DIVISION OF MINES AND GEOLOGY
Ian Campbell, *State Geologist*

STATE OF CALIFORNIA
Edmund G. Brown, *Governor*
THE RESOURCES AGENCY
Hugo Fisher, *Administrator*

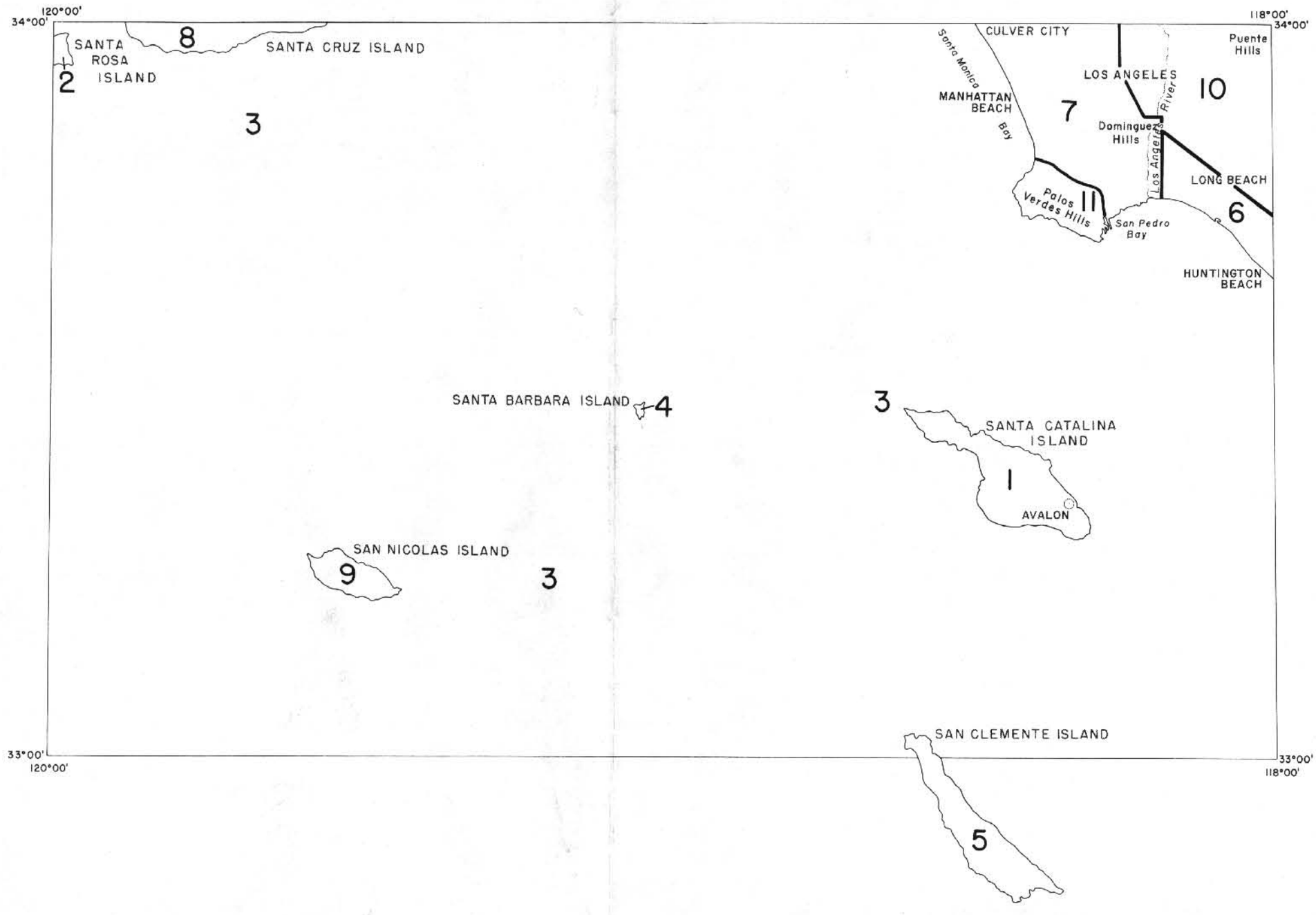
DEPARTMENT OF CONSERVATION
DeWitt Nelson, *Director*

EXPLANATORY DATA
LONG BEACH SHEET
GEOLOGIC MAP OF CALIFORNIA
OLAF P. JENKINS EDITION

Compiled by Charles W. Jennings, 1962

Second Printing, 1971

INDEX TO GEOLOGIC MAPPING
USED IN COMPILATION OF THE LONG BEACH SHEET



1. Bailey, Edgar H., Mineralogy, petrology, and geology of Santa Catalina Island, California, scale 1:62,500, Stanford University, unpublished Ph.D. thesis, 1941.

Bailey, Edgar H., 1954, Road log for Santa Catalina Island: Geol. Soc. America field trip, map: Generalized geologic map of Santa Catalina Island, scale: 1:82,000.

Smith, William S. T., 1897, The geology of Santa Catalina Island: California Acad. Sci. Proc. 3rd ser. vol. 1, no. 1, p. 1-71, pl. 1: Geological map of Santa Catalina Island, scale 1:200,000.

2. Dibblee, Thomas W., Jr., Geologic map of Santa Rosa Island, California, scale approx. 1:45,000 unpublished.

3. Emery, Kenneth O., and Shepard, F. P., 1945, Lithology of the sea floor off southern California: Geol. Soc. America Bull., vol. 56, no. 4, pp. 431-478. (In addition, unpublished offshore geologic data collected by K. O. Emery, personal communication, 1961).

Emery, Kenneth O., 1960, The sea off southern California: John Wiley and Sons, Inc., 366 pp. (Fig. 244: Positions of known offshore oil seeps).

Fowler, Gerald A., Submarine topography and geology of Lasuen Seamount, southern California: University Southern California unpublished report in marine geology, 11 pp., 1958.

Grady, J. R., Submarine geology of Santa Barbara Island and vicinity: University Southern California unpublished masters thesis in preparation.

Moore, David G., 1954, Submarine geology of San Pedro shelf: Jour. Sedimentary Petrology, vol. 24, no. 3, pp. 162-181, fig. 2 and pl. 2-5.

Resig, Johanna M., 1958, Ecology of foraminifera of the Santa Cruz basin, California: Micropaleontology, vol. 4, no. 3, pp. 287-308.

Scholl, D. W., 1960, Relationship of the insular shelf sediments to the sedimentary environments and geology of Anacapa Island, California: Jour. Sedimentary Petrology, vol. 30, no. 1, pp. 123-139, fig. 4.

Uchupi, Elazar, 1961, Submarine geology of the Santa Rosa-Cortes ridge: Jour. Sedimentary Petrology, vol. 31, no. 4, pp. 534-545, figs. 4 and 6.

Uchupi, E., and Gaal, R., Sediments of the Palos Verde Shelf: University of Southern California Hancock Foundation (in preparation).

4. Kemnitzer, Luis E., Geology of San Nicolas and Santa Barbara Islands, southern California, scale 1:10,000, California Institute of Technology, unpublished M.S. thesis, 1933.

5. Olmsted, Franklin H., 1958, Geologic reconnaissance of San Clemente Island: U.S. Geological Survey Bull. 1071-B, pl. 1: Geologic map and sections of San Clemente Island, scale 1:31,680.

6. Poland, Joseph F., Piper, Arthur M., and others 1956, Ground water geology of the coastal zone Long Beach-Santa Ana area, California: U. S. Geological Survey Water-Supply Paper 1109, pl. 3: Geologic map of the coastal zone of the Long Beach-Santa Ana area, scale 1:31,680.

7. Poland, Joseph F., Garrett, A. A. and Sinnott, Allen, 1959, Geology, hydrology, and chemical character of ground waters in the Torrance-Santa Monica area, California: U. S. Geological Survey Water-Supply Paper 1461, pl. 2: Geologic map of the Torrance-Santa Monica area, scale 1:31,680.

Castle, Robert O., 1960, Surficial geology of the Beverly Hills and Venice quadrangles, California: U. S. Geological Survey open file report, map scale 1:24,000.

Castle, Robert O., 1960, Geologic map of the Baldwin Hills area, California: U. S. Geological Survey open file report, map scale 1:12,000.

8. Superior Oil Company, Geologic map of Santa Cruz Island, by W. E. Kennett, scale 1 inch = 4000 feet, unpublished, 1944.

Bremner, Carl St.J., 1932, Geology of Santa Cruz Island, Santa Barbara County, California: Santa Barbara Mus. Nat. History Occ. Papers, no. 1, 33 pp., pl. 4: Geological map Santa Cruz Island, by C. St.J. Bremner and J. M. Kirby, scale 1:62,500.

Rand, William W., 1931, Preliminary report of the geology of Santa Cruz Island, Santa Barbara County, California: California Div. Mines XXVII Rept. State Mineralogist, vol. 27, no. 2, pp. 214-219; Geologic map of Santa Cruz Island, scale 1:62,500.

(More recent stratigraphic nomenclature after W. E. Kennett in "Cenozoic correlation section paralleling north and south margins western Ventura basin from Point Conception to Ventura and Channel Islands, California", published by: Pacific Section Amer. Assoc. Petroleum Geologists, 1952.)

9. Vedder, John G., et al., 1956, Preliminary geologic map of San Nicolas Island, California: U. S. Geological Survey open file report, map scale 1:12,000 by J. G. Vedder, R. L. Harbour, R. J. Burnside, and R. M. Norris.

Norris, Robert M., The marine geology of the San Nicolas Island region, California, scale 1:24.000, Scripps Institution of Oceanography, unpublished Ph.D. thesis, 1951.

(See also reference item 4.)

10. Woodford, A. O., Schoellhamer, J. E., Vedder, J. G., and Yerkes, R. F., 1954, Geology of the Los Angeles Basin: California Div. Mines Bull. 170, chapt. II, contr. 5, pp. 65-83, pl. 1: Geology of the Los Angeles Basin, scale 1:96,000.

Yerkes, Robert F., 1960, Preliminary geologic maps of the La Habra and Whittier quadrangles, Los Angeles Basin, California: U. S. Geological Survey open file report, map scale 1:24,000.

Kundert, Charles J., 1952, Geology of the Whittier-La Habra area, Los Angeles County, California: California Div. Mines Spec. Rept. 18, 22 pp, pl. 1: Geologic map of Whittier-La Habra region, scale 1:24,000.

11. Woodring, W. P., Bramlette, M. N., and Kew, W. S. W., 1946, Geology and paleontology of Palos Verdes Hills, California: U. S. Geological Survey Prof. Paper 207, 145 pp., pl. 1: Geologic map and sections of Palos Verdes Hills, Los Angeles County, California, scale 1:24,000. (Northern extension of Cabrillo Fault and subparallel faults by R.H. Jahns and G. B. Cleveland, Engineering geology of the Palos Verdes Hills area, California Division of Mines and Geology work in progress, 1962.) (Southern extension of Cabrillo Fault from D. G. Moore, written communication, December, 1962). (Palos Verdes fault zone from A. O. Woodford, et al., 1954, Geology of Los Angeles Basin: California Div. Mines Bull. 170, Chapt. II, contr. 5, pp. 66).

For a complete list of published geologic maps of this area see Division of Mines and Geology Special Reports 52 and 52-A.

View north toward Santa Barbara Island and Sutil Island (lower left). The islands are largely composed of vesicular massive basalt, overlain by basaltic agglomerate. A thin bed of middle Miocene foraminiferal shale separates the two volcanic units. The surface of Santa Barbara Island is partly mantled by Pleistocene marine deposits, and retains the remnants of several marine terraces.

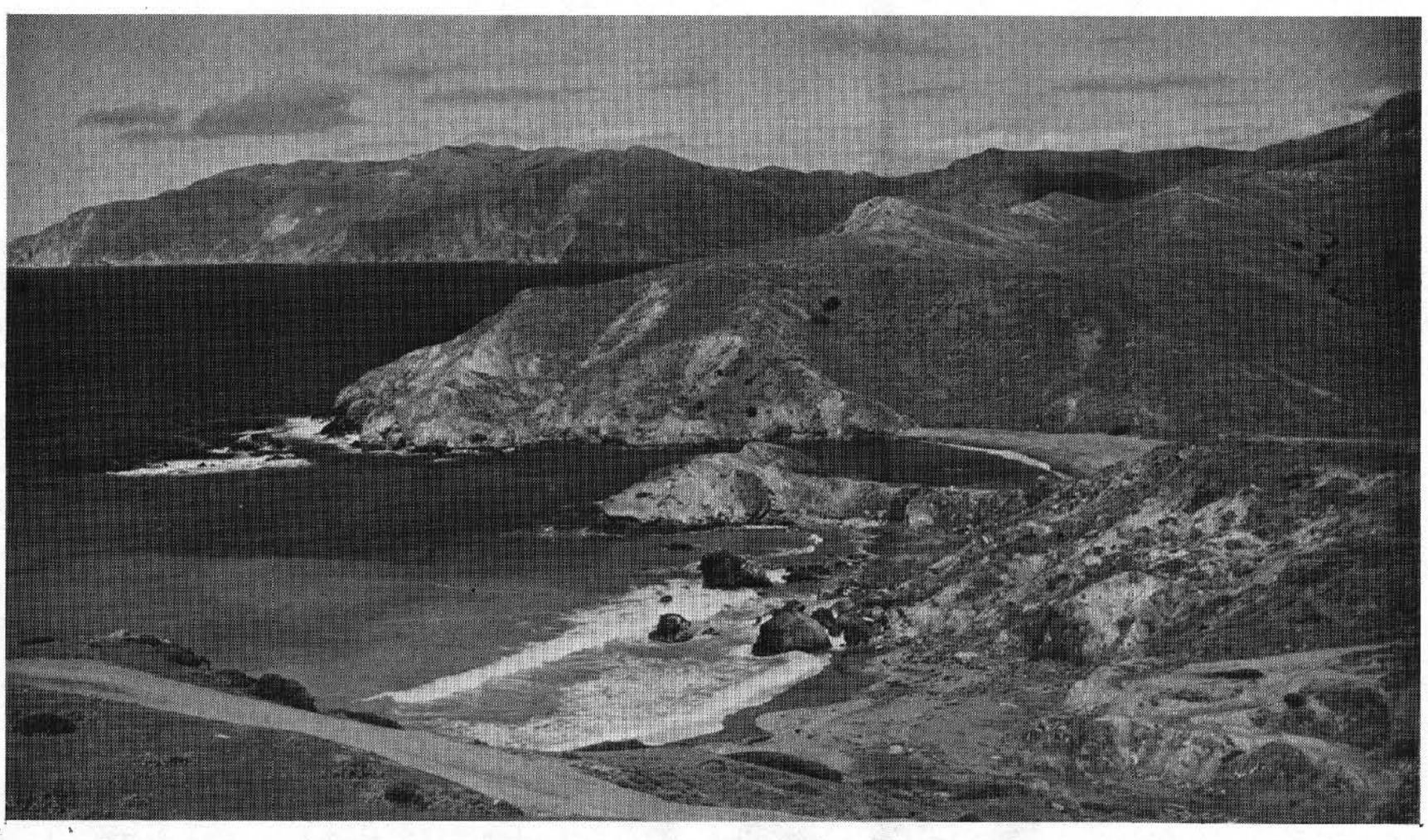
Photo by U. S. National Park Service, 1957

STRATIGRAPHIC NOMENCLATURE— LONG BEACH SHEET

AGE	STATE MAP SYMBOL	STATE MAP UNIT State Map Units listed here are not necessarily in stratigraphic sequence; the sequence used has been standardized for all sheets of the Geologic Map of California	STRATIGRAPHIC UNITS AND CHARACTERISTIC LITHOLOGIES (The formally named formations grouped within an individual State Map Unit are listed in stratigraphic sequence from youngest to oldest.)
CENOZOIC — QUATERNARY — Recent	Qs	**RECENT DUNE SAND**	Recent dune and beach sand. Includes Pleistocene dune sand in the Westchester-Torrance area.
CENOZOIC — QUATERNARY — Recent	Qal	**RECENT ALLUVIUM**	Alluvium and alluvial fan deposits. In the Los Angeles area includes flood plain deposits, marsh deposits, artificial fill, and some natural and artificial beach deposits.
CENOZOIC — QUATERNARY — Pleistocene	Qt	**QUATERNARY NONMARINE TERRACE DEPOSITS**	Stream terrace deposits on Santa Catalina Island. Nonmarine terrace cover in the Palos Verdes Hills area and the area between Inglewood and Long Beach (largely overlies wave-cut terrace surfaces).
CENOZOIC — QUATERNARY — Pleistocene	Qc	**PLEISTOCENE NONMARINE SEDIMENTARY DEPOSITS**	Older alluvium and semi-consolidated alluvial terrace deposits in the Whittier-Norwalk area. Older sand deposits, mostly weathered and locally cemented (San Clemente Island). La Habra Formation—*Conglomerate, sandstone, and mudstone.*
CENOZOIC — QUATERNARY — Pleistocene	Qm	**PLEISTOCENE MARINE DEPOSITS AND MARINE TERRACE DEPOSITS**	Marine terrace deposits including some nonmarine terrace deposits on wave-cut terrace surfaces. Palos Verdes Sand [1]—*upper Pleistocene marine sand and gravel deposits on the lowest (youngest) terraces;* San Pedro Formation [1]—*lower Pleistocene marine sand, silt, and gravel;* Timms Point silt [1]—*lower Pleistocene marine sandy silt, silty sand* and Lomita Marl [1]—*lower Pleistocene marine marl, calcareous sand, and gravel.*
CENOZOIC — QUATERNARY — Pliocene	Pu	**UPPER PLIOCENE MARINE SEDIMENTARY ROCKS**	Upper Pliocene rocks commonly called Pico Formation [2]—*siltstone, sandstone, and conglomerate* (Whittier Hills area).
CENOZOIC — QUATERNARY — Pliocene	Pml	**MIDDLE AND/OR LOWER PLIOCENE MARINE SEDIMENTARY ROCKS**	Lower Pliocene rocks commonly called Repetto Formation [3]—*lower Pliocene marine siltstone with minor sandstone and conglomerate* (Whittier Hills area and Palos Verdes Hills area).
CENOZOIC — TERTIARY — Miocene	Mu	**UPPER MIOCENE MARINE SEDIMENTARY ROCKS**	"Santa Margarita Formation"—*sandstone, shale, tuff, and agglomerates* on Santa Rosa Island. Malaga Mudstone [4]—*radiolarian mudstone and diatomite;* Valmonte Diatomite [4]—*diatomite, diatomaceous shale and diatomaceous mudstone.* Sycamore Canyon Member [5]—*conglomerate, sandstone, and siltstone;* Yorba Member [5]—*siltstone and sandstone;* Soquel Member [5]—*sandstone, siltstone, and locally conglomerate and breccia;* La Vida Member [5]—*siltstone, and sandstone, with local tuff beds.* Unnamed fossiliferous upper Miocene clastic limestone on Santa Catalina Island.
CENOZOIC — TERTIARY — Miocene	Mm	**MIDDLE MIOCENE MARINE SEDIMENTARY ROCKS**	Altamira Shale [6]—*porcelaneous shale, cherty shale, chert, siltstone, diatomite, sandstone, conglomerate, and tuff beds.* Middle Miocene Monterey Formation (undifferentiated)—*thin bedded diatomaceous, siliceous, and tuffaceous shales with thin beds of limestone near the base* (Santa Cruz Island), *siliceous shales and sandstone* on Santa Rosa Island. Unnamed middle Miocene thin-bedded siltstone, shale, diatomite, and basal sandstone with local beds of tuff breccia, ash, and pumice on San Clemente Island.
CENOZOIC — TERTIARY — Miocene	Ml	**LOWER MIOCENE MARINE SEDIMENTARY ROCKS**	Lower Miocene sandstone and conglomerate on Santa Cruz Island. Includes glaucophane-schist-bearing breccias and conglomerates of Saucesian stage on Santa Cruz Island ("San Onofre Breccia" of Rand, 1931, and Kennett, 1952).
CENOZOIC — TERTIARY — Miocene		**MIOCENE VOLCANIC ROCKS:**	
	Mv	**UNDIFFERENTIATED**	Dense, generally nonvesicular dacite flows (San Clemente Island).
	Mv^r	**RHYOLITIC**	Massive to predominately flow-banded porphyritic rhyolite flows (San Clemente Island). Rhyolite on Santa Catalina Island.
	Mv^a	**ANDESITIC**	Heterogeneous sequence of andesite flows and pyroclastic rocks on San Clemente Island. Augite-hypersthene andesite on Santa Catalina Island.
	Mv^b	**BASALTIC**	Olivine basalt on Santa Catalina Island. Olivine basalt flows with overlying basaltic pyroclastic rocks on Santa Cruz Island. Vesicular pillow basalt flows on Santa Barbara Island (middle Miocene age).
	Mv^p	**PYROCLASTIC**	Basaltic agglomerate (middle Miocene) on Santa Barbara Island. Upper Miocene rhyolite, andesite, and basalt breccia, agglomerate, scoriaceous flows, tuff, and tuff breccia on Santa Cruz Island ("Blanca Tuff" of Rand, 1931, and "Rhyolite Series" of Bremner, 1932).
CENOZOIC — TERTIARY — Eocene	E	**EOCENE MARINE SEDIMENTARY ROCKS**	Middle and upper Eocene sandstone, siltstone, and shale on San Nicolas Island. Upper and lower Eocene shales, sandstone, and conglomerates, on Santa Cruz Island ("Domengine Formation" of Bremner, 1932, and Rand, 1931).
CENOZOIC — TERTIARY — Paleocene	Ep	**PALEOCENE MARINE SEDIMENTARY ROCKS**	Paleocene sandstone interbedded with thin shale and some conglomerate on Santa Cruz Island ("Martinez Formation" of Bremner, 1932, and Rand, 1931).
CENOZOIC — TERTIARY — Undivided		**TERTIARY INTRUSIVE (HYPABYSSAL) ROCKS:**	
	Ti	**UNDIFFERENTIATED**	Dacite porphyry (hornblende quartz diorite porphyry of Bailey) on Santa Catalina Island. (Contains numerous inclusions of Franciscan-type metamorphic rocks.)
	Tib	**BASALTIC**	Miocene basaltic sills and irregular intrusive basalts in the Palos Verdes Hills. Diabase dikes on San Nicolas Island of Miocene(?) age.
	Ti^r	**RHYOLITIC**	Rhyolite of probable Miocene age comprising Begg Rock (northwest of San Nicolas Island) thought to be an eroded volcanic neck.
MESOZOIC — JURASSIC—CRETACEOUS	KJf	**FRANCISCAN FORMATION**	Metamorphic rocks on Santa Catalina Island (correlative with the Franciscan Formation in the Coast Ranges) derived from eugeosynclinal sedimentary and volcanic rocks, consisting of metasandstone with up to 30 percent lawsonite and glaucophane, fine grained glaucophane schist, quartzite, metaconglomerate, metavolcanic rocks, talc-actinolite schist, and local green or red chert. Catalina Schist—*quartz-sericite schist, quartz-talc schist, quartz-glaucophane schist, and altered basic igneous rocks* (Palos Verdes Hills; may be correlative with the Franciscan-type rocks on Santa Catalina Island or may be older).[7]
MESOZOIC — JURASSIC—CRETACEOUS	KJfv	**FRANCISCAN VOLCANIC AND METAVOLCANIC ROCKS**	Greenstone of Franciscan Formation on Santa Catalina Island.
MESOZOIC — JURASSIC—CRETACEOUS	grt	**MESOZOIC GRANITIC ROCKS** **TONALITE (QUARTZ DIORITE) AND DIORITE**	Quartz diorite and hornblende quartz diorite on Santa Cruz Island.
MESOZOIC — JURASSIC—CRETACEOUS	ub	**MESOZOIC ULTRABASIC INTRUSIVE ROCKS**	Serpentine (largely metamorphosed) containing actinolite, chlorite, talc, and locally tremolite on Santa Catalina Island.
MESOZOIC — JURASSIC—CRETACEOUS	m	**PRE-CRETACEOUS METAMORPHIC ROCKS, UNDIFFERENTIATED**	"Older" metamorphic rocks on Santa Catalina Island, chiefly gneissic or massive, consisting of chlorite-actinolite complex, quartz-muscovite-garnet rock, and green hornblende-zoisite-kyanite gneiss. Pre-Cretaceous metamorphic rocks on Santa Cruz Island consisting mainly of phyllite, chlorite schist, and greenstone.

NOTES

[1] Palos Verdes Hills area.
[2] Type locality of the Pico Formation is in the Ventura basin; upper Pliocene strata in the Los Angeles basin commonly are assigned to the Pico Formation on the basis of foraminiferal correlation; the U. S. Geological Survey is abandoning the name Pico and will use "upper member of Fernando Formation" in the Repetto Hills area (Durham, D. L. and Yerkes, R. F., Geology and oil resources of the eastern Puente Hills area: U. S. Geol. Survey Prof. Paper 420-B, in press).
[3] "Repetto" properly used only for stage designation; the U. S. Geological Survey is abandoning the name Repetto Formation and will use "lower member of the Fernando Formation" in the Puente Hills area (Durham, D. L., and Yerkes, R. F., U.S.G.S. Prof. Paper 420-B, in press).
[4] Upper Miocene member of the Monterey Formation in the Palos Verdes Hills area.
[5] Upper Miocene member of the Puente Formation in the Puente Hills area.
[6] Middle and upper Miocene member of the Monterey Formation in the Palos Verdes Hills area.
[7] A. O. Woodford, 1960, Bedrock patterns and strike slip faulting in southwestern California: Amer. Jour. Science, Bradley Volume, vol. 258-A, p. 400-417.



SANTA

CATALINA

ISLAND

View of Little Harbor embayment on the west side of Santa Catalina Island, site of many "south sea island" movies. The rocks in this view are Franciscan-type consisting largely of glaucophane-bearing metasandstone.
Photo courtesy Santa Catalina Island Company.

SANTA

CRUZ

ISLAND

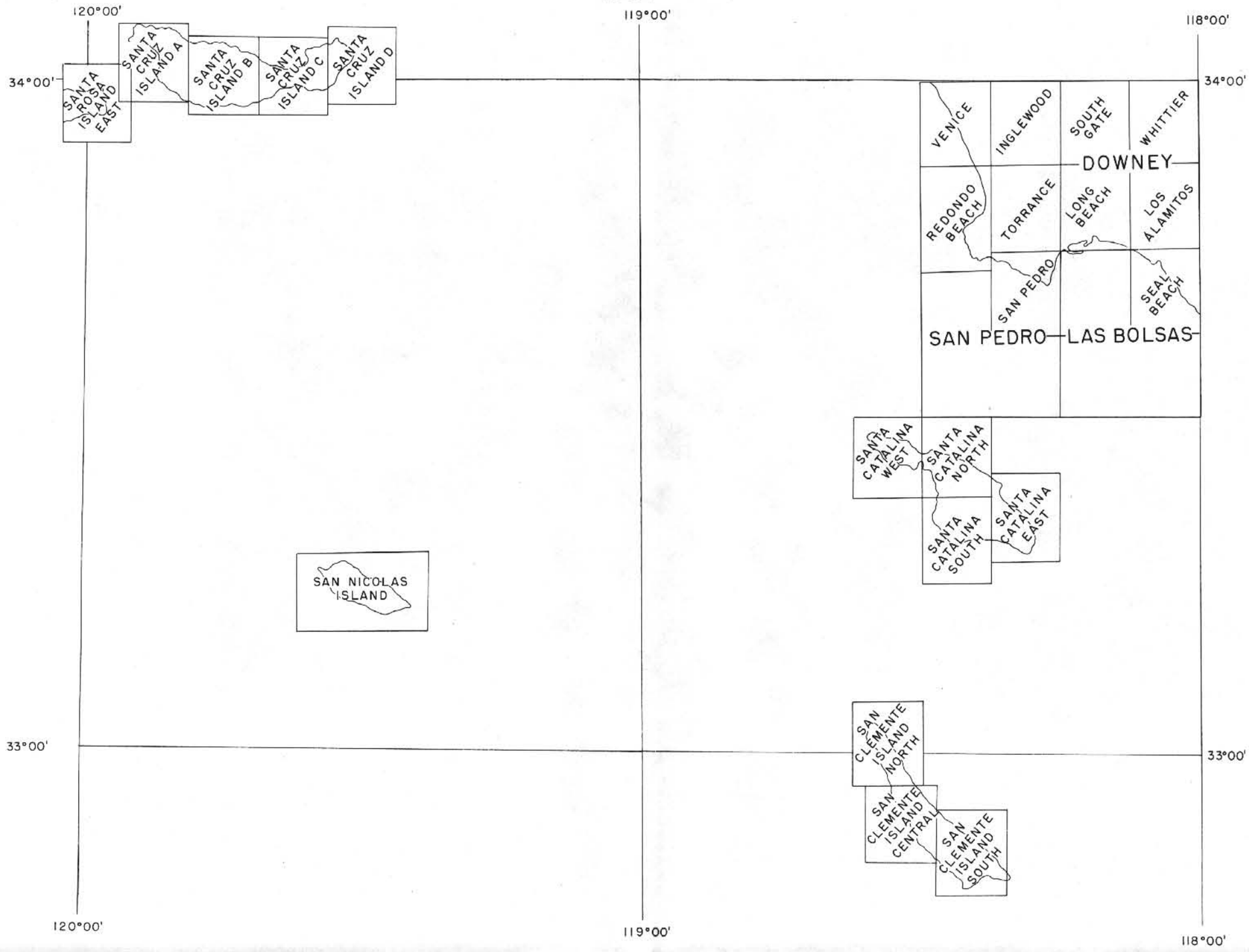
View toward north across the central part of Santa Cruz Island. Prominent rift valley (diagonally across middleground) marks the Santa Cruz Island Fault and contains Stanton Ranch (right of center). Area in background, across the fault valley, is composed of middle Miocene pyroclastic rocks and volcanic flows. The foreground, on observer's side of fault valley, consists of pre-Cretaceous metamorphic rocks (dark gray area) in fault contact with light colored upper Miocene pyroclastic rocks.
Photo courtesy Roland von Huene, 1962

TOPOGRAPHIC QUADRANGLES

WITHIN THE LONG BEACH SHEET

AVAILABLE FROM THE U.S. GEOLOGICAL SURVEY

1962



View northward of Palos Verdes Hills with Los Angeles City in background. At least five of the thirteen major late Pleistocene terraces are prominently displayed in this view. Marineland, on Long Point in center foreground, is situated on one of the lowest emergent terraces. The extensive amphitheater-like feature in the right foreground is the Portuguese Bend landslide. The Palos Verdes Hills is an uplifted block, composed largely of the middle Miocene Altamira Shale Member of the Monterey Formation. The Los Angeles basin, containing a thickness of at least 20,000 feet of Miocene and younger sedimentary rocks, is the site of several major oil fields, some of which are marked by rows of light-colored storage tanks. Plutonic and gneissic rocks comprise the San Gabriel Mountains (upper right horizon).

Photo by John S. Shelton, 1958

△82408—650 9-71 2M