

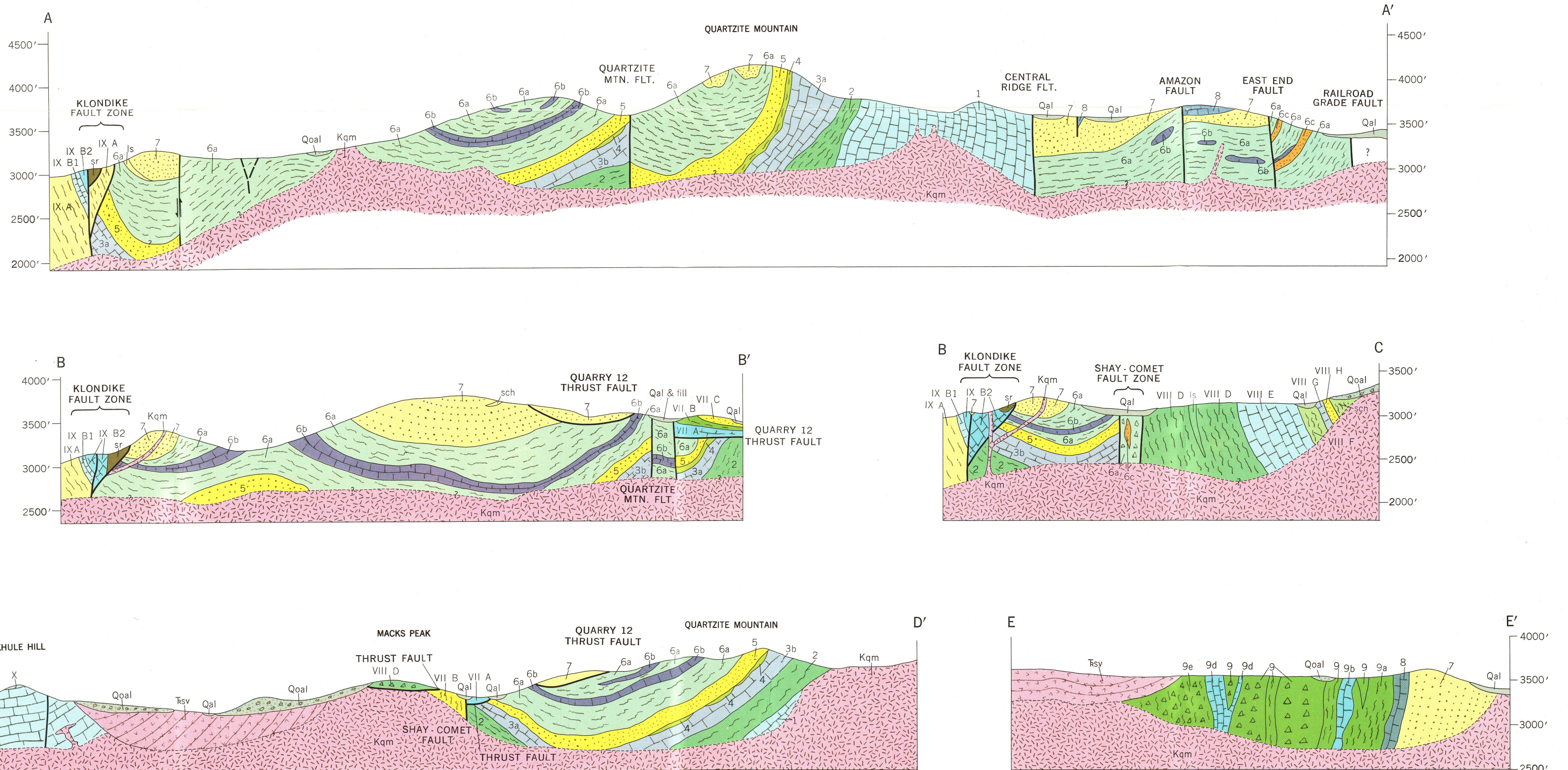
Base map by Topographic Division,  
U.S. Geological Survey  
Portions of Victorville and Helendale quadrangles

Williams & Heintz Map Corporation, Washington 27, D.C.

### SYMBOLS

Contact (Dashed where approximately located, gradational or inferred)	Strike and dip of cleavage
Fault (Dashed where approximately located, U, upthrown side; D, downthrown side)	Strike and dip of bedding and cleavage
Concealed fault	Strike and dip of beds
Fault, showing relative movement	Strike and dip of overturned beds
Thrust fault (Barbs on upper plate, dashed where approximately located)	Strike of vertical beds
	Axis of anticline
	Axis of syncline

### STRUCTURE SECTIONS



### EXPLANATION

RECENT	Slide-rock in Klondike quarry composed chiefly of limestone debris re- sulting from quarrying.
PLEISTOCENE	Alluvium. Locally includes artificial fill.
OLDER ALLUVIUM	Older alluvium, conglomerate, locally cemented to hard breccia by caliche. Locally includes artificial fill.
CRETACEOUS	Granitic rocks, chiefly medium- and coarse-grained biotite quartz monzonites; includes apatite and peridotite.
TRIASSIC (?)	SIDEWINDER VOLCANIC SERIES Black to dark-gray latite, light-gray rhyolite and dacite.

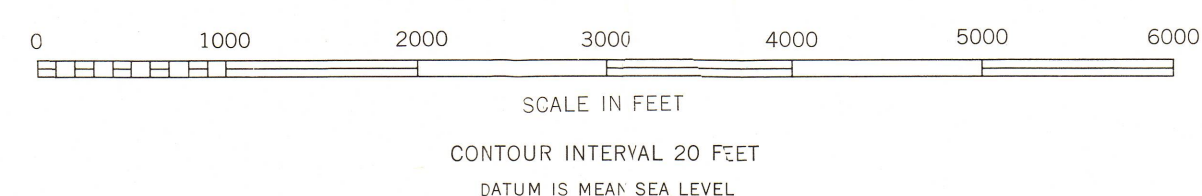
### ORO GRANDE SERIES MAP AREAS I THROUGH VI

Dark-brown to black-weathering quartzite breccia, dark quartz-mica schist and thin-bedded greenish calc-silicate hornfels (5); lower dark quartz-mica schist and hornfels (5a); blue-gray, medium-crystalline limestone (5b); middle dark quartz-mica schist and hornfels (5c); lower blue-gray to off-white, medium-crystalline dolomite (5d); up- per dark quartz-mica schist and hornfels (5e); upper blue-gray to off-white medium-crystalline dolomite with minor schist (5f) (5f).
Massive blue-gray and white, medium-crystalline limestone; lenses of dark schist (sch).
Upper commercial quartzite—massive, even-grained, medium-crystal- line, off-white quartzite. Lithologically indistinguishable from the lower quartzite; contains a few lenses of schist (sch) and limestone (5).
Principal schist—black, severely crumpled quartz-mica schist (5a); blue-gray to light-brown-weathering limestone and dolomite lime- stone, thin and commonly lenticular (5b); off-white quartzite (5c).
Lower commercial quartzite—massive, even-grained, medium-crystal- line, off-white quartzite.
Quartzite-schist transition unit—black, greenish-black and dark-brown schist and micaceous quartzite; minor calc-silicate hornfels.
Principal carbonate—blue-gray, medium-crystalline limestone (3a); brown-weathering, off-white, medium-crystalline dolomite (3b); schist (sch).
Lower schist-hornfels—green, brown, and black, thin-bedded calc, cal- silicate hornfels and micaceous quartzite.
Lowest dolomite—white, massive, medium- to coarse-crystalline dolomite, locally serpentine.

## GEOLOGIC MAP OF QUARTZITE MOUNTAIN AND VICINITY NEAR ORO GRANDE, SAN BERNARDINO COUNTY, CALIFORNIA

Geology by Oliver E. Bowen and William E. Ver Planck

1960



### MAP AREA VII - MACKS PEAK VICINITY

MASSIVE, even-grained, off-white quartzite lithologically similar to units 5, 7.
DARK-BROWN to black schist, thinly laminated.
MASSIVE, blue-gray, medium-crystalline limestone.
UPPER commercial quartzite—massive, even-grained, medium-crystal- line, off-white quartzite. Lithologically indistinguishable from the lower quartzite.

MASSIVE, even-grained, off-white quartzite lithologically similar to units 5, 7.
DARK-BROWN to black schist, thinly laminated.
MASSIVE to brecciated blue-gray, medium-crystalline limestone, sag- nation in part.
LOWEST dolomite—white, massive, medium- to coarse-crystalline dolomite, locally serpentine.

### MAP AREA VIII

#### LOWER ORO GRANDE CANYON

MASSIVE, off-white, quartzite.
Blue-gray to white, crystalline limestone, dolomite in part.
Black to dark-brown quartz-mica schist with minor limestone, horn- fels, quartzite.
Blue-gray, medium-crystalline limestone.
Black to dark-brown quartz-mica schist; few thin lenses of limestone (5), quartzite, hornfels.
MASSIVE, off-white quartzite, joints stained by iron oxide; weathers red-colored.
DARK-BROWN to black quartz-mica schist; few thin lenses of limestone, quartzite, hornfels.
MASSIVE, blue-gray to off-white, medium- to coarse-crystalline lime- stone; some dolomite.

### MAP AREA IX

#### SHAY - KLONDIKE BLOCK

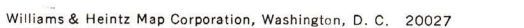
Green calc-silicate hornfels and black quartz-mica schist with one thin lens of blue-gray crystalline limestone (5).
DARK-BROWN to black quartz-mica schist with thin lens of green horn- fels and gray or light-brown dolomite (5d).
Blue-gray to white crystalline dolomite (IX B 1); light-gray crystalline limestone (IX B 2); lenses of schist and quartzite (IX B 3).
Light-gray to brownish-gray, medium-grained quartz-feldspar-mica gneiss and schist probably derived by granulization of shale.

### MAP AREA X - SPARKHULE HILL

MASSIVE, medium-crystalline limestone, light blue-gray grading to black; off-white, brown-weathering dolomite (5a).
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NOTE: LINE PATTERNS IDENTIFY MAP AREAS



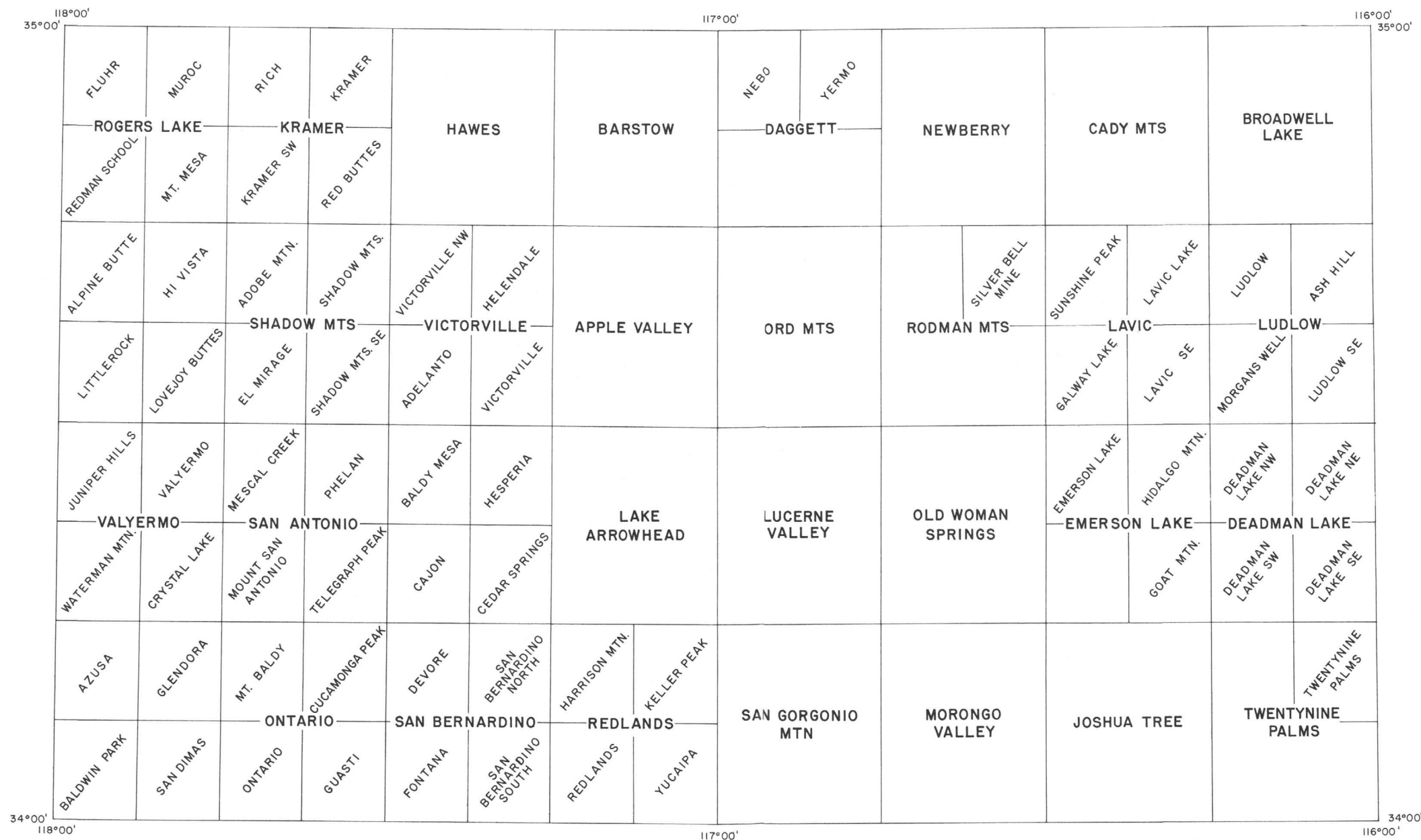


Geology by Oliver E. Bowen and William E. Ver Planck  
1960



# TOPOGRAPHIC QUADRANGLES

AVAILABLE FROM THE U.S. GEOLOGICAL SURVEY  
FEDERAL CENTER, DENVER, COLORADO 80225  
1968



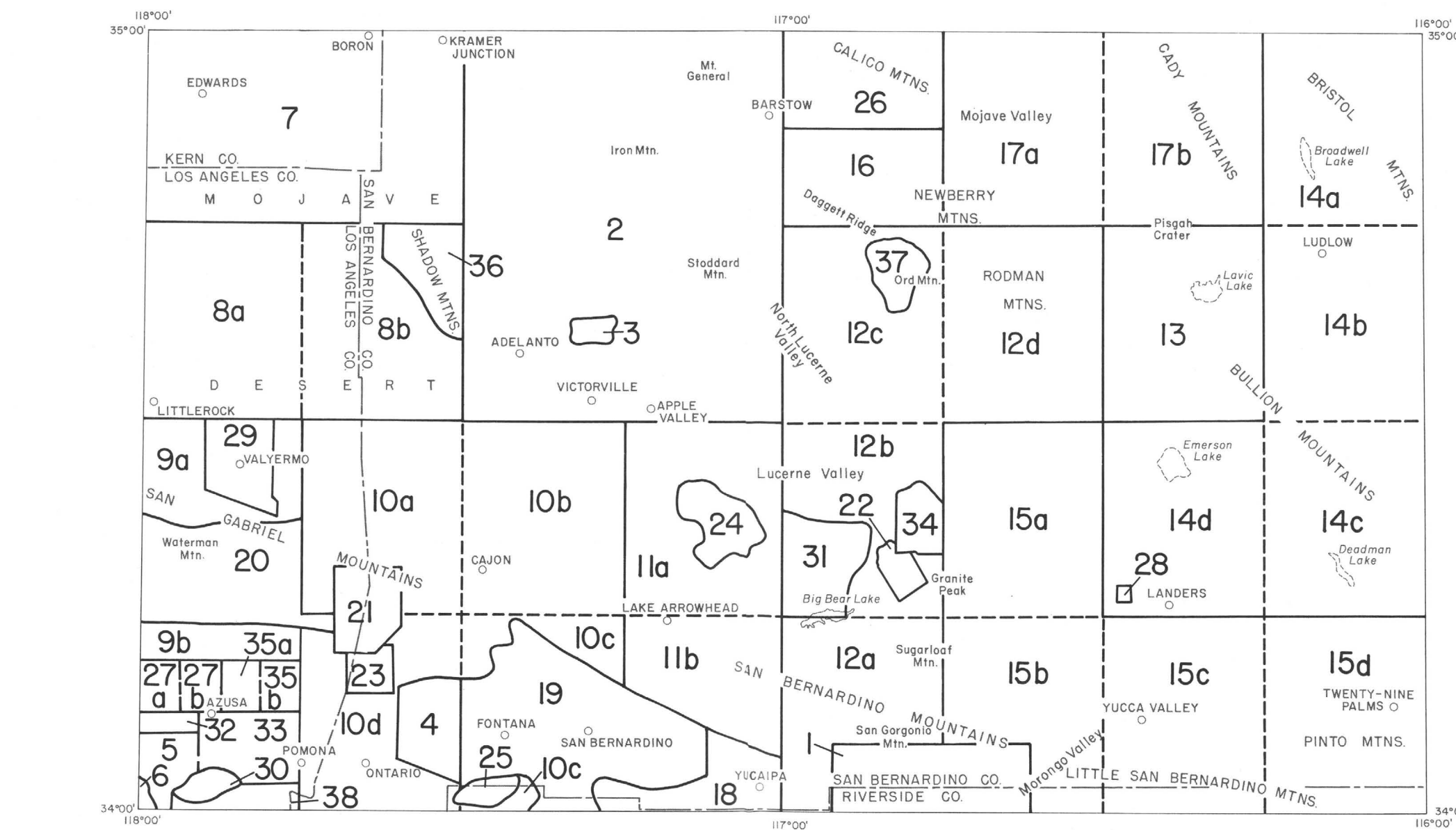
View northwest along the San Bernardino mountain front toward the city of San Bernardino, Cajon Pass, and the snow-capped San Gabriel Mountains. The linear boundary between the dark orange groves of the valley and the lighter brushy foothills of the San Bernardino Mountains coincides with the South Branch of the San Andreas fault. The North Branch of the San Andreas fault occupies a trough (NB) in the foothills, at the base of the higher more rugged part of the San Bernardino Mountains. These two branches converge into a much narrower fault zone in the distance near Cajon Pass. The rocks between these faults consist of Mesozoic granitic rocks (light colored outcrops) and severely deformed Pliocene or Miocene nonmarine beds. The remainder of the San Bernardino Mountains and the San Gabriel Mountains consists of a granitic and metamorphic complex of Mesozoic, Paleozoic and Precambrian age. Photo by R. C. Frampton, 1955

DIVISION OF MINES AND GEOLOGY  
Ronald Reagan, Governor  
THE RESOURCES AGENCY  
Norman B. Livermore, Jr., Secretary

DEPARTMENT OF CONSERVATION  
James G. Stearns, Director

## EXPLANATORY DATA SAN BERNARDINO SHEET GEOLOGIC MAP OF CALIFORNIA OLAF P. JENKINS EDITION Compiled by Thomas H. Rogers, 1967

### INDEX TO GEOLOGIC MAPPING USED IN THE COMPILATION OF THE SAN BERNARDINO SHEET



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3. Bowen, O. E., Jr., and Ver Planck, W. E., 1965, Stratigraphy, structure, and mineral deposits in the Oro Grande Series near Victorville, California: California Div. Mines and Geology Special Report 84, Pl. 1, scale 1:24,000.
4. Burnham, W. L., The geology and ground water conditions of the Eriwanda-Fontana area, California, scale 1:31,680, Pomona College, unpublished M.A. thesis, 1953.
5. California Dept. Water Resources, 1966, Planned utilization of ground water basins—San Gabriel Valley, Appendix A, Geohydrology, Plate 2A, scale 1:125,000.
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- 18a. Dibblee, T. W., Jr., 1959, Geologic map of the Alpine Butte quadrangle, California: U. S. Geol. Survey Mineral Investigations Field Studies Map MF-222, scale 1:62,500.
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  - a) Valyermo quadrangle.
  - b) Pomona quadrangle.
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  - a) San Antonio quadrangle (local additions from P. L. Ehlig, unpublished, reference no. 20).
  - b) Hesperia quadrangle (local additions from California Dept. Water Resources, Geologic Map of the Cedar Springs Reservoir-San Bernardino Tunnel area, scale 1" = 1000', unpublished, 1967; and A. Smith, Structural petrology, Crestmore, California, scale 1 inch = 1/4 mile, California Institute Technology, unpublished PhD thesis, 1947).
  - c) San Bernardino quadrangle (local additions as in b) above and from D. M. Morton, Geologic mapping in the central part of the Cucamonga Peak 7 1/2' quadrangle, California Div. Mines and Geology, 1968).
  - d) Ontario quadrangle (local additions from California Div. Water Resources, 1934, Geology and ground water storage capacity of valley fill—South Coastal Basin Investigation, Bull. 45, Pl. C, scale 1 inch=approx. 2 miles; R. Streitz, Preliminary geologic map of the SW 1/4 Mt. Baldy 7 1/2' quadrangle, California Div. Mines and Geology, work in progress, 1967; and D. M. Morton, Preliminary geologic map of the Devore 7 1/2' quadrangle, California Div. Mines and Geology, work in progress, 1968).
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  - b) Redlands quadrangle.
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  - a) San Geronimo Mountain quadrangle, 1-431 (glacial deposits from R. P. Sharp, C. R. Allen, and M. F. Meier, 1959, Pleistocene glaciers on southern California mountains: American Jour. Science, vol. 257, pp. 81-94, Fig. 5, scale 1" = approx. 2000').
  - b) Lucerne Valley quadrangle, 1-426.
  - c) Ord Mountains quadrangle, 1-427.
  - d) Rodman Mountains quadrangle, 1-430.
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  - a) Broadwell Lake quadrangle, 1-478.
  - b) Ludlow quadrangle, 1-477.
  - c) Deadman Lake quadrangle, 1-488.
  - d) Emerson Lake quadrangle, 1-490.
15. Dibblee, T. W., Jr., Geologic maps of the Old Woman Springs, Morongo Valley, Joshua Tree, and Twenty-nine Palms quadrangles, scale 1:62,500, U. S. Geol. Survey Misc. Geol. Investigations Maps:
  - a) Old Woman Springs quadrangle, 1-518.
  - b) Morongo Valley quad., 1-517, local additions from R. J. Proctor, Geology of the Desert Hor Springs-Upper Coachella Valley area, California Div. Mines and Geology Special Report 94, in press, 1967).
  - c) Joshua Tree quadrangle, 1-516.
  - d) Twenty-nine Palms quadrangle, in press.
16. Dibblee, T. W., Jr., Geologic map of the Daggett quadrangle, scale 1:62,500, U. S. Geol. Survey Misc. Geol. Investigations Map in press (additional faults west of Daggett from G. A. Miller, Ground water investigations in the Daggett area, scale 1:62,500, U. S. Geol. Survey, unpublished, 1967).
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  - a) Newberry quadrangle, 1-461.
  - b) Cady Mountains quadrangle, 1-467 (local faults from W. S. Wise, University of California, Santa Barbara, written communication, 5/12/67).
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20. Ehlig, P. L., Geologic map of a part of the eastern San Gabriel Mountains, compiled on 1:250,000 scale by P. L. Ehlig from original field maps, unpublished work in progress, 1967, California State College at Los Angeles.
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- Crowder, D. F., 1967, Mineral resources of the Devil Canyon-Bear Canyon primitive area, California: U. S. Geol. Survey Bull. 1330-G, Pl. 1, scale 1:62,500.
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- \*24. MacColl, R. S., 1964, Geochemical and structural studies in batholithic rocks of southern California: Part 1, Structural geology of Rattlesnake Mountain pluton: Geol. Soc. America Bull., vol. 75, no. 9, pp. 805-822, Pl. 1, scale 1 inch = approx. 0.6 mile.
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27. Morton, D. M., Preliminary geologic maps of a) SW 1/4 Azusa, and b) SE 1/4 Azusa quadrangles, Los Angeles County, California, scale 1:9600, California Div. Mines and Geology, work in progress, 1967. (Available on open file at California Div. Mines and Geology offices in San Francisco and Los Angeles.) Local older alluvium and concealed faults in alluvium from J. S. Shelton, 1946, 1955, references no. 32 and 33, and California Dept. Water Resources, 1966, reference no. 5.
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- \* Additional mapping by T. W. Dibblee, Jr.
- \* Part of this area is also covered by geologic maps of the Southern Pacific Co., 1923-1924, Regional geologic mapping program, scale 1:24,000, unpublished, 1956-1960. For information concerning these maps contact Manager—Land Dept., Southern Pacific Co., 65 Market St., San Francisco, California 94105.

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



STRATIGRAPHIC NOMENCLATURE—SAN BERNARDINO SHEET					
AGE	STATE MAP SYMBOL	STATE MAP UNIT <small>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</small>	STRATIGRAPHIC UNITS AND CHARACTERISTIC LITHOLOGIES <small>(The formally named formations grouped within an individual State Map Unit, are listed in stratigraphic sequence from youngest to oldest.)</small>		
CENOZOIC	QUATERNARY	Recent	Qs	RECENT DUNE SAND	Windblown sand, local dunes. Wave-deposited sandbars at north end of Rogers Dry Lake.
			Qal	RECENT ALLUVIUM	Stream, river channel, and alluvial fan deposits. Alluvial deposits in Mojave Desert of Pleistocene to Recent age shown as Qal-Qc. Playa clay and windblown sand near Rogers Dry Lake.
		Pleistocene		RECENT VOLCANIC ROCKS:	
			Qrv <sup>b</sup>	BASALTIC	Black vesicular basalt flows from Pisgah Crater (may be Pleistocene).
			Ql	QUATERNARY LAKE DEPOSITS	Manix Lake Beds—light-gray, green, and buff sand, interbedded silt, clay and gravel east of Manix (contain late Pleistocene vertebrate fossils). Unnamed clay, silt, and marl, local alkaline efflorescences, and windblown sand (Mojave Desert).
			Qt	QUATERNARY NONMARINE TERRACE DEPOSITS	Stream and river terrace deposits.
			Qg	QUATERNARY GLACIAL DEPOSITS	Glacial till on north flank of San Geronio Mountain.
			Qc	PLEISTOCENE NONMARINE SEDIMENTARY DEPOSITS	Qc: dissected, undeformed or slightly deformed alluvial fan deposits locally cemented by caliche; Burnt Canyon Breccia and Heights Fonglomerate south of San Geronio Mountain. San Dimas Formation along south flank of San Gabriel Mountains (includes local terrace remnants). Unnamed silt, sand, and gravel elsewhere. Qc <sub>1</sub> (older than Qc): folded, faulted, and dissected alluvial fan deposits locally cemented by caliche; Cabezon Fonglomerate and deformed gravels of Whitewater River south of San Geronio Mountain. Shoemaker Gravel and Harold Formation (includes interbedded brown to green shale and white marly clay) along north flank of San Gabriel Mountains. Cushman Springs Formation—fanglomerate and landslide breccia on north flank of San Bernardino Mountains. Unnamed gray, brown, and red-brown fanglomerate and conglomerate elsewhere (possibly in part late Pliocene east of Barstow).
				PLEISTOCENE VOLCANIC ROCKS:	
			Qpv <sup>b</sup>	BASALTIC	Black vesicular basalt flows from Sunshine and Malpais Craters. Black massive basalt flow on Broadwell Mesa.
	Qpv <sup>p</sup>	PYROCLASTIC	Gray, white, and buff massive tuff south of Lavié Lake.		
	✱	QUATERNARY CINDER CONES	Black and brown-black basaltic pumice of Pisgah Crater (Recent) and Sunshine Crater (Pleistocene).		
	Pliocene		PLIOCENE VOLCANIC ROCKS:		
		Pvr <sup>f</sup>	RHYOLITIC	Gray to light-brown massive fine-grained felsite and dacite (may be in part Pleistocene). Red rhyolitic to dacitic flow breccia in Ord Mountains.	
		Pvb <sup>b</sup>	BASALTIC	Black massive vesicular and nonvesicular basalt (may be in part Pleistocene).	
		Pvp <sup>p</sup>	PYROCLASTIC	Light-gray massive rhyolitic tuff and tuff breccia (may be in part Pleistocene).	
		Pu	UPPER PLIOCENE MARINE SEDIMENTARY ROCKS	Upper Member of the Fernando Formation (includes rocks commonly called Pico Formation) <sup>1</sup> —sandy siltstone, conglomerate, and sandstone (southwest of Azusa).	
		Pml	MIDDLE AND/OR LOWER PLIOCENE MARINE SEDIMENTARY ROCKS	Lower Member of the Fernando Formation (includes rocks commonly called Repetto Formation) <sup>2</sup> —siltstone, conglomerate, and fine sandstone (southwest of Azusa).	
Pmlc		MIDDLE AND/OR LOWER PLIOCENE NONMARINE SEDIMENTARY ROCKS	Anaerode Formation—yellow and white arkosic sandstone and conglomerate, interbedded gray gypsiferous shale and red to green siltstone (south of Little Rock on the north flank of the San Gabriel Mountains). Potato Sandstone—red, gray, and white massive conglomerate, buff arkosic sandstone and siltstone, green to gray rhythmically-bedded shale and pebbly sandstone, minor gray limestone (according to D. I. Axelrod, in R. E. Smith, <sup>3</sup> upper part of this formation contains an early Pliocene flora; lower part of formation may be Miocene; north of Redlands).		
Pc		UNDIVIDED PLIOCENE NONMARINE SEDIMENTARY ROCKS	Duarte Conglomerate <sup>4</sup> —light-gray massive conglomerate and local sandstone (south flank San Gabriel Mountains). Crowder Formation <sup>4</sup> —gray fanglomerate, conglomerate, and sandstone (Cajon Pass area). San Timoteo Formation—gray, yellow, and brown semi-consolidated gravel, sand, silt, and clay (contains a late Blancan vertebrate fauna now regarded as early Pleistocene according to R. H. Tedford, written communication 6/12/67). Santa Ana Sandstone <sup>5</sup> —buff to gray, friable, arkosic sandstone, minor micaceous siltstone and pebbly conglomerate, local black basalt (San Bernardino Mountains). Unnamed brown, gray, and white sandstone, fanglomerate and marl in Mojave Desert <sup>4</sup> .		
TERTIARY	Miocene	Mc	UNDIVIDED MIOCENE NONMARINE SEDIMENTARY ROCKS	Tropico Group—undifferentiated sandstone, chert, clay shale, granitic breccia, limestone or dolomite, and local rhyolitic tuff (may be in part Pliocene; Rogers Dry Lake-Kramer Hills area). Bissell Formation (of Tropico Group)—limestone and/or dolomite. Punchbowl Formation—buff, massive, conglomeratic sandstone and siltstone, interbedded red, green, and brown siltstone and shale, local brown and gray gypsiferous shale and coarse conglomerate west of San Andreas fault (contains a late Miocene and a middle Miocene vertebrate fauna east of San Andreas fault and an early Pliocene vertebrate fauna west of San Andreas fault; R. H. Tedford and T. Downs, 1963, Geol. Soc. America, Spec. Paper 87, p. 234; Cajon Pass-Valermeo area). Unnamed nonmarine sediments east of Barstow including light-colored locally tuffaceous sand, variegated locally-opaline shale, varicolored claystone and siltstone, light-colored limestone, dolomite, and magnetite, minor conglomerate, fanglomerate, sedimentary breccia, chert, celestite beds, rhyolitic tuff, olivine basalt, and dacite mudflow breccia (unnamed sediments contain a middle and a late Miocene vertebrate fauna in the northern Cady Mountains and a middle Miocene fauna at Daggett Ridge; D. P. Whistler, written communication, 5/17/67; correlation of fossiliferous strata with similar unnamed sediments elsewhere in map area is uncertain; may be in part Oligocene elsewhere).	
		Muc	UPPER MIOCENE NONMARINE SEDIMENTARY ROCKS	Barstow Formation—fluviatile and lacustrine sandstone and shale, locally silicified (contains a late Miocene and a late middle Miocene vertebrate fauna in the Calico Mountains according to D. P. Whistler, written communication, 5/17/67 and R. H. Tedford, written communication, 6/12/67). Coachella Fonglomerate—red-brown massive conglomerate and sandstone (south of Morongo Valley).	
	Paleocene/Oligocene	Mmc	MIDDLE MIOCENE NONMARINE SEDIMENTARY ROCKS	Unnamed lacustrine limestone, sandstone, shale, conglomerate, sedimentary breccia, and interbedded olivine basalt flows (Calico Mountains). Biotite dacite mudflow breccia of the Pickhandle Formation (Calico Mountains).	
			MIOCENE VOLCANIC ROCKS:		
		Mv	UNDIFFERENTIATED	Glendora "Volcanics"—undifferentiated massive andesite, basalt, dacite(?), and rhyolite, interbedded tuff and tuff breccia (Azusa-Glendora area).	
		Mvr <sup>f</sup>	RHYOLITIC	Dacite vitrophyre and dacite of the Tropico Group (Rogers Dry Lake-Kramer Hills area). Rhyolitic felsite and dacite porphyry east of Ludlow. Dacite and rhyolite of the Glendora "Volcanics" (Azusa area).	
		Mva <sup>d</sup>	ANDESITIC	Brown, red, green, and gray porphyritic andesite flows and breccia of the Glendora "Volcanics" (Azusa area). Andesite associated with the Barstow Formation (Calico Mountains). Unnamed andesite flow breccia, andesite-dacite breccia, and hornblende andesite elsewhere (contains early Miocene vertebrate fauna in the southern Cady Mountains according to D. P. Whistler, written communication, 5/17/67).	
		Mvb <sup>b</sup>	BASALTIC	Red Buttes Quartz Basalt (of Tropico Group)—black quartz-bearing volcanic rocks (referred to as quartz basalt by T. W. Dibble, Jr., 1960, ref. no. 7, and quartz andesite by O. E. Bowen, 1954, ref. no. 2; may be in part Pliocene). Olivine basalt flows of Tropico Group (may be in part Pliocene). Basalt porphyry, pillow lava, associated palagonite tuff of the Glendora "Volcanics" (Azusa area). Unnamed black massive vesicular and nonvesicular basalt and basalt breccia elsewhere.	
		Mvp <sup>p</sup>	PYROCLASTIC	Gem Hill Formation (of Tropico Group)—rhyolitic tuff (Rogers Dry Lake-Kramer Hills area). Pickhandle Formation—undifferentiated tuff, tuff breccia, agglomerate, and tuffaceous sandstone (Calico Mountains). Andesitic tuff, tuff breccia, and tuffaceous sediments of the Glendora "Volcanics" (Azusa area). Unnamed varicolored tuff, tuff breccia, and agglomerate elsewhere.	
		Mu	UPPER MIOCENE MARINE SEDIMENTARY ROCKS	Puente Formation—white and tan, well-bedded siltstone, shale, siliceous shale, and conglomerate, minor feldspathic sandstone and tuff (south of Azusa).	
Mm	MIDDLE MIOCENE MARINE SEDIMENTARY ROCKS	Topanga Formation—buff conglomerate, sandstone, siltstone, and shale, interbedded vesicular basalt flows (Azusa area). Volcanic conglomerate and reworked tuffs associated with Glendora "Volcanics" (San Jose Hills).			
MI	LOWER MIOCENE MARINE SEDIMENTARY ROCKS	Vaqueros Formation—fossiliferous arkosic sandstone and conglomerate (near Cajon Canyon).			
Φc	OLIGOCENE NONMARINE SEDIMENTARY ROCKS	Vasquez Formation—conglomerate, arkosic sandstone, and siltstone, associated andesitic and basaltic volcanic rocks (northwest of Valermeo).			
Ep	PALEOCENE MARINE SEDIMENTARY ROCKS	San Francisco Formation—dark gray to black shale, coarse conglomerate, tan to gray sandstone, abundant thin lignite seams and limestone lenses (formerly mapped as "Martinez Formation"; Cajon Pass-Valermeo area).			

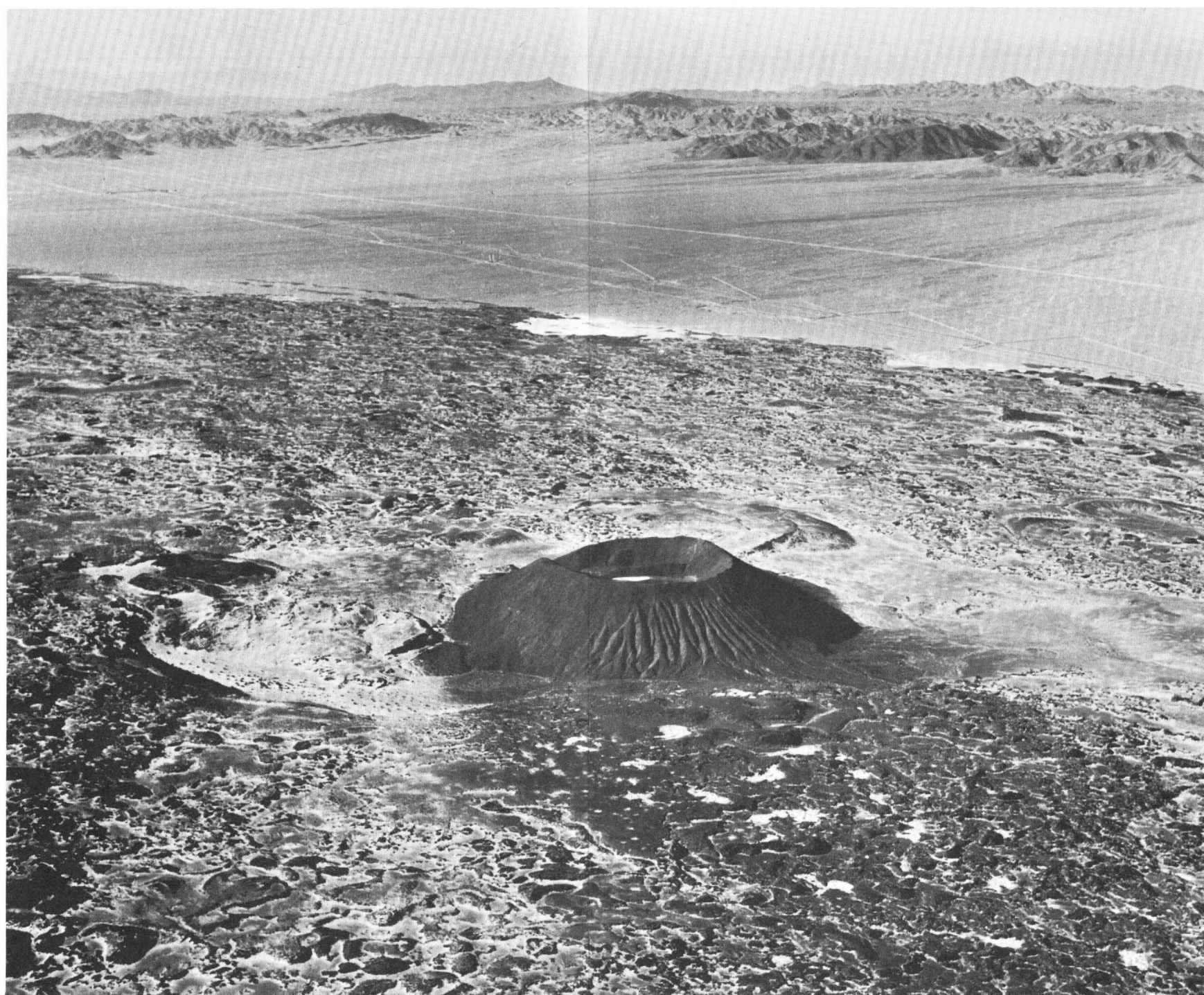
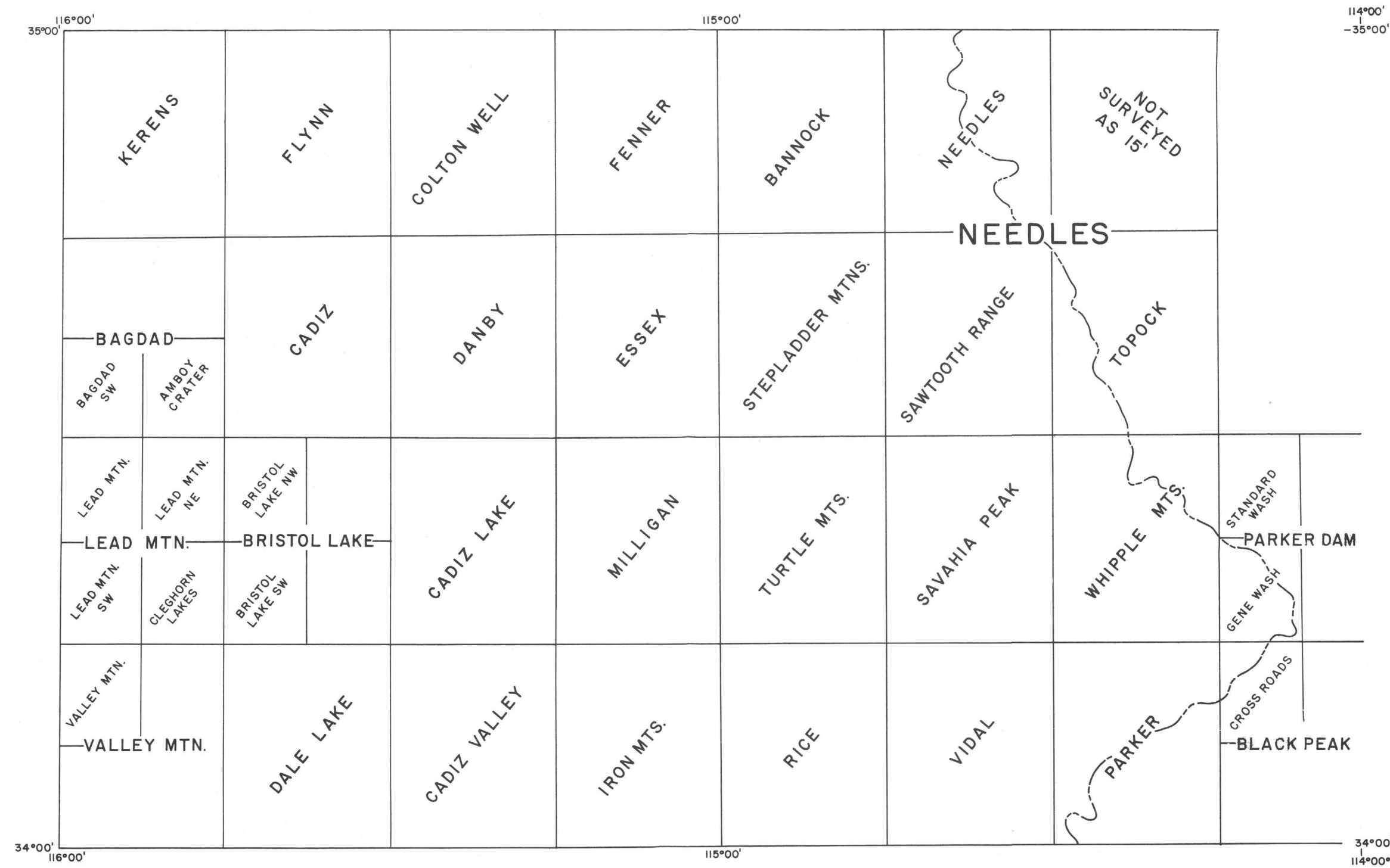
STRATIGRAPHIC NOMENCLATURE—Continued				
AGE	STATE MAP SYMBOL	STATE MAP UNIT <small>State Map Units listed here are not necessarily in stratigraphic sequence; the sequence used has been standardized for all sheets of the Geologic Map of California</small>	STRATIGRAPHIC UNITS AND CHARACTERISTIC LITHOLOGIES <small>(The formally named formations grouped within an individual State Map Unit, are listed in stratigraphic sequence from youngest to oldest.)</small>	
CENOZOIC	Tertiary	Tc	TERTIARY NONMARINE SEDIMENTARY ROCKS	Old Woman Sandstone—buff to pink massive arkosic sandstone, interbedded conglomerate, siltstone, and mudstone (probably late Tertiary; north flank San Bernardino Mountains).
		Tl	TERTIARY LAKE DEPOSITS	Unnamed red-brown and green massive claystone, white vuggy limestone, interbedded white bentonitic tuff (west of Pisgah Crater; altered tuff marketed as "theoretic").
		Ti	TERTIARY INTRUSIVE (HYPABYSSAL) ROCKS:	
			UNDIFFERENTIATED	Felsite east of the Rodman Mountains. Stoddard Canyon Quartz Monzonite <sup>6</sup> —light-gray quartz monzonite porphyry forming stocks and dikes, local chilled border phases resembling quartz latite and dacite (San Gabriel Mtns.).
		Tir	RHYOLITIC	Mountain Meadows Dacite Porphyry <sup>7</sup> —buff, gray, or green massive biotite dacite porphyry (San Gabriel Mountains). Unnamed intrusive dacite, rhyolitic and dacite breccia, dacite porphyry, and pelite breccia in the Mojave Desert (locally extrusive in Barstow area).
		Tia	ANDESITIC	Intrusive andesite, andesite breccia, and andesite porphyry in the Mojave Desert.
		Tib	BASALTIC	Intrusive basalt, diabase, and olivine diabase in the Mojave Desert (may be Pleistocene).
	Mesozoic	gr	MESOZOIC GRANITIC ROCKS	
		gr <sup>a</sup>	UNDIFFERENTIATED	Quartz monzonite, granodiorite, quartz diorite, and monzonite. An intrusive complex of quartz monzonite porphyry, latite porphyry, and porphyritic felsite near Stoddard Well, Mount Lowe Granodiorite <sup>8</sup> —light-colored, foliated, quartz-poor granitic rock of monzonitic to dioritic composition (Permian-Triassic; San Gabriel Mountains).
			GRANITE AND ADAMELLITE (QUARTZ MONZONITE)	White Tank Quartz Monzonite and Palms "Granite"—white to gray biotite quartz monzonite (Twenty-nine Palms area). Cactus Quartz Monzonite—gray-buff biotite quartz monzonite (San Bernardino Mountains). Holcomb Quartz Monzonite—gray to pink quartz monzonite (Valermeo area). Unnamed light-colored unfoliated or slightly foliated, biotite and biotite-hornblende quartz monzonite, hornblende quartz monzonite, hornblende granite, granite porphyry, aplite, and pegmatite.
		gr <sup>g</sup>	GRANODIORITE	Woodson Mountain Granodiorite—light-colored granodiorite, scattered small dark inclusions (Jurupa Mountains). Unnamed biotite granodiorite and biotite granodiorite porphyry.
		gr <sup>t</sup>	TONALITE (QUARTZ DIORITE) AND DIORITE	Bonita Tonalite—light- to dark-gray tonalite containing abundant, large, oriented inclusions (Jurupa Mountains). Unnamed hornblende-biotite quartz diorite, quartz diorite porphyry, dark-colored locally foliated diorite, local thin cataclastic and mylonitic zones.
		bi	MESOZOIC BASIC INTRUSIVE ROCKS	San Marcos Gabbro—dark-gray and white, mottled hornblende gabbro (Jurupa Mountains). Gold Park Gabbro-Diorite—highly variable hornblende gabbro and diorite (near Twenty-nine Palms; possibly Precambrian re. W. J. Miller, 1938, Geol. Soc. America Bull., p. 438). Unnamed black, massive, hornblende gabbro and diorite-gabbro.
		JRv	JURASSIC AND/OR TRIASSIC METAVOLCANIC ROCKS	Sidewinder Volcanic "Series"—highly variable, locally metamorphosed pyroclastic, volcanic, and some hypabyssal intrusive rocks including light-colored dacitic and rhyolitic tuff and vitrophyre, dark-colored andesitic tuff, latite agglomerate, dark-gray andesite, latite, and basalt, brown and white rhyolite and dacite, blue-gray massive keratophyre, and dark-gray basalt porphyry and diorite porphyry, local piemontite (may range from Late Permian to Jurassic in age). Ord Mountain Group—andesitic flows, tuff, and breccia, hypabyssal porphyritic andesite and monzonite.
		R	PERMIAN MARINE SEDIMENTARY AND METASEDIMENTARY ROCKS	Fairview Valley Formation—dark-gray massive limestone conglomerate, thin-bedded gray-green silty and sandy limestone (metamorphosed locally to hornfels), minor thin-bedded calcareous siltstone and shale (contains Permian fossils in limestone clasts; may be in part Triassic).
		C	UNDIVIDED CARBONIFEROUS MARINE SEDIMENTARY AND METASEDIMENTARY ROCKS	Oro Grande "Series"—blue-gray and white, massive, calcite and dolomite marble, dark-colored quartz-mica schist and argillite, quartz-biotite hornfels, green thin-bedded calc-silicate hornfels, pink to white quartzite, local quartzite breccia, dolomite marble breccia, and metasilstone (possibly in part older than Carboniferous). Tule Lake Limestone—white and blue gray, massive and thin-bedded, calcite and dolomite marble, minor pink calc-silicate hornfels, dark-gray micaceous phyllite, and gray to white quartzite.
		P	PALEOZOIC MARINE SEDIMENTARY AND METASEDIMENTARY ROCKS	Sarasoga Quartzite—light-gray to white, massive, cross-bedded, vitreous quartzite, dark-gray phyllite, and dark-gray fine-grained schist. Chicopee Canyon Formation—white, cross-bedded and ripple-marked, thin-bedded, micaceous quartzite and calc-silicate hornfels (mapped as part of Sarasoga Quartzite by T. W. Dibble, Jr., ref. no. 12b). Unnamed gray, white, and pink quartzite, gray-brown massive metaconglomerate, pink to green hornfels, and black fine-grained schist in Mojave Desert.
	Paleozoic	Is	LIMESTONE AND/OR DOLOMITE	White calcite and dolomite marble, green to red-brown tactite, minor graphitic and micaceous schist.
		gr-m	PRE-CENOZOIC GRANITIC AND METAMORPHIC ROCKS	Injection gneiss, granitic gneiss intruded by pegmatite and aplite, and gneissic hornblende diorite in Barstow area (possibly Paleozoic). Migmatites of biotite quartz monzonite south of Lucerne Valley (probably Mesozoic). Granite-migmatite complex near Broadwell Lake (probably Mesozoic, possibly older).
		mv	PRE-CRETACEOUS METAVOLCANIC ROCKS	Hodge Volcanic Formation—dark-colored quartz latite and dacite, light-colored, commonly schistose, tuffaceous metasedimentary and metavolcanic rocks including gray biotite schist, red-brown massive metabasalt, and white to pink quartzite (older than the Sidewinder Volcanic "Series" according to O. E. Bowen (ref. no. 2)). Unnamed gray massive metavolcanic rocks in Cady Mountains.
		ms	PRE-CRETACEOUS METASEDIMENTARY ROCKS	San Antonio Canyon Group—quartzite, thin-bedded graphitic schists, dark-colored gneiss, and light-colored migmatite (San Gabriel Mountains). Unnamed quartzitic schist, quartz-biotite hornfels, calc-silicate hornfels, and calcite marble.
		m	PRE-CRETACEOUS METAMORPHIC ROCKS, UNDIFFERENTIATED	Pelona Schist—gray and green feldspar-quartz-mica schist, massive amphibolite, minor thin quartzite, and piemontite-bearing metachert (age uncertain and in dispute; believed to be Mesozoic by some geologists and as old as Precambrian by others). Light-colored schistose to gneissic granitic rocks near Victorville. Mylonite, mylonite gneiss, mylonite schist, granite cataclasis, flaser gneiss, cataclastic quartz diorite gneiss, and cataclastic metasediments in San Gabriel and San Bernardino Mountains.
		Is	LIMESTONE AND/OR DOLOMITE	Light-colored marble, associated tactite and skarn.
		pCc	PRECAMBRIAN IGNEOUS AND METAMORPHIC ROCK COMPLEX:	San Gabriel Complex <sup>9</sup> —hornblende, biotite, quartz, feldspar gneiss-migmatite complex, transected by dikes of amphibolite, aplite, pegmatite, and semi-concordant bodies of quartz diorite. San Geronio Igneous-Metamorphic Complex <sup>10</sup> —migmatite-gneiss, flaser gneiss, piemontite-bearing gneiss, and green schist, pervasively intruded by quartz monzonite and associated pegmatite. Cucamonga Complex <sup>11</sup> —quartz diorite gneiss, paragneiss, graphitic marble, quartz monzonite mylonite, pegmatite. Unnamed gray banded gneiss cut by abundant granitic rocks and locally sheared and folded (Little San Bernardino Mountains and Mojave Desert).
		pC	UNDIVIDED PRECAMBRIAN METAMORPHIC ROCKS:	
			UNDIFFERENTIATED	Tar to gray vitreous quartzite <sup>12</sup> in Mill Creek Canyon.
		pCs	SCHIST	Gray, black, and green, fine- to medium-grained schist in the Mojave Desert (age uncertain).
		pCg	GNEISS	Pinto Gneiss <sup>13</sup> —dark-colored, strongly foliated, quartz-biotite gneiss (Twenty-nine Palms area). Baldwin Gneiss <sup>14</sup> —fine-grained gneiss and schist, augen gneiss, and granitic gneiss. Waterman Gneiss <sup>15</sup> —dark-colored hornblende-feldspar-mica gneiss, local diorite and pegmatite dikes, marble, and quartzite (rocks shown as pCg <sup>1</sup> in the Barstow area may be Paleozoic). Unnamed dark-gray, banded, quartz diorite gneiss and augen gneiss, light-gray granitic gneiss, minor gray and green schist, amphibolite, and marble, local thin cataclastic zones, tight folds, and intrusive granitic rocks <sup>16</sup> .
	Precambrian			

NOTES

- <sup>1</sup> The 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 has abandoned the name Pico, and for the Los Angeles basin assigns these rocks to the Upper Member of the Fernando Formation (Durham, D. L. and Yerkes, R. F., 1964, U. S. Geol. Survey Prof. Paper 420-B).
- <sup>2</sup> The "Repetto" is defined and properly used only as a stage designation. The U. S. Geological Survey has abandoned the name "Repetto Formation" and assigns these rocks to the "Lower Member of the Fernando Formation" (Durham, D. L. and Yerkes, R. F., 1964, U. S. Geol. Survey Prof. Paper 420-B).
- <sup>3</sup> R. E. Smith, Geology of the Mill Creek area, San Bernardino County, California, University California, Los Angeles, unpublished M.A. thesis, 1919.
- <sup>4</sup> No fossils have been reported from these rocks; Pliocene age is based on stratigraphic position.
- <sup>5</sup> Radiometric age dates (K/A) of 17 ± 5 m.y. and 26 ± 3 m.y. are reported by K. J. Hsu (1963) Geol. Soc. America Bull., v. 74, pp. 507-512.
- <sup>6</sup> Radiometric age date (K/A) of 27.5 ± 2.5 m.y. is reported by R. Streitz (1964), ref. no. 35.
- <sup>7</sup> Radiometric age date (Pb<sup>206</sup>/U<sup>238</sup>) of 245 ± 10 m.y. determined by L. T. Silver, 1968, Preliminary history for the crystalline complex of the central Transverse Ranges, Los Angeles County, California: Geol. Soc. Amer. Spec. Paper No. 101 (abstract), p. 201-202. Subsequent determinations indicate the age of these rocks is younger and may be Triassic—L. T. Silver, oral communication 5/1968.
- <sup>8</sup> The age of some of these rocks is uncertain and actually may be younger than Precambrian.



TOPOGRAPHIC QUADRANGLES  
WITHIN THE NEEDLES SHEET  
AVAILABLE FROM THE U.S. GEOLOGICAL SURVEY  
FEDERAL CENTER, DENVER, COLORADO 80225  
1963



View northwest of Amboy Crater, a very recent cone composed of volcanic ejecta, surrounded by dark basaltic flow rocks. A thin veneer of wind blown sand gives the basalt a light appearance; thicker sand deposits are white. The Bristol Mountains, composed of dark Precambrian complex rocks and lighter granitic rocks are seen in the upper right, with the Granite Mountains on the skyline behind. The Lava Hills, in the upper left, are composed of Tertiary volcanic rocks underlain by Mesozoic granitic rocks and pre-Cenozoic granitic and metamorphic rocks. Photo by R. C. Frampton and J. S. Shelton, Claremont, California.

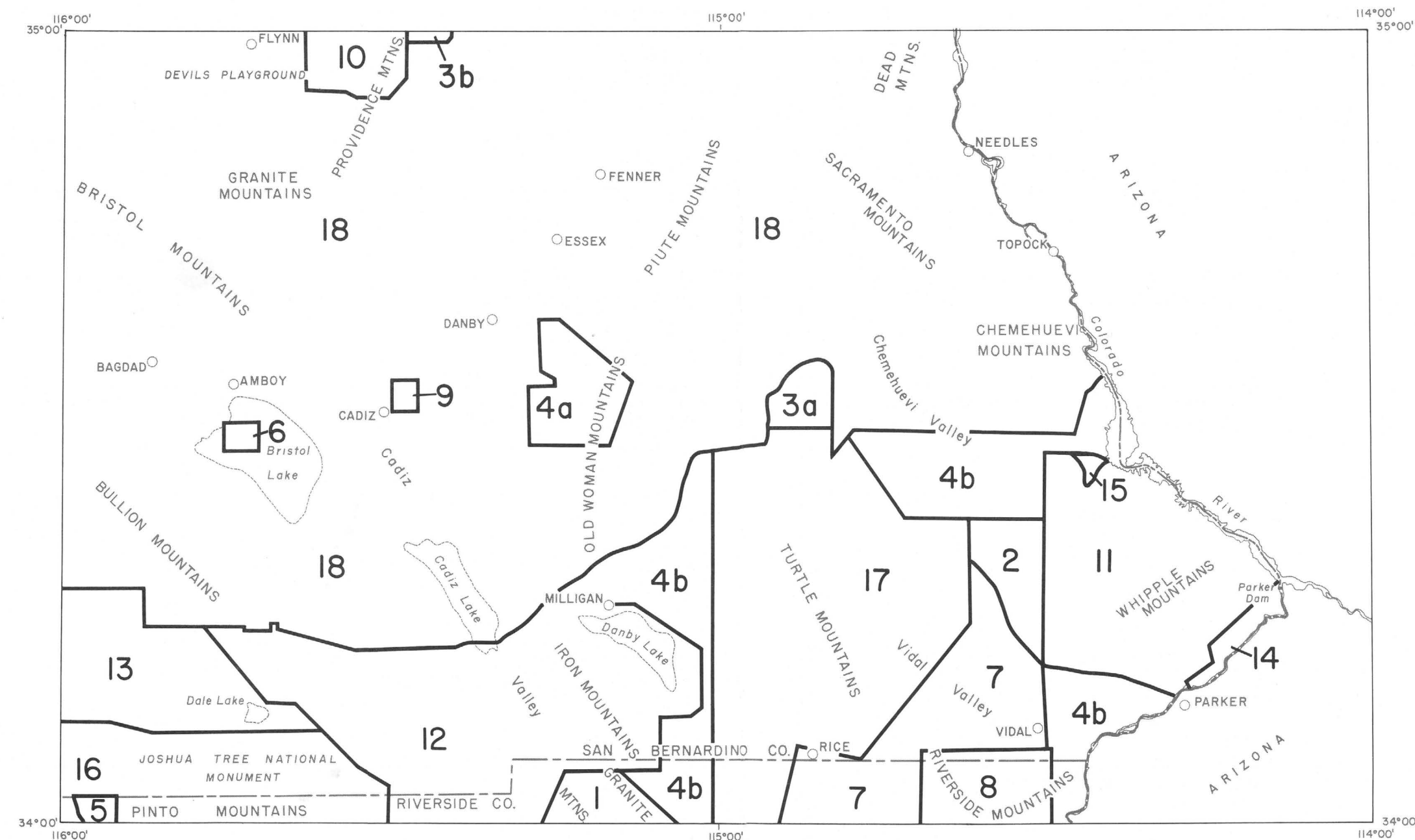
DIVISION OF MINES AND GEOLOGY  
Ian Campbell, State Geologist

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

DEPARTMENT OF CONSERVATION  
DeWitt Nelson, Director

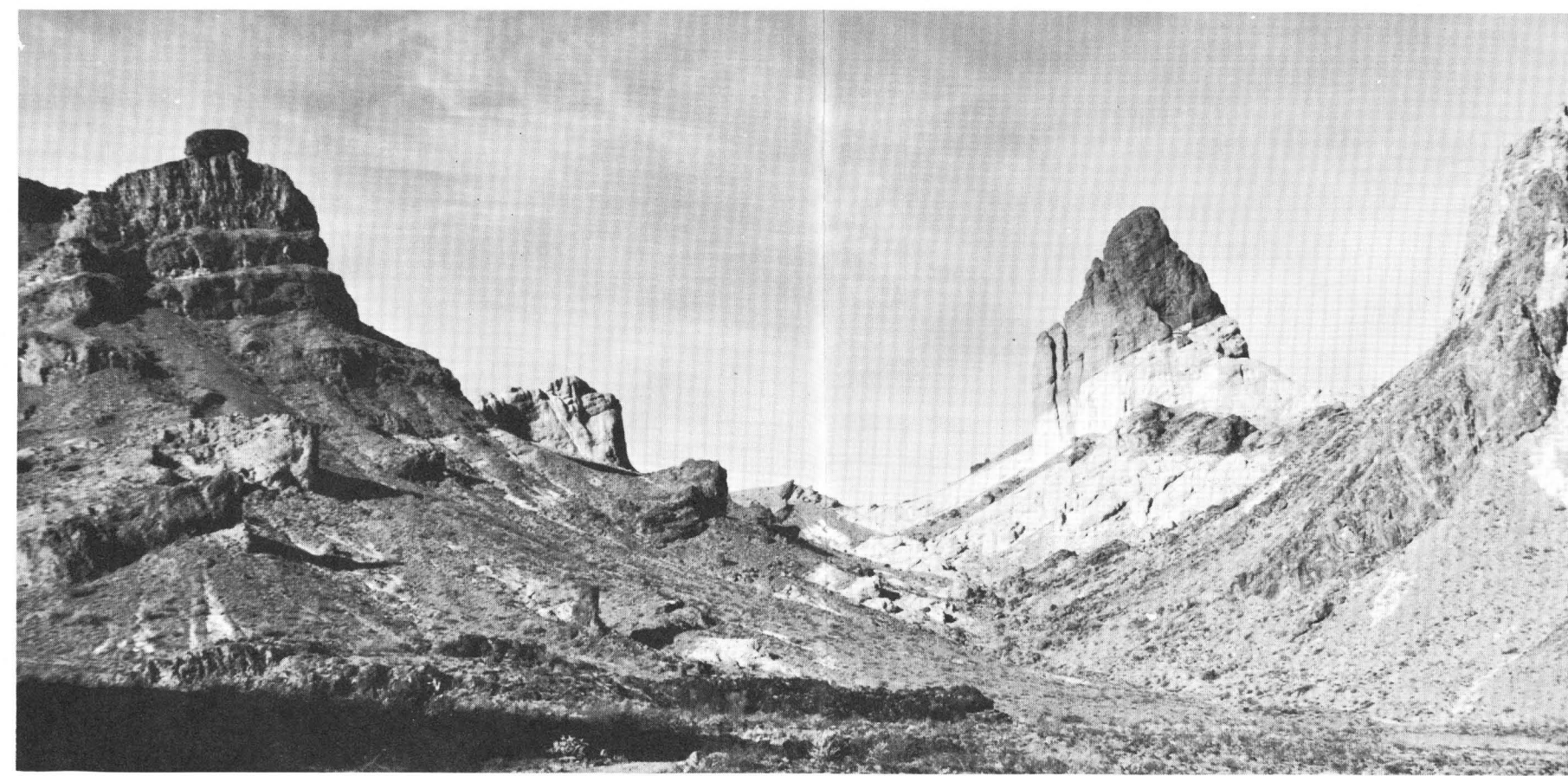
EXPLANATORY DATA  
NEEDLES SHEET  
GEOLOGIC MAP OF CALIFORNIA  
OLAF P. JENKINS EDITION  
Compiled by Charles C. Bishop, 1963

INDEX TO GEOLOGIC MAPPING  
USED IN THE COMPILATION OF THE  
NEEDLES SHEET



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



View west from Coffin Spring in the northern part of the Turtle Mountains showing typical exposures of Tertiary volcanic rocks. Light colored pyroclastic material is interbedded with darker andesitic flow rocks. Photo by Richard B. Saul, 1963



STRATIGRAPHIC NOMENCLATURE—NEEDLES SHEET			
AGE	STATE MAP SYMBOL	STATE MAP UNIT <small>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</small>	STRATIGRAPHIC UNITS AND CHARACTERISTIC LITHOLOGIES <small>(The formally named formations grouped within an individual State Map Unit are listed in stratigraphic sequence from youngest to oldest.)</small>
CENOZOIC	QUATERNARY	Recent	
		Qs	RECENT DUNE SAND
		*	QUATERNARY CINDER CONES
		Qrvb	RECENT VOLCANIC ROCKS: BASALTIC
		Qal	RECENT ALLUVIUM
	PLEISTOCENE	Qst	QUATERNARY SALT DEPOSITS
		Ql	QUATERNARY LAKE DEPOSITS
		Qc	PLEISTOCENE NONMARINE SEDIMENTARY DEPOSITS
		Qpvb	PLEISTOCENE VOLCANIC ROCKS: BASALTIC
		Qpvp	PYROCLASTIC
	PLIOCENE	QP	PLIOCENE-PLEISTOCENE NONMARINE SEDIMENTARY DEPOSITS
		Mv	MIocene VOLCANIC ROCKS: UNDIFFERENTIATED
		Mva	ANDESITIC
		Mvb	BASALTIC
		Mvp	PYROCLASTIC
	TERTIARY	Tc	TERTIARY NONMARINE SEDIMENTARY ROCKS
		Tjr	RHYOLITIC
		Tjo	ANDESITIC
		Tv	TERTIARY VOLCANIC ROCKS: UNDIFFERENTIATED
		Tva	ANDESITIC
MESOZOIC	CRETACEOUS	Tvb	BASALTIC
		Tvp	PYROCLASTIC
		gr	MESOZOIC GRANITIC ROCKS: UNDIFFERENTIATED
		gra	ADAMELLITE (QUARTZ MONZONITE)
		grf	TONALITE (QUARTZ DIORITE)
	JURASSIC	bi	MESOZOIC BASIC INTRUSIVE ROCKS
		Jrv	JURASSIC AND/OR TRIASSIC METAVOLCANIC ROCKS
		R	TRIASSIC MARINE SEDIMENTARY AND METASEDIMENTARY ROCKS

STRATIGRAPHIC NOMENCLATURE—Continued			
AGE	STATE MAP SYMBOL	STATE MAP UNIT <small>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</small>	STRATIGRAPHIC UNITS AND CHARACTERISTIC LITHOLOGIES <small>(The formally named formations grouped within an individual State Map Unit are listed in stratigraphic sequence from youngest to oldest.)</small>
MESOZOIC	UNDIVIDED	ls	PRE-CRETACEOUS METAMORPHIC ROCKS: UNDIFFERENTIATED ls = LIMESTONE AND/OR DOLOMITE
		ms	PRE-CRETACEOUS METASEDIMENTARY ROCKS
		mv	PRE-CRETACEOUS METAVOLCANIC ROCKS
		gr-m	PRE-CENOZOIC GRANITIC AND METAMORPHIC ROCKS
		IP IP ls	PALEOZOIC MARINE SEDIMENTARY AND METASEDIMENTARY ROCKS ls = LIMESTONE
	PERMIAN	Rm	PERMIAN MARINE SEDIMENTARY AND METASEDIMENTARY ROCKS
		CP	PENNSYLVANIAN MARINE SEDIMENTARY AND METASEDIMENTARY ROCKS
		CM	MISSISSIPPIAN MARINE SEDIMENTARY AND METASEDIMENTARY ROCKS
		D	DEVONIAN MARINE SEDIMENTARY AND METASEDIMENTARY ROCKS
		E	CAMBRIAN MARINE SEDIMENTARY AND METASEDIMENTARY ROCKS
	CARBONIFEROUS	pE	UNDIVIDED PRECAMBRIAN METAMORPHIC ROCKS: UNDIFFERENTIATED
		pEs	SCHIST
		pEg	GNEISS
		pEgr	UNDIVIDED PRECAMBRIAN GRANITIC ROCKS
		pEc	PRECAMBRIAN IGNEOUS AND METAMORPHIC ROCK COMPLEX
	DEVONIAN	epE	EARLIER PRECAMBRIAN METAMORPHIC ROCKS
PRECAMBRIAN	CAMBRIAN		
	UNDIVIDED		

NOTES

1. Fossil vertebrates found in the Sacramento Mountains are of a fairly primitive species of *Merychippus* and are probably middle Miocene according to John F. Lance, personal communication 12/18/1963.

2. Radiometric dates of granite rocks from the following areas indicate:  
*Marble Mountains* (central part)  
165 million years (minimum), Pb<sup>206</sup>/U<sup>238</sup>, L. T. Silver, personal communication, 2/5/1964.  
*Ship Mountains*  
170 million years (minimum), Pb<sup>206</sup>/U<sup>238</sup>, L. T. Silver, personal communication, 2/5/1964.  
*Pinto Mountains*  
70.3 million years (± 3.0 m.y.), K/A, Geochron Laboratories, for Calif. Div. Mines and Geology, Sept. 1963.  
*West Riverside Mountains*  
98.5 million years (± 4.0 m.y.), K/A, Geochron Laboratories, for Calif. Div. Mines and Geology, Sept. 1963.  
*Pinto Mountains*  
163 million years (± 7 m.y.), K/A, Geochron Laboratories, for Calif. Div. Mines and Geology, Oct. 1963.

3. The age of some of these rocks is uncertain and actually may be younger than Precambrian.

4. Radiometric dates of granitic rocks from the following area indicate:  
*Marble Mountains* (southern part)  
1410 million years (± 20 m.y.), Pb<sup>206</sup>/U<sup>238</sup>, Silver, L. T. and McKinney, C. R., 1963, U/Pb isotopic age studies of a Precambrian granite, Marble Mountains: Geol. Soc. Amer. Spec. Papers, No. 73 (1962 meetings), p. 65 (abstract).  
1250 million years (± 20 m.y.), K/A, and 1300 million years (± 10 m.y.), Rb-Sr, Lanphere, M. A., 1964, Geochronologic studies in the eastern Mojave Desert, California: Jour. Geol., in press.  
1190 million years (± 20 m.y.), K/A, and 1215 million years (± 10 m.y.), Rb-Sr, Lanphere, M. A., 1964, Geochronologic studies in the eastern Mojave Desert, California: Jour. Geol., in press.  
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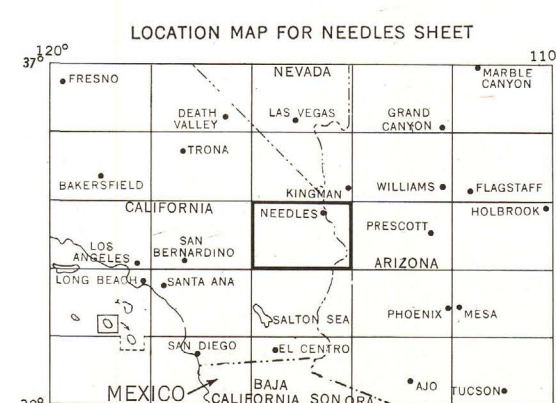


SEDIMENTARY AND METASEDIMENTARY ROCKS

IGNEOUS AND META-IGNEOUS ROCKS

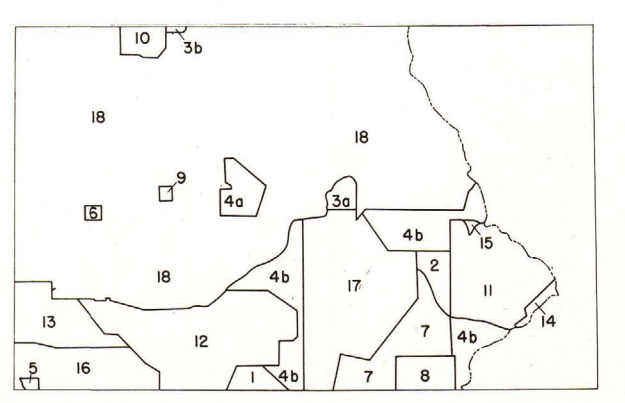
QUATERNARY		Recent	Pleistocene	Pliocene	Miocene	Oligocene	Eocene	Paleocene	Undivided	Cretaceous	Jurassic	Triassic	Undivided	Permian	Carboniferous	Devonian	Silurian	Ordovician	Cambrian	Precambrian
Qs	Dune sand																			
Qal	Alluvium																			
Qsc	Stream channel deposits																			
Qf	Fan deposits																			
Qb	Basin deposits																			
Qh	Salt deposits																			
Ql	Quaternary lake deposits																			
Qd	Glacial deposits																			
Qm	Quaternary nonmarine terrace deposits																			
Qp	Pleistocene marine and marine terrace deposits																			
Qc	Pleistocene nonmarine																			
Qp	Plio-Pleistocene nonmarine																			
Pc	Undivided Pliocene nonmarine																			
Pu	Upper Pliocene nonmarine																			
Pv	Upper Pliocene marine																			
Pm	Middle and/or lower Pliocene nonmarine																			
Pm	Middle and/or lower Pliocene marine																			
Mu	Undivided Miocene nonmarine																			
Mu	Upper Miocene nonmarine																			
Mu	Upper Miocene marine																			
Mm	Middle Miocene nonmarine																			
Mm	Middle Miocene marine																			
Mo	Lower Miocene marine																			
Ou	Oligocene nonmarine																			
Om	Oligocene marine																			
Eu	Eocene nonmarine																			
Em	Eocene marine																			
Pe	Paleocene nonmarine																			
Pm	Paleocene marine																			
Cu	Cenozoic nonmarine																			
Cu	Cenozoic marine																			
Tu	Tertiary nonmarine																			
Tu	Tertiary lake deposits																			
Tu	Tertiary marine																			
Uc	Undivided Cretaceous marine																			
Uc	Upper Cretaceous marine																			
Lc	Lower Cretaceous marine																			
Ju	Jurassic marine																			
Ju	Upper Jurassic marine																			
Ju	Middle and/or Lower Jurassic marine																			
Tr	Triassic marine																			
Pr	Pre-Cretaceous metamorphic rocks (ls = limestone or dolomite)																			
Pr	Pre-Cretaceous metasedimentary rocks																			
Pm	Paleozoic marine (ls = limestone or dolomite)																			
Pm	Paleozoic metamorphic rocks																			
Pm	Permian marine																			
Pm	Undivided Carboniferous marine																			
Pm	Pennsylvanian marine																			
Pm	Mississippian marine																			
Pm	Devonian marine																			
Pm	Silurian marine																			
Pm	Pre-Silurian metamorphic rocks																			
Pm	Ordovician marine																			
Pm	Cambrian marine																			
Pm	Cambrian - Precambrian marine																			
Pm	Undivided Precambrian metamorphic rocks																			
Pm	Later Precambrian sedimentary and metamorphic rocks																			
Pm	Earlier Precambrian metamorphic rocks																			
Pm	Precambrian igneous and metamorphic rock complex																			
Pm	Undivided Precambrian granitic rocks																			

TOPOGRAPHIC BASE MAP  
Prepared by the Army Map Service (KGBM), Corps of Engineers, U. S. Army, Washington, D. C. Compiled in 1957 by U. S. Coast & Geodetic Survey by photogrammetric methods and from United States Quadrangle maps, 1:24,000, 1:50,000, 1:62,000, USGS and AMS, 1947-1954. Metropolitan Water District, 1:120,000, California, Sheet 69, 1929. Planimetric detail revised by photogrammetric methods. Horizontal and vertical control by USC&GS, USGS, and CE. Photography field annotated 1956.  
Land not prepared by U. S. Geological Survey  
Minor corrections and additions to culture by California Division of Mines and Geology, 1963



Contact  
Dashed where approximately located,  
gradational or inferred  
Fault  
Dashed where approximately located;  
dotted where concealed  
Thrust fault  
Dashed on upper plate; dashed where  
approximately located; dotted where  
concealed  
(Verrebrasse fossil locality)  
(Radiometric age determination)

Scale 1:250,000  
CONTOUR INTERVAL 200 FEET  
TRANSVERSE MERCATOR PROJECTION  
GEOLOGIC MAP OF CALIFORNIA  
OLAF P. JENKINS EDITION  
NEEDLES SHEET  
COMPILATION BY CHARLES C. BISHOP, 1963



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HEAVY BORDER ON BOXES INDICATES UNITS THAT APPEAR ON THIS SHEET