUATERNARY / Recent	Qs	**RECENT SAND DUNES** (Dune and beach sand)										Dune and beach sand		
	Qal	**RECENT ALLUVIUM** (Alluvium, stream gravel)	Alluvium	Alluvium, sand and gravel	Alluvium	Stream alluvium and terraces	Alluvium	Stream alluvium	Younger alluvium and older alluvium	Alluvium		Fluviatile and alluvial deposits, river gravels	Alluvium	
	Qsc	**RECENT RIVER AND MAJOR STREAM CHANNEL DEPOSITS IN THE GREAT VALLEY** (River channel and major stream sediments, including adjacent natural levees: Columbia and Temple soil series)												
	Qf	**RECENT ALLUVIAL FAN DEPOSITS IN THE GREAT VALLEY** (Sediments deposited from streams emerging from highlands surrounding the Great Valley: Dinuba, Grangeville, Hanford, Oxalis, Panhill, Panoche, and Sorrento soil series)												
	Qb	**RECENT BASIN DEPOSITS IN THE GREAT VALLEY** (Sediments deposited during flood stages of major streams in the area between natural stream levees and fans: Fresno, Lethent, Levis, Lewis, Merced and Traver soil series)												
	Qt	**RIVER AND STREAM TERRACE DEPOSITS** (Terrace gravels, terrace gravels and fan deposits undifferentiated)	Terrace gravels and fan deposits	Terrace gravels	Terraces		Terraces		Terrace deposits	Terraces			Terraces	
Pleistocene	Qm	**PLEISTOCENE MARINE DEPOSITS AND MARINE TERRACE DEPOSITS** (Marine terrace deposits)						Marine terrace deposits				Alluvium (deposited on wave-cut terraces)		
	Qc	**PLEISTOCENE NONMARINE SEDIMENTARY DEPOSITS** (Aromas red sands, Dos Picachos gravels, Peckham fm., older alluvium, older fan deposits in the Great Valley having characteristic mature soil profile)	Aromas red sands				Peckham fm.			Dos Picachos gravels				Older alluvium (includes some eolian deposits)
	QP	**PLIOCENE-PLEISTOCENE NONMARINE SEDIMENTARY DEPOSITS** (Paso Robles fm. [includes locally marine Etchegoin —see footnote 1], San Benito gravels, Tulare fm.)			Tulare fm.				Tulare(?) fm.	San Benito gravels	Paso Robles fm.		San Benito gravels	Tulare fm.
	Pc	**UNDIVIDED PLIOCENE NONMARINE SEDIMENTARY ROCKS** (Oro Loma fm.; nonmarine units mapped as Etchegoin and Jacalitos fms.; unnamed Pliocene beds)			Oro Loma fm.				Etchegoin and Jacalitos fms. (nonmarine)			Pliocene conglomerate (in part marine)		
	Pu	**UPPER PLIOCENE MARINE SEDIMENTARY ROCKS** (Merced fm., San Joaquin fm. [in part nonmarine])												San Joaquin fm.
Pliocene	Pml	**MIDDLE AND LOWER PLIOCENE MARINE SEDIMENTARY ROCKS** (Etchegoin fm.,[1] Etchegoin-Jacalitos fms. undifferentiated [in part nonmarine], Pancho Rico fm. [in part upper Miocene], Purisima group)	Purisima group (in part nonmarine; upper and middle Pliocene age)							Purisima fm.[2]	Poncho Rico fm.		Etchegoin group (upper Pliocene in part)	Etchegoin fm.
	Pmlc	**MIDDLE AND LOWER PLIOCENE NONMARINE SEDIMENTARY ROCKS** (Basal red beds of Etchegoin group)											Basal red beds of Etchegoin group	
	Muc	**UPPER MIOCENE NONMARINE SEDIMENTARY ROCKS** (San Pablo fm. nonmarine facies)			San Pablo fm. (mostly nonmarine)									
	Mu	**UPPER MIOCENE MARINE SEDIMENTARY ROCKS** (McLure shale, Reef Ridge shale, San Pablo sandstone, Santa Margarita fm.)				San Pablo sandstone					"Santa Margarita" (in part lower Pliocene)	San Pablo sandstone	Santa Margarita fm.	

Mmc	**MIDDLE MIOCENE NONMARINE SEDIMENTARY ROCKS** ("Monterey" group nonmarine arkose, "Temblor" arkosic sandstone)		Temblor (fanglomerate, arkosic gravel, and diatomaceous shale)								Temblor sandstone (continental arkosic red and gray sandstone)	Monterey group (nonmarine arkose)	
Mm	**MIDDLE MIOCENE MARINE SEDIMENTARY ROCKS** (Monterey fm. [in part upper Miocene])	Monterey shale and sandstone (in part upper Miocene)			Monterey fm. (in part upper Miocene)					Monterey shale (in part upper Miocene)	Monterey fm.	Monterey group (upper Miocene?)	
Ml	**LOWER MIOCENE MARINE SEDIMENTARY ROCKS** (Sandholdt shale, Temblor fm. [middle Miocene in part, including Big Blue nonmarine member], Vaqueros sandstone; unnamed lower Miocene unit)	Vaqueros group			Vaqueros-Temblor sandstone	Vaqueros fm.		Temblor fm. (middle Miocene)	Vaqueros fm.; unnamed middle or lower Miocene sandstone, shale and conglomerate	Sandholdt shale (in part middle Miocene), Vaqueros sandstone		Temblor group (middle Miocene)	
Mv, Mv^r Mv^a, Mv^b Mv^p	**MIOCENE VOLCANIC ROCKS: UNDIFFERENTIATED—Mv; RHYOLITIC—Mv^r; ANDESITIC—Mv^a; BASALTIC—Mv^b; PYROCLASTIC—Mv^p** (Quien Sabe volcanic rocks—Mv; rhyolite and obsidian—Mv^r; Pinnacles fm., vent tuff—Mv^p)	Volcanic group (andesite porphyry, agglomerate, basalt, and some arkosic sandstone)—Mv	Pinnacles fm. (rhyolitic tuff and breccia), vent tuff—Mv^p; rhyolite (obsidian, flows and dikes)—Mv^r		Andesite flows	Quien Sabe volcanics (andesite, basalt flows and agglomerates)—Mv			Quien Sabe volcanic rocks (flows, agglomerate, plugs, dikes and sandstone member)—Mv		Augite andesite flows—Mv^a	Rhyolite—Mv^r; basalt—Mv^b; Pinnacles fm.—Mv^p	
ϕc	**OLIGOCENE NONMARINE SEDIMENTARY ROCKS** (Berry conglomerate)									Berry conglomerate			
ϕ	**OLIGOCENE MARINE SEDIMENTARY ROCKS** (Church Creek beds, San Lorenzo group [probably Eocene to lower Miocene], Tumey fm.)	San Lorenzo group (may include some Vaqueros sandstone)					Church Creek beds[1]	Sandstone member of Kreyenhagen shale (Tumey fm.?)					
E	**EOCENE MARINE SEDIMENTARY ROCKS** (Domengine sandstone, Indart sandstone, Junipero sandstone, Kreyenhagen fm., Los Muertos Creek fm., Lucia shale, Tesla fm., The Rocks sandstone, Tres Pinos sandstone, Yokut sandstone)			Kreyenhagen fm., Tesla (?) fm.	Middle Eocene sandstone			Kreyenhagen shale, Domengine sandstone, Yokut sandstone	Tres Pinos sandstone, Los Muertos Creek shale, Indart sandstone	The Rocks sandstone, Lucia shale, Junipero sandstone		Domengine sandstone, Yokut sandstone, Tres Pinos sandstone, Los Muertos Creek fm.	
Ep	**PALEOCENE MARINE SEDIMENTARY ROCKS** (Laguna Seca fm.; Lodo fm. [may be Eocene in part], Martinez fm.; unnamed Paleocene unit in Santa Lucia Mtns.)			Laguna Seca fm.			Martinez fm.	Lodo fm. [Arroyo Hondo shale, Cantua sandstone and Cerros shale members] (Eocene in part)					
Ti	**TERTIARY INTRUSIVE ROCKS** (Intrusive andesite, rhyolite and soda syenite)		Andesite intrusives			Intrusive andesite			Rhyolite plugs				
Ku	**UPPER CRETACEOUS MARINE SEDIMENTARY ROCKS** (Chico group(?), Moreno fm., Panoche fm., unnamed Upper Cretaceous beds)			Moreno fm., Panoche fm.		Upper Cretaceous sandstone, shale, and conglomerate	Chico	Moreno fm. [Dos Palos shale, Cima sandstone, and Marca shale members]	Unnamed Upper Cretaceous sandstone, shale and conglomerate		Chico group	Moreno shale, Panoche group	
Kl	**LOWER CRETACEOUS MARINE SEDIMENTARY ROCKS** (Paskenta fm., Paskenta and Knoxville fms. undifferentiated, Wisenor fm., unnamed Lower Cretaceous beds)			Wisenor fm.					Unnamed Lower Cretaceous shale and sandstones			Paskenta and Knoxville fms. undifferentiated	
KJf	**FRANCISCAN GROUP** (Franciscan sandstone, shale, chert and conglomerate; locally small areas of greenstone, limestone, basalt and schist)	Franciscan sandstone, limestone and chert		Franciscan sandstone, shale, chert and schist		Franciscan sandstone, shale, chert, basalt, conglomerate, and schist	Franciscan sandstone, shale and chert		Franciscan sandstone, some chert and basalt		Franciscan sandstone, shale and radiolarian chert		
KJfv	**FRANCISCAN VOLCANIC AND METAVOLCANIC ROCKS** (Franciscan greenstone, basalt, agglomerate and diabase)	Franciscan basalt and agglomerates		Franciscan greenstone		Franciscan diabase	Franciscan greenstone				Franciscan greenstone		
gr	**MESOZOIC GRANITIC ROCKS** (Santa Lucia quartz diorite, granite, quartz monzonite; minor amounts of gneiss)	Santa Lucia granite (includes Sur series except for the Gabilan limestone)	Santa Lucia quartz diorite, granite and gneiss		Santa Lucia quartz diorite		Santa Lucia fm.: granitic intrusives		Plutonic intrusives (chiefly granodiorite; pre-Franciscan, probably Precambrian)		Santa Lucia quartz diorite, and porphyritic quartz monzonite	Santa Lucia granite	
ub	**MESOZOIC ULTRABASIC INTRUSIVE ROCKS** (Serpentine, peridotite, gabbro)	Serpentine		Serpentine, diabase-gabbro	Serpentine	Serpentine	Serpentine		Serpentine		Serpentinized peridotite	Serpentine	
m ls	**PRE-CRETACEOUS METAMORPHIC ROCKS, UNDIFFERENTIATED, ls = LIMESTONE** (Sur series, minor amounts of granite—m; Gabilan limestone, dolomite—ls)	Gabilan limestone—ls	Gavilan limestone (marble with quartzite and schist)—ls		Sur series (schist, gneiss)—m; marble lenses—ls		Sur series (crystalline schist)—m; marble lenses—ls		Schist and quartzite—m; Gabilan limestone—ls		Sur series (quartzite, marble schist and gneiss)—m; lentils of Gavilan limestone—ls	Gabilan limestone—ls	

TERTIARY — Miocene; Oligocene; Eocene; Paleocene; Undivided

MESOZOIC — CRETACEOUS; UNDIVIDED

PALEOZOIC

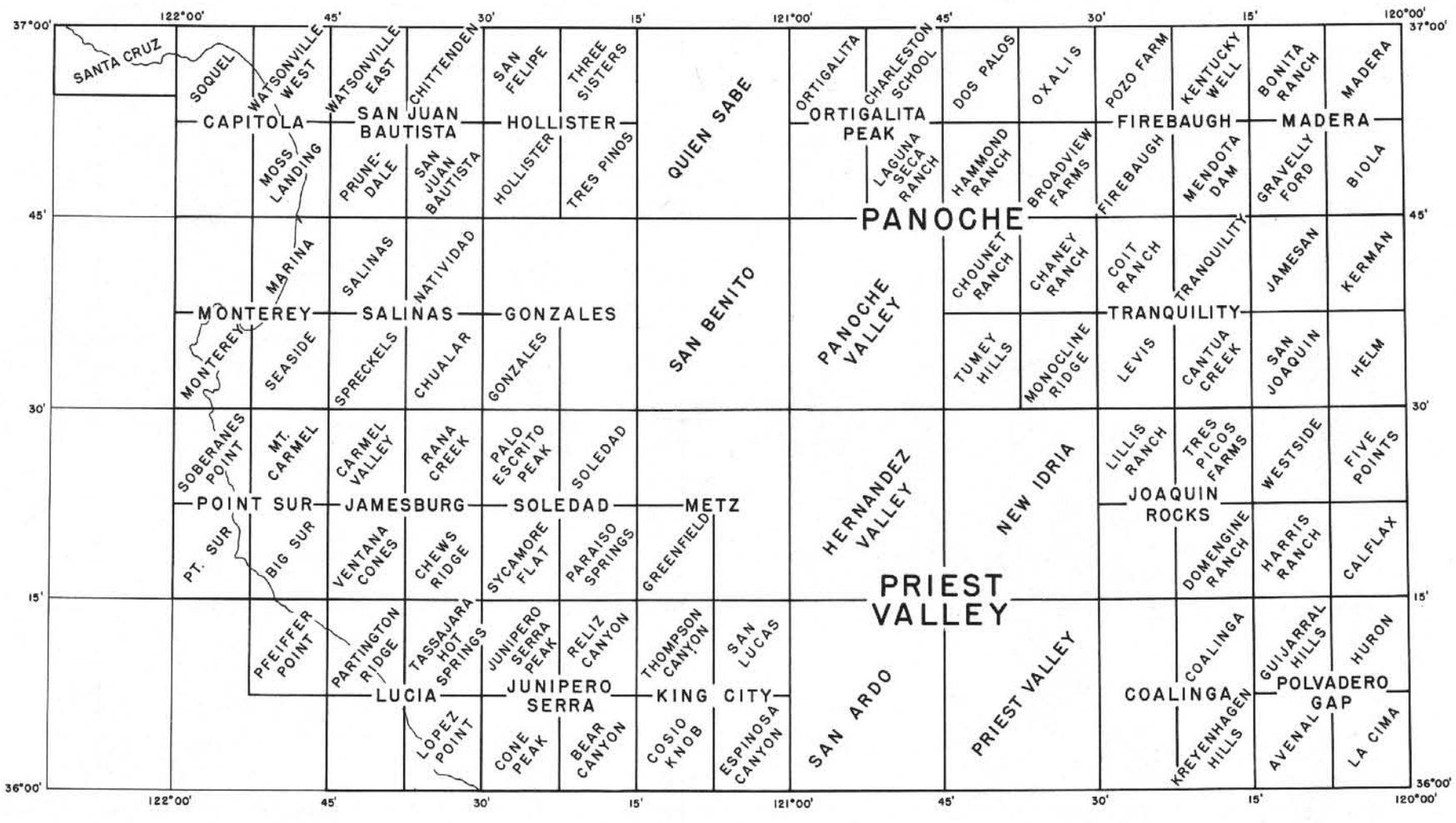
NOTES
[1] Etchegoin fm.: mostly middle Pliocene; locally grades upward into overlying nonmarine Paso Robles formation and contains upper Pliocene beds.
[2] Nonmarine facies in upper part of formation has been shown separately as Pc based on other mapping.
[3] Considered Eocene-Oligocene by Reiche (1940); remapped and differentiated by Dickinson (1956).

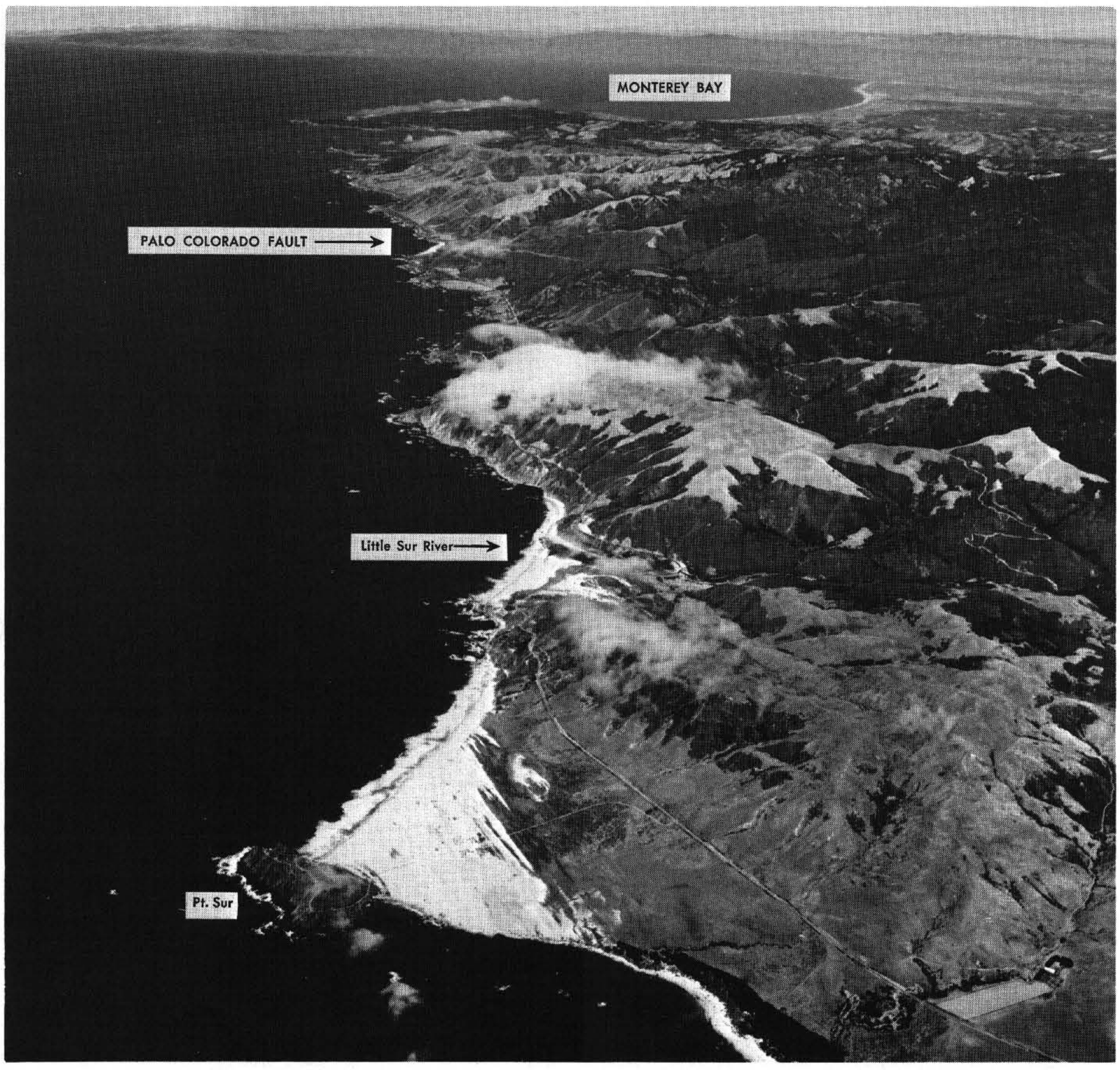
TOPOGRAPHIC QUADRANGLES

WITHIN THE SANTA CRUZ SHEET

AVAILABLE FROM THE U.S. GEOLOGICAL SURVEY

1958





View northward along the coast from Point Sur in the foreground to Monterey Bay in the distance. Dune sand and a marine terrace connect altered Franciscan volcanic rocks of Point Sur with the adjacent mainland composed predominantly of Franciscan sandstone and shale. Santa Lucia quartz diorite and Sur series metamorphic rocks comprise the dissected terrain in the middleground. *Photo by Clyde Sunderland.*

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