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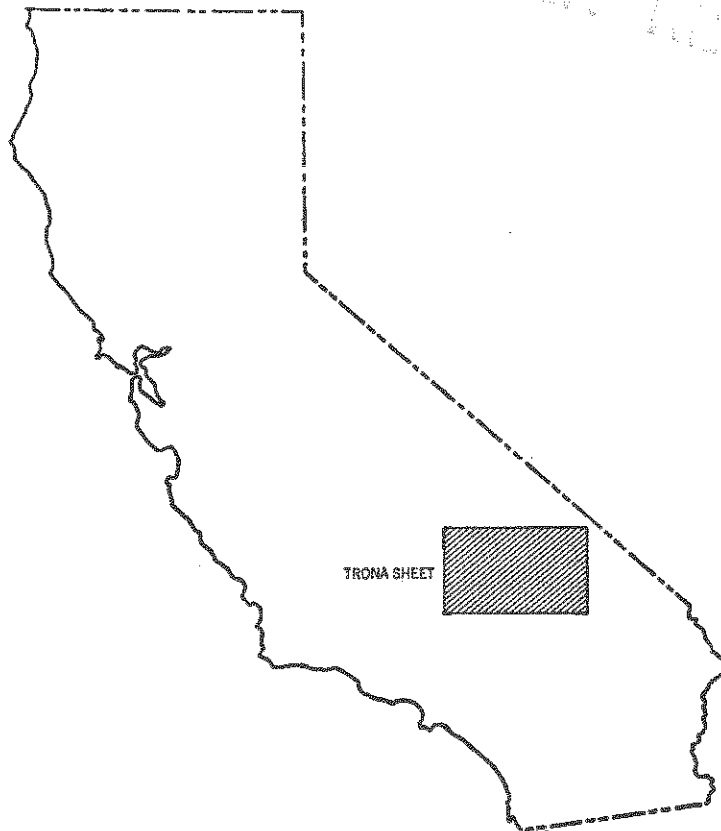
STATE OF CALIFORNIA
RONALD REAGAN, Governor
THE RESOURCES AGENCY
NORMAN B. LIVERMORE, JR., Administrator
DEPARTMENT OF CONSERVATION
RAY B. HUNTER, Director

BOUGUER GRAVITY MAP OF CALIFORNIA TRONA SHEET

Scale 1:250,000
1974

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folio*

O'BRIEN RESOURCES



CALIFORNIA DIVISION OF MINES AND GEOLOGY
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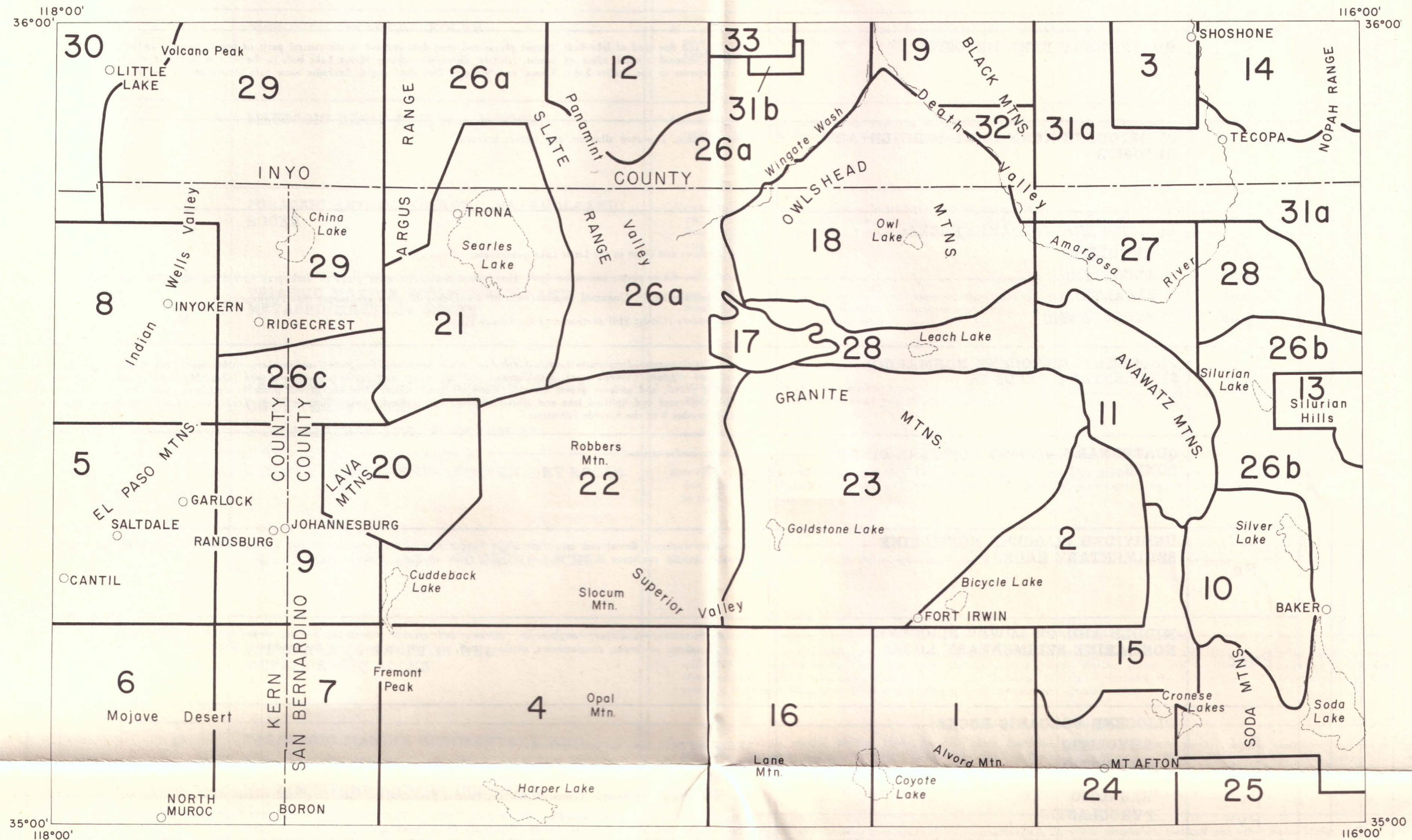
TRONA GRAVITY

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
Second Printing 1968

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

This data sheet is a reprint of the data sheet accompanying the Trona Sheet, Geologic Map of California, Olaf P. Jenkins edition, first published in 1962. It has not been altered. The geology shown on the Trona Sheet of the Bouguer Gravity Map of California is also reprinted from the Geologic Map of California, 1962. The gravity data presented were compiled in 1972 and published in 1974.



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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>
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.
	Qst	QUATERNARY SALT DEPOSITS	Mostly deposits of sodium chloride; some sodium sulphate on surface of Searles Lake.
QUATERNARY	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 undisturbed); Pleistocene deposits exposed around edges of basins (mostly dissected)—chiefly Manix Lake beds in the Alford 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.
	Qpvf Qpv ^a Qpv ^b Qvp	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 Funglomerate— <i>funglomerate with interbedded basal flows and fine-grained sedimentary rocks</i> and China Ranch Beds— <i>funglomerate and siltstone</i> (Tecopa area). Muehlberger's "Upper sedimentary sequence"— <i>silt and sand</i> (Quail Mountains). Sedimentary breccia, granitic gravel, and andesite gravel (Alford Mountain quadrangle). Unnamed gravels probably correlative with the Funeral Funglomerate. Deformed and uplifted lake and alluvial deposits in the Searles Lake, Wingate Wash, Trona, and Manly Peak quadrangles. Diller's member 8 of the Ricardo Formation.
	*	QUATERNARY AND/OR PLIOCENE CONE 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 Diggins area (Randburg quadrangle).
	Pmlc	MIDDLE AND/OR LOWER PLIOCENE NONMARINE SEDIMENTARY ROCKS	Ricardo Formation— <i>siltstone, 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 Randburg, Cuddeback Lake and Searles Lake quadrangles.
	Pvf Pv ^a Pvb Pvp	PLIOCENE VOLCANIC ROCKS: RHYOLITIC ANDESITIC BASALTIC PYROCLASTIC	Rhyolitic 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 rocks (Lava Mountains). Basalt flows within the Ricardo Formation and the Funeral Funglomerate. 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 (Alford 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 chert" (Virgin Springs area).
	Muc	UPPER MIOCENE NONMARINE SEDIMENTARY ROCKS	Barrow Formation— <i>funglomerate, sandstone, arkosic sandstone, conglomerate with minor tuff, limestone, basalt and andesite</i> (middle Miocene in part).
Mmc	MIDDLE MIOCENE NONMARINE SEDIMENTARY ROCKS	Clews Funglomerate— <i>reddish-brown funglomerate with a lower bentonitic sandstone and siltstone unit and an upper arkosic sandstone and tuff unit</i> (Alford Mountain quadrangle). Granitic and dacite breccia (Lane Mountain quadrangle). Granitic conglomerate and granitic and rhyolitic breccia (Opal Mountain quadrangle).	
MIOCENE	Mv Mvf Mv ^a Mvb Mvp	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 Barrow Formation; Alford Peak Basalt— <i>nonporphyritic basalt</i> . Unnamed basalt flows. Spanish Canyon Formation— <i>tuff and tuffaceous sandstone with two distinct basal flows and interbedded arkosic sandstone</i> (Alford Mountain quadrangle). Tuff and tuff breccia of the Tropic Group. Unnamed tuff, tuff breccia, and agglomerate.
	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).
	Epc	PALEOCENE NONMARINE SEDIMENTARY ROCKS	Goler Formation— <i>arkosic sandstone and conglomerate</i> .
	Tc	TERTIARY NONMARINE SEDIMENTARY ROCKS	Avawatz Formation— <i>siltstone, sandstone, funglomerate, 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. Monolithic breccias which formed during the Tertiary; includes small klippe of Precambrian rock at Bitter Spring (D. E. Huxley, personal communication, 1942). Muehlberger's "Middle and Lower sedimentary sequence"— <i>siltstone, sandstone, conglomerate, tuff, and agglomerate</i> in the Quail Mountains. Elsewhere includes undivided Tertiary sedimentary rocks.
TERTIARY	Ti Tif 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. Basaltic intrusive rocks (Salt Lake quadrangle).
	Tv Tv ^a Tv ^b Tv ^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.

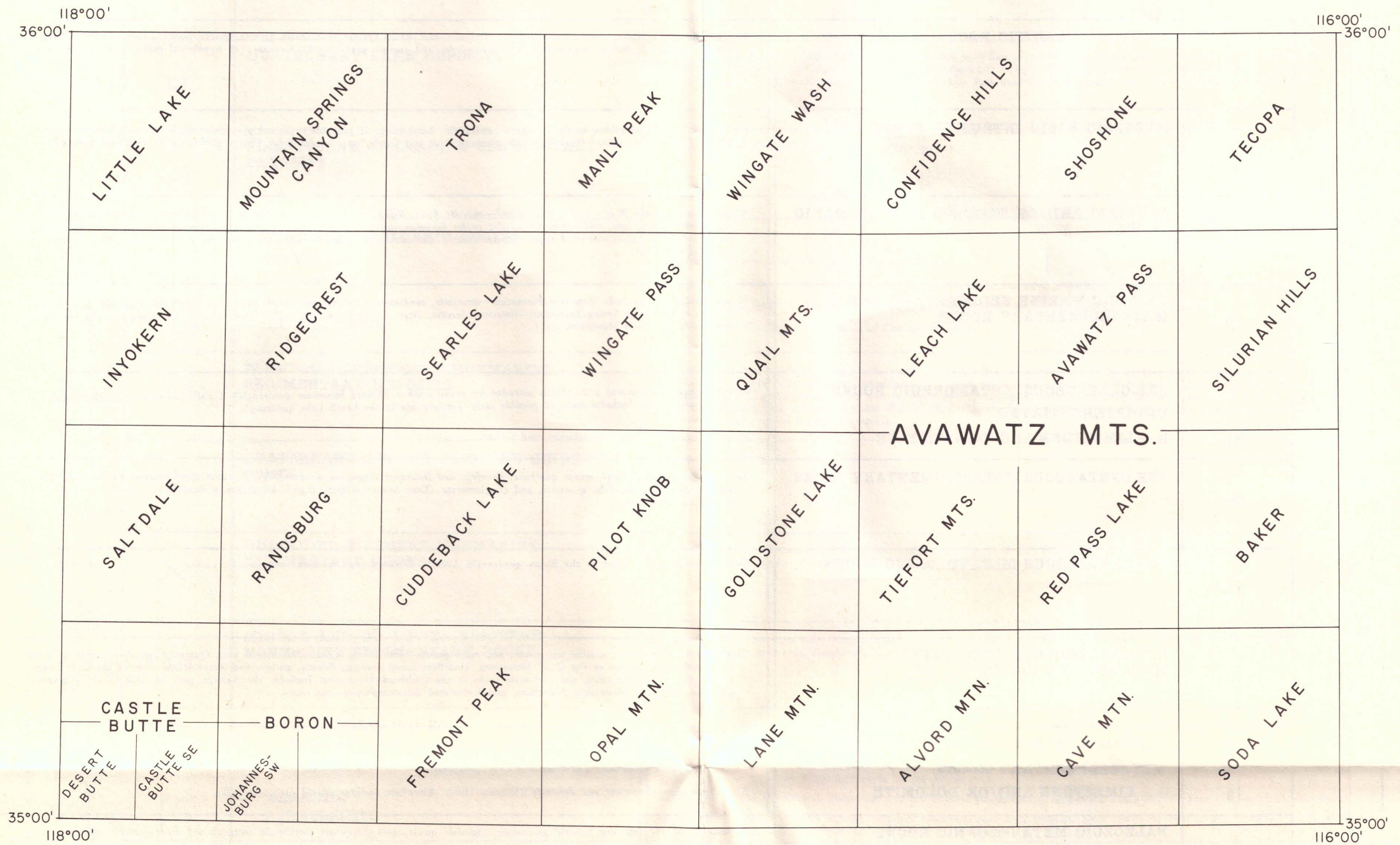
STRATIGRAPHIC NOMENCLATURE— Continued

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 QTvp	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 Tronoma and Anala 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).
	bi	MESOZOIC BASIC INTRUSIVE ROCKS	Hornblende diorite and gabbro in the Inyokern quadrangle. Amphibolite of probable unaltered pyroxenite origin (Alford 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— <i>andesite flows</i> . Volcanic part of the Soda Mountain Formation— <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.
MESOZOIC UNDIVIDED	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 (Alford Mountain quadrangle). Locally unnamed and undifferentiated metamorphic rocks. Includes rocks of possibly early Tertiary age in the Leach Lake quadrangle. Coarsely crystalline limestone, dolomite, and tectite.
	ms	PRE-CRETACEOUS METASEDIMENTARY ROCKS	Kernville Series— <i>mica schist, minor quartzite, hornfels, and limestone</i> (Inyokern quadrangle). Quartzite conglomerate and hornfels (Salt Lake 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.
	gr-m	PRE-CENOZOIC GRANITIC AND METAMORPHIC ROCKS	Undifferentiated quartzite, marble, calc schist, and meta-igneous rocks in the Crossed 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 Owlhead Mountains. Includes the western part of Muehlberger'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 GARDNER LAKE quadrangle. Riggs Formation— <i>limestone and dolomite</i> (Silurian Hills). Elsewhere undifferentiated carbonate rocks.
	ipv	PALEOZOIC METAVOLCANIC ROCKS	Andesite porphyry, tuff and basaltic greenstone (Salt Lake quadrangle). Elsewhere metabasalt, meta-tuff and other metavolcanic rocks.
	R	PERMIAN MARINE SEDIMENTARY AND METASEDIMENTARY ROCKS	Anvil Spring Formation— <i>limestone, cherty limestone, minor shale and dolomite</i> (Manly Peak quadrangle). Bird Spring Formation— <i>limestone and hornfels</i> (Warm Spring Canyon, Soda Mountains). Unnamed carbonate rocks in the northeast part of the Avawatz Pass quadrangle.
	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> (Nogah Range).
PALEOZOIC UNDIVIDED	Є	CAMBRIAN MARINE SEDIMENTARY AND METASEDIMENTARY ROCKS	Corfield 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— <i>limestone and dolomitic limestone</i> (Manly Peak quadrangle).
	Є?	CAMBRIAN-PRECAMBRIAN MARINE SEDIMENTARY AND METASEDIMENTARY ROCKS	Stirling Quartzite— <i>massive to thin layered quartzite</i> ; Johanne Formation— <i>sandy dolomite, quartzite, shale, siltstone and sandstone</i> ; Noonday Dolomite— <i>dolomite and limestone</i> .
	pCg pCs	UNDIVIDED PRECAMBRIAN METAMORPHIC ROCKS: GNEISS SCHIST	Waterman Gneiss— <i>quartz diorite gneiss with white marble</i> (may be Paleozoic). Johanneburg Gneiss— <i>hornblende-biotite-plagioclase-quartz gneiss</i> (may be Paleozoic). Quartz diorite gneiss in the Boron quadrangle (may be Paleozoic). Unnamed gneiss and quartzite. Mesquite Schist— <i>biotite-quartz-sericite schist and limestone</i> (Salt Lake quadrangle); Rand Schist— <i>mica-quartz-albite schist and actinolite schist</i> (Salt Lake and Randburg quadrangles). Unnamed schist. The age of the rocks shown as pCs is uncertain and may be younger than Precambrian.
	lpC	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, diorite, and shale</i> . Palump Group undifferentiated— <i>dolomite, hornfels, quartzite, conglomerate, and diorite</i> .
	epC	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 gabbro and diorite 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., 1911, Paleocene mammal, Goler Formation, Mojave Desert, California: Am. Assoc. Petroleum Geologists Bull., vol. 19, pp. 512-515, and McKenna, M. C., 1940, A continental Paleocene vertebrate fauna from California: Amer. Museum Novitates, no. 3224, Nov. 23, 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 Arastre 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.

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