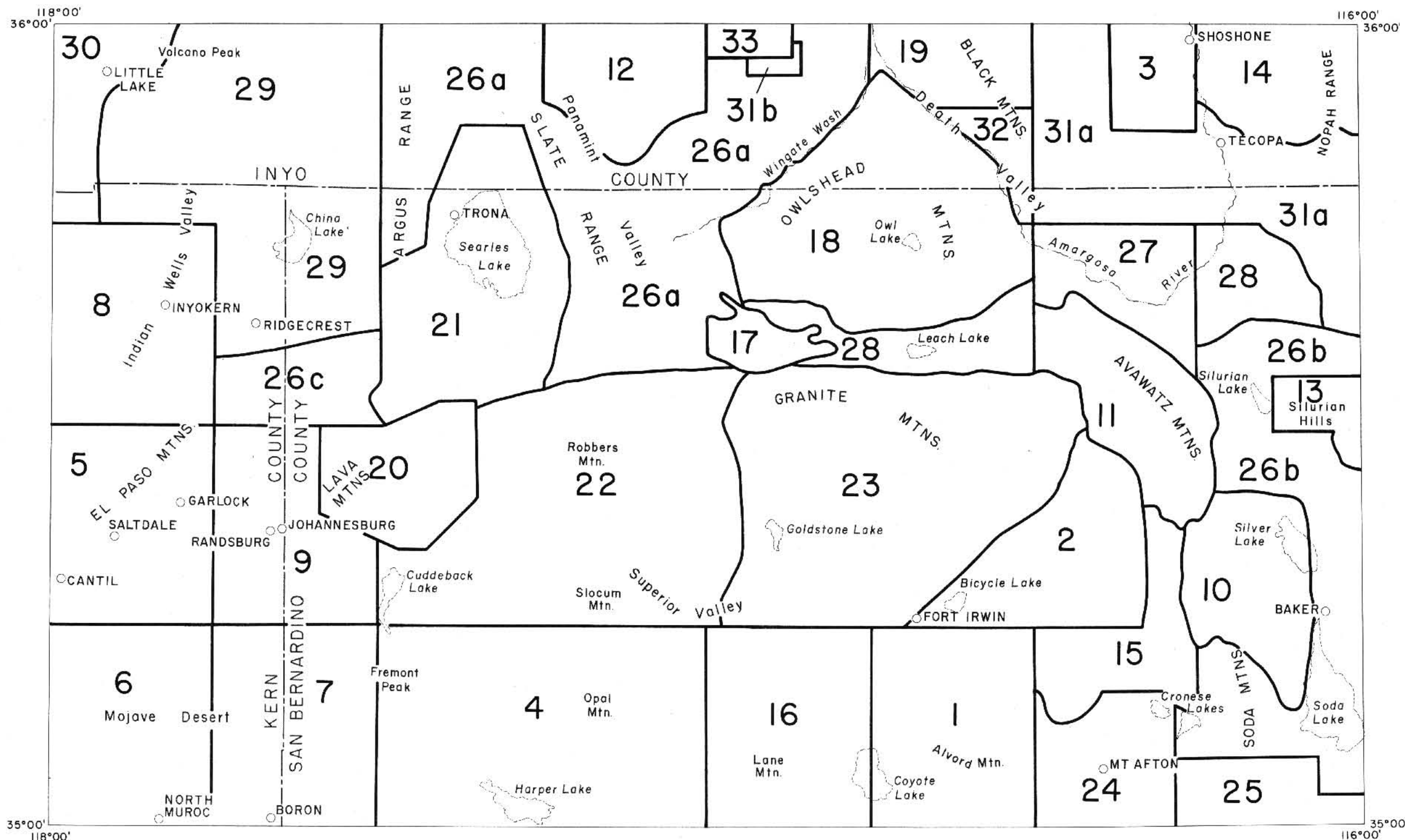


EXPLANATORY DATA
TRONA SHEET
GEOLOGIC MAP OF CALIFORNIA
OLAF P. JENKINS EDITION

Compiled by Charles W. Jennings, John L. Burnett, and Bennie W. Troxel, 1962

(Third Printing, 1975)

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



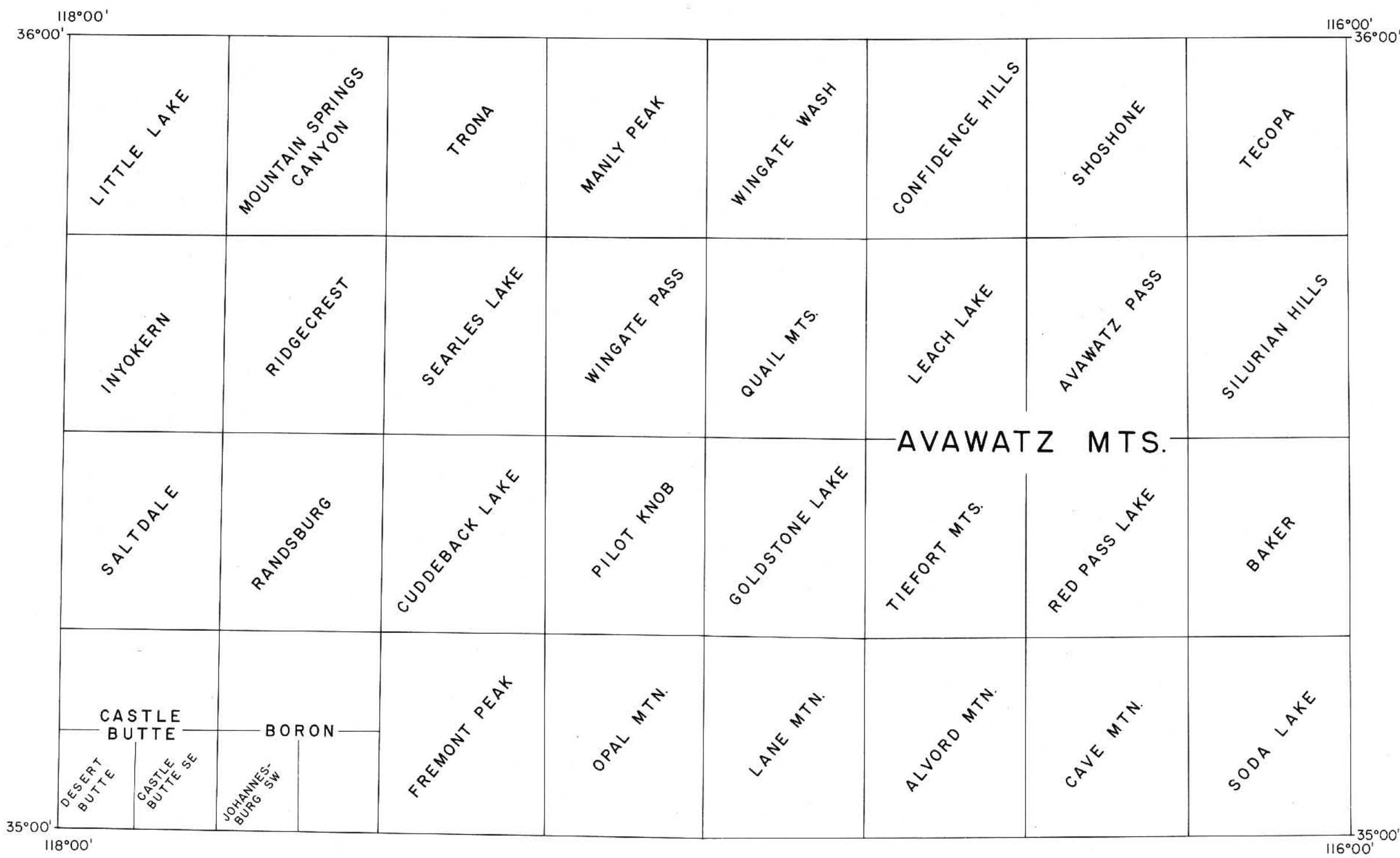
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3. Chesterman, C. W., Geologic map of the northeastern quarter of the Shoshone quadrangle, California, scale 1:15,840, California Div. Mines and Geology work in progress, 1960.
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10. Dibblee, T. W., Jr., Geologic map of the Randsburg quadrangle, California, scale 1:62,500, unpublished, 1958 (compiled, field checked and modified by T. W. Dibblee after: D. M. Lemmon and J. F. N. Dorr, 1940, U. S. Geol. Survey Bull. 922-H, pl. 35; D. L. Gardner, unpublished data, T. W. Dibblee, Jr., 1952, California Div. Mines Bull. 160, fig. 3; C. D. Hullin, 1925, California Div. Mines Bull. 95, pl. 1). (Additional data added by D. L. Gardner and by B. W. Troxel, 1961.)
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15. Kupfer, D. H., Structural geology of the Silurian Hills, San Bernardino County, California, scale 1:24,000, Yale University, Ph.D. thesis, 1951 (southeast portion of thesis map unpublished).
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17. McAllister, J. F., Reconnaissance geologic map of parts of the Red Pass Lake and Cave Mountain quadrangles, California, scale 1:62,500, U. S. Geol. Survey unpublished mapping, 1953. (Modified locally by B. W. Troxel and C. H. Gray, Jr., 1962.)
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19. Muehlberger, W. R., 1954, Geology of the Quail Mountains, San Bernardino County; California Div. Mines Bull. 170, Map Sheet 16, scale 1:48,000.
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24. Haines, D. V., 1959, Core logs from Searles Lake, San Bernardino County, California; U. S. Geol. Survey Bull. 1045-F, pp. 139-317, fig. 6. Index map of Searles Lake, San Bernardino County, California, scale approximately 1:145,000.
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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.

STRATIGRAPHIC NOMENCLATURE— TRONA 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 Dune sand and other windblown sand deposits.
			Qal RECENT ALLUVIUM Alluvium. Alluvial fan deposits. Includes dissected alluvium of probable Pleistocene age in some areas.
		Pleistocene	Qst QUATERNARY SALT DEPOSITS Mostly deposits of sodium chloride; some sodium sulphate on surface of Searles Lake.
			Ql QUATERNARY LAKE DEPOSITS Clay, silt, and fine sand of lake beds. Recent playas and mud flats exposed in the central parts of basins (mostly undissected); Pleistocene deposits exposed around edges of basins (mostly dissected)—chiefly Manix Lake beds in the Alvord Mountain quadrangle and Searles Lake deposits in the Searles Lake, Trona, and Wingate Pass quadrangles. Includes some tufa masses around Searles Lake.
			Qc PLEISTOCENE NONMARINE SEDIMENTARY DEPOSITS Older alluvium. Dissected alluvium and terrace gravels.
	Pliocene	Pliocene	Qpv ^r Qpv ^a Qpv ^b Qvp ^p PLEISTOCENE VOLCANIC ROCKS: RHYOLITIC ANDESITIC BASALTIC PYROCLASTIC Rhyolite flows and cones in the Little Lake quadrangle. Andesite sills, dikes, plugs, and some flows (Lava Mountains). Intrusive plugs of dark gray to red andesite (Panamint Valley). Black Mountain Basalt. Unnamed basalts (some of which may be older or younger than Pleistocene). Basaltic cinders (Cinder Hill northwest of Confidence Hills).
			QP PLIOCENE-PLEISTOCENE NONMARINE SEDIMENTARY DEPOSITS Funeral Fanglomerate— <i>fanglomerate with interbedded basalt flows and fine-grained sedimentary rocks</i> and China Ranch Beds— <i>fanglomerate and siltstone</i> (Tecopa area). Muehlberger's "Upper sedimentary sequence"— <i>silt and sand</i> (Quail Mountains). Sedimentary breccia, granitic gravel, and andesite gravel (Alvord Mountain quadrangle). Unnamed gravels probably correlative with the Funeral Fanglomerate. Deformed and uplifted lake and alluvial deposits in the Searles Lake, Wingate Wash, Trona, and Manly Peak quadrangles. Dibblee's member 8 of the Ricardo Formation.
			* QUATERNARY AND/OR PLIOCENE CINDER CONES Pleistocene cinder cones.
			Pc UNDIVIDED PLIOCENE NONMARINE SEDIMENTARY ROCKS Sedimentary rocks of fluvial and lacustrine origin (upper part of the Tropic Group) in the Boron area (Pliocene age uncertain). Arkosic pebbly sandstone in the Summit Diggings area (Randsburg quadrangle).
			Pmlc MIDDLE AND/OR LOWER PLIOCENE NONMARINE SEDIMENTARY ROCKS Ricardo Formation— <i>sandstone, conglomerate, volcanic and granitic gravels, tuff breccia, ash and bentonite</i> (El Paso Mountains and Boron area); arkosic sandstone, conglomerate, siltstone, tuff, and volcanic breccia in the Randsburg, Cuddeback Lake and Searles Lake quadrangles.
	Miocene	Miocene	Pv ^r Pv ^a Pv ^b Pvp ^p PLIOCENE VOLCANIC ROCKS: RHYOLITIC ANDESITIC BASALTIC PYROCLASTIC Rhyolite and dacite flows and intrusive rocks. Andesite and latite flows within the Ricardo Formation. Andesite and latite flows (Lane Mountain quadrangle). Andesite flows and flow breccias, some volcanic domes and necks (Lava Mountains). Basalt flows within the Ricardo Formation and the Funeral Fanglomerate. Saddleback Basalt— <i>basalt flows</i> . Unnamed basaltic flows. Tuffs, volcanic breccias, some massive volcanic rocks intrusive into breccias, some sandstone beds (Lava Mountains). Rhyolitic tuff breccia and tuffaceous sediments (Alvord Mountain quadrangle).
			Mc UNDIVIDED MIOCENE NONMARINE SEDIMENTARY ROCKS Sedimentary rock portion of the Tropic Group— <i>Moderately consolidated sedimentary and pyroclastic rocks, limestone, conglomerate, sandstone, shale, and chert</i> (Castle Butte and Boron quadrangles). Unnamed Miocene conglomerate in the Cave Mountain quadrangle. Sedimentary rocks of the "Jubilee chaos" (Virgin Springs area).
			Muc UPPER MIOCENE NONMARINE SEDIMENTARY ROCKS Barstow Formation— <i>fanglomerate, sandstone, arkosic sandstone, conglomerate with minor tuff, limestone, basalt and andesite</i> (middle Miocene in part).
			Mmc MIDDLE MIOCENE NONMARINE SEDIMENTARY ROCKS Clews Fanglomerate— <i>reddish-brown fanglomerate with a lower bentonitic sandstone and siltstone unit and an upper arkosic sandstone and tuff unit</i> (Alvord Mountain quadrangle). Granitic and dacitic breccia (Lane Mountain quadrangle). Granitic conglomerate and granitic and rhyolitic breccia (Opal Mountain quadrangle).
			Mv Mv ^r Mv ^a Mv ^b Mvp ^p MIOCENE VOLCANIC ROCKS: RHYOLITIC ANDESITIC BASALTIC PYROCLASTIC Undifferentiated volcanic rocks. Rhyolite flows, tuff and perlite. Andesite and dacite. Andesitic breccia and dacite of the Tropic Group. Basalt flows in the Barstow Formation; Alvord Peak Basalt— <i>nonporphyritic basalt</i> . Unnamed basalt flows. Spanish Canyon Formation— <i>tuff and tuffaceous sandstone with two olivine basalt flows and interbedded arkosic sandstone</i> (Alvord Mountain quadrangle). Tuff and tuff breccia of the Tropic Group. Unnamed tuff, tuff breccia, and agglomerate.
	Tertiary	Oligocene	Φc OLIGOCENE NONMARINE SEDIMENTARY ROCKS Conglomerate, sandstone, minor fine-grained sedimentary rocks, and limestone of probable Oligocene age (Shoshone quadrangle).
			Φv Φv ^a OLIGOCENE VOLCANIC ROCKS: UNDIFFERENTIATED ANDESITIC Volcanic flows and pyroclastic rocks of probable Oligocene age (Shoshone quadrangle). Andesite flows and coarse pyroclastic rocks of probable Oligocene age (Avawatz Pass quadrangle)
		Paleocene	Epc PALEOCENE NONMARINE SEDIMENTARY ROCKS Goler Formation ¹ — <i>arkosic sandstone and conglomerate</i> .
			Tc TERTIARY NONMARINE SEDIMENTARY ROCKS Avawatz Formation— <i>siltstone, sandstone, fanglomerate, and breccia</i> (early Pliocene and Miocene age; includes rocks which may be as old as Oligocene). Undifferentiated detrital sedimentary rocks and evaporite rocks in the Quail Mountains, Leach Lake, and Confidence Hills quadrangles. Monolithologic breccias which formed during the Tertiary; includes small klippe of Precambrian rock at Bitter Spring (D. F. Hewett, personal communication, 1962). Muehlberger's "Middle and Lower sedimentary sequences"— <i>siltstone, sandstone, conglomerate, tuff, and agglomerate</i> in the Quail Mountains. Elsewhere includes undivided Tertiary sedimentary rocks.
		Undivided	Ti Ti ^r Ti ^a Tib TERTIARY INTRUSIVE (HYPABYSSAL) ROCKS: UNDIFFERENTIATED RHYOLITIC ANDESITIC BASALTIC Intrusive volcanic rocks and very fine-grained plutonic rocks. Rhyolite and dacite intrusive rocks and volcanic flows. Andesite and latite dikes and plugs. Basalt intrusive rocks (Salt Lake quadrangle).
			Tv Tv ^r Tv ^a Tv ^b Tvp ^p TERTIARY VOLCANIC ROCKS: UNDIFFERENTIATED RHYOLITIC ANDESITIC BASALTIC PYROCLASTIC Volcanic flows, some volcanic necks, dikes, and pyroclastic rocks. Rhyolite and dacite flows, some plugs and dikes. Andesite, and latite flows, some plugs and dikes. Basalt flows, some plugs and dikes. Tuff and volcanic breccia.

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	UNDIVIDED	QTc	CENOZOIC NONMARINE SEDIMENTARY ROCKS	Undivided nonmarine Cenozoic sedimentary rocks.	
		QTV QTV ^a QTV ^b QTV ^p	CENOZOIC VOLCANIC ROCKS: UNDIFFERENTIATED ANDESITIC BASALTIC PYROCLASTIC	Cenozoic flows, volcanic necks, dikes, and pyroclastic rocks. Andesite. Basalt. Pyroclastic rocks and tuff.	
		gr	MESOZOIC GRANITIC ROCKS	Mainly undivided granitic rocks, but including Teutonia and Atolia Quartz Monzonites, granite, quartz diorite, quartz monzonite, granodiorite, hornblende diorite, pegmatite, aplite, granophyre, and gneissic granite. gr? = Mesozoic (?) hypabyssal rocks, largely porphyritic (Searles Lake quadrangle).	
	UNDIVIDED	bi	MESOZOIC BASIC INTRUSIVE ROCKS	Hornblende diorite and gabbro in the Inyokern quadrangle. Amphibolite of probable uralitized pyroxenite origin (Alvord Mountain quadrangle). Hornblende diorite (Opal Mountain, Fremont Peak and Castle Butte quadrangles). Diorite-gabbro (Lane Mountain quadrangle).	
		JRv	JURASSIC AND/OR TRIASSIC METAVOLCANIC ROCKS	Upper member of the Warm Spring Formation ² — <i>andesite flows</i> . Volcanic part of the Soda Mountain Formation ² — <i>meta-andesite flow breccia, quartzite, sandstone, and minor pyroclastic rocks</i> . Rhyolite intrusive rocks, andesite, diorite and granodiorite dikes in the Manly Peak quadrangle. Undifferentiated types of metavolcanic and associated metasedimentary rocks in the Avawatz Mountains and in the area west and south.	
	JURASSIC	R	TRIASSIC MARINE SEDIMENTARY AND METASEDIMENTARY ROCKS	Upper member of the Soda Mountain Formation— <i>quartzite, sandstone and minor pyroclastic rocks</i> (probable Triassic-Jurassic age); Lower member of the Warm Spring Formation— <i>limestone breccia</i> ; Butte Valley Formation— <i>calc-silicate hornfels</i> . Unnamed Lower Triassic sedimentary rocks (Soda Mountains area).	
		m ls	PRE-CRETACEOUS METAMORPHIC ROCKS, UNDIFFERENTIATED, ls = LIMESTONE AND/OR DOLOMITE	Quartz-feldspar gneisses and mica schists intruded by granitic dikes (Alvord Mountain quadrangle). Locally unnamed and undifferentiated metamorphic rocks. Includes rocks of possible early Tertiary age in the Leach Lake quadrangle. Coarsely crystalline limestone, dolomite, and tactite.	
	TRIASSIC	ms	PRE-CRETACEOUS METASEDIMENTARY ROCKS	Kernville Series— <i>mica schist, minor quartzite, hornfels, and limestone</i> (Inyokern quadrangle). Quartzite conglomerate and hornfels (Salt-dale quadrangle). Hornfels, quartzite, and conglomerate (Lane Mountain quadrangle). Limestone, siliceous limestone, slate and phyllite in the Lava Mountains.	
		mv	PRE-CRETACEOUS METAVOLCANIC ROCKS	Metamorphosed quartz latite in the Boron quadrangle. Locally unnamed pre-Cretaceous metavolcanic rocks.	
	PALEOZOIC	UNDIVIDED	gr-m	PRE-CENOZOIC GRANITIC AND METAMORPHIC ROCKS	Undifferentiated quartzite, marble, talc schist, and meta-igneous rocks in the Cronese Mountains area. Quartzite, phyllite, dolomite, mica schist and meta-andesite in the Quail Mountains. Undifferentiated granitic, dioritic, gneissic and metavolcanic rocks in the Slate Range. Mixed granitic, metavolcanic, and carbonate rocks in the Owlshhead Mountains. Includes the western part of Muehlburger's granite-gneiss in the Quail Mountains. Elsewhere, undifferentiated metamorphic-igneous rocks.
			IP ls	PALEOZOIC MARINE SEDIMENTARY AND METASEDIMENTARY ROCKS, ls = LIMESTONE AND/OR DOLOMITE	Garlock Series— <i>tactite, marble, phyllite, schist, hornfels, chert, limestone, and shale</i> (Permian in part). Unnamed quartzite, schist, hornfels, metaconglomerate, and pure to impure limestone in the Slate Range, Lane Mountains, Silurian Hills quadrangle, Soda Lake quadrangle, Avawatz Mountains, and Goldstone Lake quadrangle. Riggs Formation— <i>limestone and dolomite</i> (Silurian Hills). Elsewhere undifferentiated carbonate rocks.
		UNDIVIDED	IPv	PALEOZOIC METAVOLCANIC ROCKS	Andesite porphyry, tuff and basaltic greenstone (Salt-dale quadrangle). Elsewhere metabasalt, metatuff and other metavolcanic rocks.
			R	PERMIAN MARINE SEDIMENTARY AND METASEDIMENTARY ROCKS	Anvil Spring Formation ² — <i>limestone, cherty limestone, minor shale and dolomite</i> (Manly Peak quadrangle). Bird Spring Formation ² — <i>limestone and hornfels</i> (Warm Spring Canyon, Soda Mountains). Unnamed carbonate rocks in the northeast part of the Avawatz Pass quadrangle.
		PERMIAN	C	UNDIVIDED CARBONIFEROUS MARINE SEDIMENTARY AND METASEDIMENTARY ROCKS	Limestone, hornfels and quartzite in the Soda Mountains.
			CM	MISSISSIPPIAN MARINE SEDIMENTARY AND METASEDIMENTARY ROCKS	Monte Cristo Limestone— <i>limestone with thin layers of bedded chert</i> (Nopah Range).
		MISSISSIPPIAN	€	CAMBRIAN MARINE SEDIMENTARY AND METASEDIMENTARY ROCKS	Cornfield Springs Formation— <i>dolomite</i> ; Bonanza King Formation— <i>dolomite</i> ; Cadiz Formation— <i>sandstone, shale and limestone</i> ; Wood Canyon Formation— <i>sandstone and shale</i> (lower part may be Precambrian); Lotus Formation ² — <i>limestone and dolomitic limestone</i> (Manly Peak quadrangle).
			€?	CAMBRIAN-PRECAMBRIAN MARINE SEDIMENTARY AND METASEDIMENTARY ROCKS	Stirling Quartzite— <i>massive to thin layered quartzite</i> ; Johnnie Formation— <i>sandy dolomite, quartzite, shale, siltstone and sandstone</i> ; Noon-day Dolomite— <i>dolomite and limestone</i> .
		CAMBRIAN	UNDIVIDED	p€g p€s	UNDIVIDED PRECAMBRIAN METAMORPHIC ROCKS: GNEISS SCHIST
lp€				LATER PRECAMBRIAN SEDIMENTARY AND METAMORPHIC ROCKS—Algonkian on some maps	Kingston Peak Formation— <i>conglomerate, graywacke, limestone, sandstone, and shale</i> ; Beck Spring Dolomite— <i>gray dolomite</i> ; Crystal Spring Formation— <i>dolomite, quartzite, diabase, and shale</i> . Pahrump Group undifferentiated— <i>dolomite, hornfels, quartzite, conglomerate, and diabase</i> .
PRECAMBRIAN			ep€	EARLIER PRECAMBRIAN METAMORPHIC ROCKS—Archean on some maps	Gneiss, schist, and metaconglomerate in the Manly Peak quadrangle. Granite gneiss in the Quail Mountains. Quartzite, calc-silicate rocks, gneiss, schist, basic complex of gabbroic and dioritic gneiss, and migmatite in the Soda Mountains area. Diorite, marble and other meta-sedimentary rocks, diorite gneiss, and granite gneiss in the Avawatz Mountains. Elsewhere undifferentiated earlier Precambrian metamorphic rocks.
NOTES					
¹ Paleocene (or older) age. McKenna, M. C., 1955, Paleocene mammal, Goler Formation, Mojave Desert, California: Am. Assoc. Petroleum Geologists Bull., vol. 39, pp. 512-515, and McKenna, M. C., 1960, A continental Paleocene vertebrate fauna from California: Amer. Museum Novitates, no. 2024, Nov. 29, p. 1-20.					
² Not necessarily in stratigraphic sequence inasmuch as interrelationships of these formations are not completely understood.					

TOPOGRAPHIC QUADRANGLES
WITHIN THE TRONA SHEET
AVAILABLE FROM THE U.S. GEOLOGICAL SURVEY
1962



View north over the Avawatz Mountains toward Death Valley. Prominent white beds in center background are fine-grained sediments deposited by the Amargosa River. White cliffs (center) are steeply dipping beds of Precambrian marble. Avawatz Peak, right foreground, composed of Mesozoic granitic rocks, is bounded on its left flank by the Arrastre Spring fault zone. The distinctly bedded exposure in the left foreground consists of early Tertiary nonmarine strata lying on Jura-Triassic metavolcanic rocks.

Photo by Pacific Air Industries, 1949.