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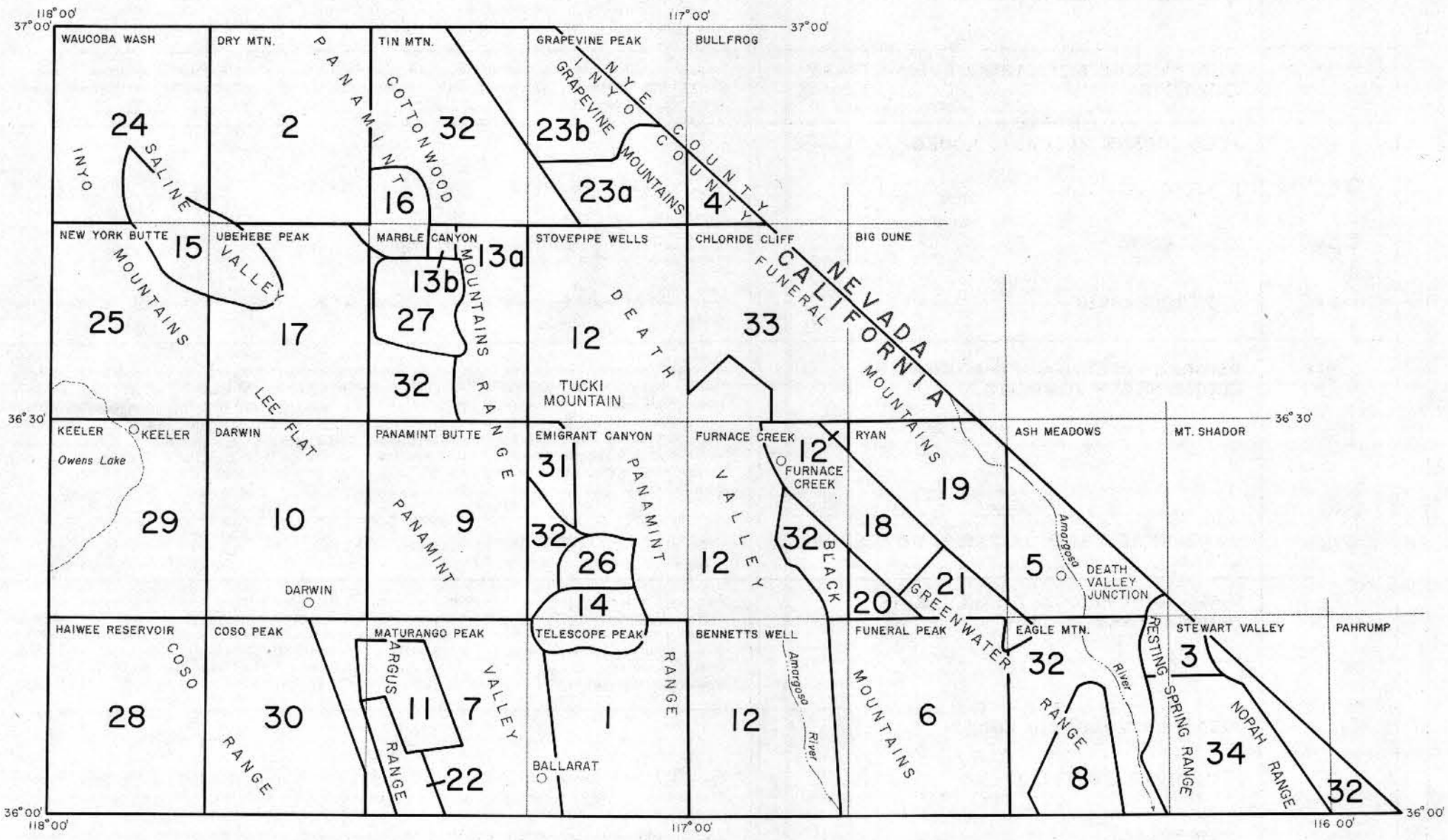
EXPLANATORY DATA
DEATH VALLEY SHEET
GEOLOGIC MAP OF CALIFORNIA

Compiled by Robert Streitz and Melvin C. Stinson, 1974

THIS DATA SHEET IS A REPRINT OF THE DATA SHEET ACCOMPANYING THE DEATH VALLEY SHEET, GEOLOGIC MAP OF CALIFORNIA, PUBLISHED IN 1977. IT HAS NOT BEEN ALTERED. THE GEOLOGY SHOWN ON THE DEATH VALLEY SHEET OF THE BOUGUER GRAVITY MAP OF CALIFORNIA IS ALSO REPRINTED FROM THE GEOLOGIC MAP OF CALIFORNIA, 1977. THE GRAVITY DATA PRESENTED WERE COMPILED IN 1972 AND PUBLISHED IN 1973.

INDEX TO GEOLOGIC MAPPING
USED IN COMPILATION OF THE DEATH VALLEY SHEET



1. Albee, A.L., Lanphere, M.A., and McDowell, S.D., 1971, Geology of part of the Telescope Peak quadrangle, scale 1:62,500: Compiled for the State Geologic Map. See footnote B.

McDowell, S.D., 1974, Emplacement of the Little Chief Stock, Panamint Range, California: Geological Society of America Bulletin, v. 85, no. 10, p. 1535-1546, figure 2, scale approximately 1:60,000.

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3. Burchfiel, B.C., 1971, Reconnaissance geology of part of the Resting Springs Range, California, scale 1:250,000: Prepared for the State Geologic Map. See footnote B.

4. Cornwall, H.R., and Kleinhampl, F.J., 1964, Geology of Bullfrog quadrangle and ore deposits related to Bullfrog Hills Caldera, Nye County, Nevada, and Inyo County, California: U.S. Geological Survey Professional Paper 454-J, plate 1, scale 1:48,000.

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6. Drewes, Harald, 1963, Geology of the Funeral Peak quadrangle, California, on the east flank of Death Valley: U.S. Geological Survey Professional Paper 413, scale 1:62,500. (Contact between salt deposits and alluvium at junction of Bennetts Well and Funeral Peak quadrangles from Hunt and Mabey, reference 12). See footnotes A and B.

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11. Holden, K.D., 1974, Geology of the central Argus Range, Inyo County, California, scale 1:62,500: San Jose State University, M.A. thesis, work in progress.

12. Hunt, C.B., and Mabey, D.R., 1966, Stratigraphy and structure of Death Valley, California: U.S. Geological Survey Professional Paper 494-A, plate 1, scale 1:96,000. See footnotes A and B.

13a. Johnson, E.A., 1971, Geology of part of the southeastern side of the Cottonwood Mountains, Death Valley, California, scale 1:31,250: Rice University, unpublished Ph.D. thesis.

13b. Johnson, E.A., 1969, Geology of part of the Marble Canyon quadrangle, scale 1:62,500: Written communication.

14. Lanphere, M.A., 1962, Part I Geology of the Wildrose area, Panamint Range, California; Part II Geochronologic studies in the Death Valley-Mojave Desert region, California, scale 1:24,000: California Institute of Technology, unpublished Ph.D. thesis. (Ages of some earlier Precambrian rocks correlated with later Precambrian rocks by compiler for regional consistency. Fault extension by Wes Hildreth, Department of Geology and Geophysics, University of California, Berkeley, written communication, 1972).

15. Lombardi, O.W., 1963, Observations on the distribution of chemical elements in the terrestrial saline deposits of Saline Valley, California: U.S. Naval Ordnance Test Station (Report) NOTS TP 2916, 42 p., plate 1, scale 1:48,000.

16. McAllister, J.F., 1952, Rocks and structure of the Quartz Spring area, northern Panamint Range, California: California Division of Mines Special Report 25, 38 p., plate 1, scale 1:32,000.

17. McAllister, J.F., 1956, Geology of the Ubehebe Peak quadrangle, California: U.S. Geological Survey Geologic Quadrangle Map GQ-95, scale 1:62,500.

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20. McAllister, J.F., 1971, Geologic map of the southwest corner of the Ryan quadrangle, California, scale 1:62,500: U.S. Geological Survey, work in progress.

21. McAllister, J.F., 1973, Geologic map and sections of the Amargosa Valley borate area—southeast continuation of the Furnace Creek area—Inyo County, California: U.S. Geological Survey Miscellaneous Geologic Investigations Map I-782, scale 1:24,000.

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23a. Reynolds, M.W., 1969, Stratigraphy and structural geology of the Titus and Titanothere Canyons area, Death Valley, California, scale approximately 1:21,000: University of California, Berkeley, unpublished Ph.D. thesis.

23b. Reynolds, M.W., 1961-1963, Geologic map of the Grapevine Peak quadrangle and part of the Tin Mountain quadrangle, California-Nevada, scale 1:125,000: Unpublished detailed, reconnaissance, and photogeologic mapping. See footnote A.

24. Ross, D.D., 1967, Geologic map of the Waucoba Wash quadrangle, Inyo County, California: U.S. Geological Survey Geologic Quadrangle Map GQ-612, scale 1:62,500.

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Merriam, C.W., 1963, Geology of the Cerro Gordo mining district, Inyo County, California: U.S. Geological Survey Professional Paper 408, plate 2, scale 1:62,500.

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27. Stadler, C.A., 1968, Geology of the Goldbelt Spring area, northern Panamint Range, Inyo County, California, scale 1:15,840: University of Oregon, unpublished M.S. thesis.

28. Stinson, M.C., 1971, Geologic map of the Haiwee Reservoir quadrangle, California, scale 1:31,250: California Division of Mines and Geology, work in progress. See footnote D.

29. Stinson, M.C., 1971, Geologic map of the Keeler quadrangle, California, scale 1:31,250: California Division of Mines and Geology, work in progress. See footnotes C and D.

30. Stinson, M.C., 1971, Geologic map of the Coso Peak quadrangle, scale 1:62,500: California Division of Mines and Geology, reconnaissance mapping for State Geologic Map. (Geology of Wild Horse Mesa area modified slightly by J.W. Babcock, University of California, Santa Barbara, written communication, 1974).

31. Thompson, J.H., 1963, Precambrian geology of the Emigrant Canyon area, Panamint Range, California, scale 1:20,833: University of Southern California, unpublished M.S. thesis. See footnotes A and B.

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32. Streitz, Robert, 1970, Reconnaissance geologic mapping and photogeologic interpretation of parts of the Eagle Mountain, Emigrant Canyon, Furnace Creek, Marble Canyon, Pahrump, Stewart Valley, and Tin Mountain quadrangles, scale 1:62,500: California Division of Mines and Geology, unpublished mapping. See footnotes A and B.

33. Troxel, B.W., and Wright, L.A., 1971, Geologic map of parts of Chloride Cliff and Big Dune quadrangles, California, scale 1:31,680: California Division of Mines and Geology, work in progress. See footnote A.

34. Wilhelms, D.E., 1963, Geology of part of the Nopah and Resting Springs Ranges, Inyo County, California, scale 1:24,000: University of California, Los Angeles, unpublished Ph.D. thesis.

Footnotes

A. Location of some Quaternary faults from: Brogan, G.E., Active faults of the Death Valley-Furnace Creek fault system, Death Valley and Fish Lake Valley, California and Nevada, scale 1:24,000: University of Nevada, Ph.D. thesis, in progress 1972. (Some of the surface ruptures shown in Death Valley, Panamint Valley, Saline Valley, and around Owens Lake may be caused by liquefaction or settlement-compaction rather than by tectonic processes).

B. Fault additions or modifications by B.W. Troxel, California Division of Mines and Geology, personal communication, 1972 and 1977.

C. Location of additional faults and breaks along periphery of Owens Lake from: Carver, G.A., 1970, Quaternary tectonism and surface faulting in the Owens Lake basin, California: University of Nevada, Mackay School of Mines, Technical Report AT-2, 103 p., plate 2, scale approximately 1:90,500.

D. Location of some major subsurface faults based on geophysical evidence from: Pakiser, L.C., Kane, M.F., and Jackson, W.H., 1964, Structural geology and volcanism of Owens Valley region, California—a geophysical study: U.S. Geological Survey Professional Paper 438.

For a complete list of published geologic maps of this area see Division of Mines and Geology Special Reports 52, 52-A, 52-B and 102.

STRATIGRAPHIC NOMENCLATURE—DEATH VALLEY 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 Formally named Cenozoic and Mesozoic formations grouped in stratigraphic sequence (separated by semicolons) are listed from youngest to oldest.
CENOZOIC / QUATERNARY / Holocene	Qs	**HOLOCENE DUNE SAND**	Large deposits of dune sand at north end of Panamint Valley, Mesquite Flat, Saline Valley, and southern Owens Valley; includes wind-transported, saline-rich sediments at southeast end of Owens Lake.
	Qal	**HOLOCENE ALLUVIUM**	Alluvium, consolidated and unconsolidated; younger alluvial fan deposits; colluvial material and talus rubble; locally includes older, dissected fan materials, older gravels, and playa and flood-plain deposits.
		HOLOCENE VOLCANIC ROCKS	
	Qrv^{p}	**PYROCLASTIC**	Veneer of cinder deposits from Ubehebe Crater at north end of Panamint Range.
	Qst	**QUATERNARY SALT DEPOSITS**	Carbonate, sulfate, chloride, and borate evaporites of Death Valley and Saline Valley.
	Ql	**QUATERNARY LAKE DEPOSITS**	Mostly sand, silt, marl, and claystone; cobble and gravel deposits as bars and embankments; local caliche (usually calcium carbonate, minor calcium sulfate); fresh water limestones and other playa deposits (age may range from middle Pleistocene to late Holocene); also includes minor evaporite deposits, salt crust; and sandy, silty, soda-rich crust of Owens Lake.
/ Pleistocene	Qc	**PLEISTOCENE NONMARINE SEDIMENTARY DEPOSITS**	Bouldery, cobbly, and finer-grained material of assorted lithology; older, slightly tilted, dissected, unconsolidated alluvial fans; includes locally derived colluvium, landslide deposits, and older "alluvium" formed by partly weathering in place; also includes large areas of desert pavement.
		PLEISTOCENE VOLCANIC ROCKS:	
	Qpv^{r}	**RHYOLITIC**	Rhyolite flows, perlite domes, and obsidian masses of Coso Range.
	Qpv^{b}	**BASALTIC**	Basalt and basaltic-andesite flows of Coso Range[1].
	Qpv^{p}	**PYROCLASTIC**	Lapilli tuff (rhyolitic) associated with perlite domes and rhyolite flows of Coso Range; includes cinder cones (basaltic) of Coso Range.
/ Pliocene	QP	**PLIOCENE-PLEISTOCENE NONMARINE SEDIMENTARY DEPOSITS**	Funeral Formation—*conglomerate with pebbles, cobbles, and boulders in mud and sand matrix, incipiently lithified; gravelly mudstone and sandstone; local travertine and well-lithified conglomerate.* In Black Mountains, includes megabreccia in addition to poorly indurated conglomerate with varying proportions of felsite, quartzite, and limestone; fanglomerate firmly cemented in places with calcium carbonate, some caliche (mostly gypsum rather than calcium carbonate); Coso Formation—*fanglomerate, arkosic sandstone, shale, buff-colored clay; locally iron-stained or silicified; minor, thin beds of impure limestone.* Includes moderately consolidated, elevated, dissected, and tilted fanglomerate of west side Panamint Range; gravels that form dissected alluvial cones or banks on sides of present canyons on west side of Grapevine Mountains; and well-lithified breccia and large blocks of Paleozoic rocks near Travertine Point.
	✳	**QUATERNARY AND/OR PLIOCENE CINDER CONES**	Basaltic and andesitic cinder cones.
	Pc	**UNDIVIDED PLIOCENE NONMARINE SEDIMENTARY ROCKS**	Furnace Creek Formation—*predominantly lacustrine mudstone and sandstone with conglomerate, tuff, limestone, gypsum, and borate deposits;* Copper Canyon Formation—moderately red conglomerate, yellowish-gray siltstone, and evaporites. Minor interlayered and intrusive volcanic rocks; older red or buff moderately well-cemented tilted fanglomerate of Towne Pass area; buff to reddish conglomerate of Kit Fox Hills; dissected sedimentary rocks of northern Cottonwood Mountains; monolithologic breccia of Inyo, Panamint, and Amargosa Ranges, and Panamint Valley; minor fresh-water limestone deposits; faulted and locally tilted fanglomerate, and some lacustrine mudstone on east side of Saline Valley.
		PLIOCENE VOLCANIC ROCKS:	
	Pv	**UNDIFFERENTIATED**	Volcanic rocks of southern Greenwater Range (Eagle Mountain area), including rhyolite flows and pyroclastic rocks.
	Pv^{r}	**RHYOLITIC**	Rhyolite and rhyodacite vitrophyre of Black Mountains and Greenwater Range[2], including massive vitrophyre, felsitic vitrophyre, and vitrophyre agglomerate; also includes vitrophyre incipiently altered in part to a nonglassy texture; mostly flows, but includes some near-vent intrusions and contact-welded pumice of northern Greenwater Range. Biotite in vitrophyre from Black Mountains 2.9 miles southwest of Ryan dated by K-Ar method at 5.18 ± 0.15 m.y. and from Greenwater Range 8.85 miles southeast of Ryan dated at 5.88 ± 0.20 m.y. (McAllister, 1973).
	Pv^{a}	**ANDESITIC**	Porphyritic andesite of the southern Inyo Range, light gray, reddish or reddish-gray, with sharply defined jointing resistant to weathering. Also includes andesite flows of southern Greenwater Range.
	Pv^{b}	**BASALTIC**	Dark-gray olivine basalt. Sample from north end of Ash Hills dated by K-Ar method at 4.05 ± 0.15 m.y. (Hall, 1971). Red, purple, green, or gray quartz-olivine basalt with amygdaloidal structure and palagonitic alteration locally prevalent where associated with lacustrine deposits. Sample from near Towne Pass dated by K-Ar method at 5.13 ± 0.35 m.y. (Hall, 1971). Andesite and basalt flows and minor tuff of southern Greenwater Range. Basalt of Funeral Formation, Furnace Creek area; a sample from 2.75 miles northnortheast of Ryan dated by K-Ar method at 4.03 ± 0.12 m.y. (McAllister, 1973). Gray to olive basaltic flows, intrusives, and agglomerate of Furnace Creek Formation. Flows of medium to dark gray, dense to vesicular trachyandesite with scattered olivine phenocrysts in the Saline Range[3].
	Pv^{p}	**PYROCLASTIC**	Basaltic to andesitic agglomerate, tuff-breccia and lapilli-tuff, commonly light-brown, poorly to well bedded. White, light-gray, reddish to pinkish welded rhyolite tuff of east flank of Argus Range; pale orange to grayish pink rhyolitic tuff-breccia of Greenwater Range; also includes pumicite and tuffaceous sedimentary rock of Greenwater Range. Volcanic rocks of the Funeral Formation—*basaltic agglomerate, red scoria, greenish-gray, or pale-orange tuff-breccia, minor vitrophyre breccia* (possibly Pleistocene). Volcanic rocks of the Coso Formation—*rhyolitic tuff, lapilli tuff, and tuff-breccia, white to light brown, sometimes reddish, moderately well bedded, often slightly welded, limy, or ferruginous* (may range in age from Pliocene to Pleistocene). Water-laid pumiceous material with sand or gravel beds and basalt flow, welded rhyolite tuff, and pumice tuff of Last Chance Range.
/ Oligocene	ϕc	**OLIGOCENE NONMARINE SEDIMENTARY ROCKS**	Titus Canyon Formation—*red, brown, green, and gray quartzitic conglomerate; red, yellow, green, and gray calcareous sandstone, siltstone, mudstone, marl, limestone, limestone breccia, and tuffaceous sandstone.*
TERTIARY	Tc	**TERTIARY NONMARINE SEDIMENTARY ROCKS**	Artist Drive Formation—*brown, green, and olive conglomerate, sandstone, and mudstone;* age may range from Oligocene to early Pliocene (McAllister, 1970). Fanglomerate, conglomerate, shale, and limestone of southern Funeral Mountains and south slope of Eagle Mountain; blocks, conglomerate, gravel, sandstone, and white tuff on west margin of Chicago Valley; megabreccia deposits of the Grapevine Mountains north of Leadfield; older fanglomerate of southern Last Chance Range; intra-basalt gravel of Saline Range; and "red beds" of the western Coso Range.
		TERTIARY INTRUSIVE ROCKS:	
	Ti^{r}	**RHYOLITIC**	Rhyolite, rhyodacite, and dacite plugs and dikes of southern Greenwater Range and Black Mountains[4]. Felsic volcanic rocks, in part intrusive, of the Saline Range.
	Ti^{b}	**BASALTIC**	Intrusive basalt and andesite, pegmatitic in part, of the Saline Range[3].
/ Undivided		**TERTIARY VOLCANIC ROCKS:**	
	Tv	**UNDIFFERENTIATED**	Volcanic rocks, including some interbedded sedimentary rocks, on the east slope of Panamint Range and northern Black Mountains[5]. Rhyolite flows and shallow intrusives, latite flows, and pyroclastic rocks of the Grapevine Mountains.
	Tv^{r}	**RHYOLITIC**	Gray to black pumice vitrophyre, porphyritic aphanite, massive and layered tuff. Includes "older" rhyolitic rocks of Black Mountains and southern Greenwater Range consisting of rhyolite flows alternating with tuffs and acid lava flows (felsophyre and vitrophyre), tuffs, and commonly irregularly shaped intrusive bodies of red to brown felsophyre[6]. Rhyodacite flows, and latite flows and plugs of the Grapevine Mountain; red welded tuff and white pumice tuff of the Saline Range; rhyolite and minor rhyolite vitric tuff of the northern Coso Range; and felsic volcanic rocks.
	Tv^{a}	**ANDESITIC**	Andesite flows, sills, and plugs of western Coso Range[7]. Andesite and basalt flows are interbedded in the Copper Canyon and Furnace Creek Formations (Funeral Peak quadrangle); andesite and basalt flows and intrusive bodies of central Black Mountains; andesite flows of eastern Argus Range.
	Tv^{b}	**BASALTIC**	Dark-gray, green, or olive, porphyritic basalt flows, sills, dikes, and necks of Artist Drive Formation; basalt flows of Coso Peak and eastern Argus Range.
	Tv^{p}	**PYROCLASTIC**	Artist Drive Formation—upper pyroclastic member of *pale blue-green and grayish-pink, massive tuff-breccia,* and lower pyroclastic member of *green and buff well-lithified, partly altered, massive tuff breccia;* also *light brownish-gray felsite as flows, sills, dikes, and necks.* Minor lake beds, sandstone, conglomerate, and borate deposits of south end of Resting Spring Range (Gerstley Lake Beds); welded tuff, crystal lithic tuff with minor conglomerate and sandstone, and vitric tuff with minor porcelaneous shale, conglomerate, and sandstone of Grapevine Mountains; tuff, pumice, ash, and reworked pyroclastic and volcanic rocks of Saline Range; andesite tuff, tuff-breccia, and reworked pyroclastic rocks of the Coso Range[8].
	Tgr	**TERTIARY GRANITIC ROCKS**	Includes porphyritic quartz monzonite of southern Greenwater Range[9]; quartz monzonite with porphyritic quartz latite and minor monzonite, latite, granodiorite, and granite of Black Mountains; hornblende-biotite granite of the eastern Panamint Range[10].

STRATIGRAPHIC NOMENCLATURE—Continued

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 Formally named Paleozoic formations are grouped in alphabetical order within each period. See correlation chart of Paleozoic formations for stratigraphic position.
MESOZOIC — CRETACEOUS	gr	**MESOZOIC GRANITIC ROCKS**	Hunter Mountain Quartz Monzonite—*medium- to coarse-grained hornblende-biotite quartz monzonite*[11]. Includes monzonite and olivine gabbro, minor syenitic rocks (Tin Mountain area), granodiorite, alaskite, quartz diorite, and diorite. Light-colored, coarse-grained porphyritic quartz monzonite, locally highly foliated, of Waucoba Wash quadrangle[12]. Also includes gneissic and porphyritic quartz monzonite of Skidoo area (central Panamint Range)[13].
	bi	**MESOZOIC BASIC INTRUSIVE ROCKS**	Diorite, gabbro, and hornblende gabbro.
MESOZOIC — TRIASSIC	JTRv	**JURASSIC AND TRIASSIC METAVOLCANIC ROCKS**	Andesite flows, tuff, and breccia with intercalated sandstone, shale, and conglomerate of southern Inyo Mountains. Includes mafic flows, volcanic breccia, tuff, and interbedded sandstone near Shepard Canyon, Argus Range.
	TR	**TRIASSIC MARINE SEDIMENTARY AND METASEDIMENTARY ROCKS**	Massive and platy fossiliferous limestone and shale of southern Inyo Mountains.
MESOZOIC — UNDIVIDED	m	**PRE-CRETACEOUS METAMORPHIC ROCKS, UNDIFFERENTIATED**	Gneiss, metavolcanic, meta-igneous, and metasedimentary rocks (Coso Range).
	mv	**PRE-CRETACEOUS METAVOLCANIC ROCKS**	Metarhyolite, metadacite, and metatuff in Coso Peak quadrangle.
PALEOZOIC — UNDIVIDED	IP	**PALEOZOIC MARINE SEDIMENTARY AND METASEDIMENTARY ROCKS**	Marble, quartzite, and calc-silicate rock as inclusions, pendants, and border rocks of Mesozoic plutons. Bluish-gray limestone and white to light-gray, diopside-rich calc-hornfels of eastern Darwin quadrangle; sedimentary breccia, conglomerate, calc-hornfels, quartzite, and limestone in the Maturango Peak quadrangle (probably Pennsylvanian and Permian); chaotic blocks of dolomite, limestone, quartzite, and shale in Funeral Peak quadrangle (possibly Cambrian); undivided Paleozoic rocks of New York Butte, Coso Peak, and Keeler quadrangles.
PALEOZOIC — PERMIAN	Pm	**PERMIAN MARINE SEDIMENTARY AND METASEDIMENTARY ROCKS**	Owens Valley Formation—*gray, brown, red, and yellow conglomerate, quartzite, sandstone, siltstone, shale, limestone, and limestone breccia.* Includes Bird Spring(?) Formation of Ubehebe Peak quadrangle (Pennsylvanian in part).
PALEOZOIC — CARBONIFEROUS	CP	**PENNSYLVANIAN MARINE SEDIMENTARY AND METASEDIMENTARY ROCKS**	Bird Spring Formation—*pebbly sandstone, coarsely bioclastic limestone, sandy limestone, limestone, dolomite, and chert nodules.* Keeler Canyon Formation—*bluish-gray limestone, shaly limestone, black siliceous shale, pink fissile shale, and limestone breccia* (possibly Pennsylvanian in part). Lee Flat Limestone—*white to light-gray marble, light-brown dolomite marble, dark-gray limestone, and chert lenses* (possibly Mississippian in part). Rest Spring Shale—*olive-gray to olive-brown argillaceous shale and siltstone* (Mississippian in part). Tihvipah Limestone—*light-gray platy limestone, shaly limestone, medium-gray, fine-grained limestone, and calcareous shale* (Tin Mountain quadrangle). Includes unnamed formations of conglomerate, limestone, and some shale overlying the Rest Spring Formation at east foot of Tucki Mountain (Permian in part).
	CM	**MISSISSIPPIAN MARINE SEDIMENTARY AND METASEDIMENTARY ROCKS**	Chainman Shale—*black shale with minor sandstone and limestone.* Monte Cristo Formation—*light-gray and dark-gray limestone and dolomite and brown chert.* Perdido Formation—*medium-gray platy limestone, conglomerate, quartzite, sandstone, siltstone, and brown-weathering chert.* Resting Spring Shale (Waucoba Wash and Dry Mountain quadrangles) *olive-weathering shale and shaly siltstone, occasional beds of sandy siltstone or fine-grained sandstone and concretions* (possibly Pennsylvanian in part). Tin Mountain Limestone—*bluish-gray, fine-grained cherty limestone; calcareous silty shale.* Includes undivided Mississippian rocks of south-eastern Cottonwood Mountains consisting of gray, medium-grained limestone, cherty limestone, and bedded chert; and unnamed Mississippian rocks of northern Grapevine Mountains.
PALEOZOIC — DEVONIAN	D	**DEVONIAN MARINE SEDIMENTARY AND METASEDIMENTARY ROCKS**	Lost Burro Formation—upper and middle parts: *light-gray dolomite prominently striped with nearly black limestone and dolomite;* lower part: *interbedded light-and dark-gray dolomite, quartzite, and sandy or cherty dolomite.* Also *sandstone, limestone, and multi-colored breccia* (Nopah Ranges). Stewart Valley Formation—*dark-gray limestone, cherty limestone, sandstone, quartzite, and conglomerate.*
PALEOZOIC — SILURIAN	S	**SILURIAN MARINE SEDIMENTARY AND METASEDIMENTARY ROCKS**	Hidden Valley Dolomite—*light-gray to medium-gray thick-bedded dolomite, nodular chert zone near bottom* (Devonian in part). May include minor Ordovician and Devonian rocks of western Inyo Mountains.
PALEOZOIC — ORDOVICIAN	O	**ORDOVICIAN MARINE SEDIMENTARY AND METASEDIMENTARY ROCKS**	Al Rose Formation—*gray, olive, and brown hornfelsic siltstone and shale,* includes carbonate beds with "crepe structure" in lower part of formation. Antelope Valley Limestone—*cherty, siliceous, thinly-bedded limestone, silt, shale, thin-bedded shaly limestone and silty limestone, dark-gray thick-bedded limestone, interbedded silty partings, orange-weathering sandy limestone and siltstone; also thin-bedded medium-grained dolomite* (southeastern Cottonwood Mountains). Badger Flat Limestone—*blue-gray limestone with irregular brown-weathering silty lenses.* Barrel Spring Formation—*dark-gray micaceous hornfels.* Ely Springs Dolomite—upper part: *light-gray dolomite,* lower part: *dark-gray dolomite with black nodular chert.* Eureka Quartzite—upper part: *white cross-bedded vitreous quartzite,* lower part: *hematitic platy quartzite, sandy and silty dolomite and limestone.* Johnson Spring Formation—*white to light-gray quartzite, minor carbonate, impure quartzite, and siltstone.* Pogonip Group (Formation, Limestone)—*gray sandy and cherty limestone and dolomite; crinkled, wavy, and "crepe structure" chert beds; minor buff-weathering shale beds.*
PALEOZOIC — CAMBRIAN	€	**CAMBRIAN MARINE SEDIMENTARY AND METASEDIMENTARY ROCKS**	Bonanza King Formation—*broadly banded, light-gray and dark-gray dolomite and limestone; blue-gray limestone; yellow- to orange-weathering silty dolomite, and thinly laminated dolomitic limestone; narrowly striped light gray and dark gray, locally cherty dolomite.* Campito Formation—*dark-colored, thinly laminated sandstone, siltstone, and shale; light-gray, fine-grained quartzite* (Cambrian(?) or Precambrian in part). Carrara Formation—*green and brown shale, light-colored quartzite, orange-weathering thin-bedded silty limestone, gray to dark-gray coarse-grained limestone, brown calcareous sandstone and quartzite, cream colored dolomite.* Harkless Formation—*brown- to red-weathering quartzite, green shale and siltstone.* Lead Gulch Formation—*medium-gray, thin-bedded limestone interbedded with light-brown siltstone and chert; white to gray, coarsely crystalline marble with minor siltstone; medium-gray flaggy shale.* Monola Formation— upper unit: *blue-gray, thin-bedded limestone, siltstone, and dolomite with "crepe structure",* lower unit: *dark-gray to olive-gray, laminated to thick-bedded brown-weathering siltstone.* Mule Spring Limestone — *dark blue-gray oolitic silty limestone* ("crepe structure" near base). Nopah Formation—*interbedded light- and dark-gray dolomite, chert nodules, brown siltstone, shale, and shaly and cherty limestone.* Poleta Formation—*white, red, dark-gray quartzite, blue-gray limestone, light-gray to medium-gray siltstone, minor marble.* Racetrack Dolomite—*interbedded dark-gray and buff dolomite;* also *nodular chert and some shaly dolomite* (Ubehebe Peak quadrangle). Saline Valley Formation—*interbedded sandstone, quartzite, limestone, siltstone, and minor shale.* Tamarack Canyon Dolomite—*light- to medium-gray, laminated to massive dolomite, irregular nodules and thin beds of chert.* Wood Canyon Formation—*dark-colored interlayered shale, siltstone, and quartzite, and lighter-colored brownish-weathering dolomite or limestone, conglomerate, quartzite, and oolitic limestone* (lower part, below trilobites, is Cambrian(?) or Precambrian). Zabriskie Quartzite—*light-gray, thin-bedded to massive quartzite; weathers salmon pink to rusty brown.*
PRECAMBRIAN	€?	**CAMBRIAN-PRECAMBRIAN MARINE SEDIMENTARY AND METASEDIMENTARY ROCKS**	Deep Spring Formation—*blue-gray limestone, red quartzite, and gray, cross-bedded, fine-grained quartzite, hornfels, and schist.* Johnnie Formation—*purple, red, green, fissile shale, interbedded quartzite, olive-brown shale, yellow silicified dolomite, thin-bedded dolomite interbedded with sandstone and quartzite, siltstone, pebble conglomerate; also minor limestone and tuff* (Resting Spring Range). Noonday Dolomite—*cream and gray dolomite.* Sterling Quartzite—*white vitreous quartzite, cross-bedded, massive to thin-bedded quartzite, sandstone, shale, siltstone, and dolomite.*
PRECAMBRIAN		**UNDIVIDED PRECAMBRIAN METAMORPHIC ROCKS**	
PRECAMBRIAN	p€	**UNDIFFERENTIATED**	Complex of metamorphic rocks intruded by granitic rocks and by a still younger northward-trending dike swarm in southern Panamint Range. Includes quartzite in Emigrant Canyon quadrangle.
PRECAMBRIAN	p€s	**SCHIST**	Quartz mica schist, micaceous quartzite and dolomite (probably late Precambrian; Panamint Butte quadrangle).
PRECAMBRIAN	lp€	**LATER PRECAMBRIAN SEDIMENTARY AND METAMORPHIC ROCKS—Algonkian on some maps**	Pahrump Group: Kingston Peak Formation—*conglomerate, quartzite, shale, limestone and dolomite;* Beck Spring Dolomite—*blue-gray dolomite;* Crystal Spring Formation—*conglomerate, quartzite, shale, dolomite, limestone, diabase, and chert.* Panamint Metamorphic Complex—*granite, gneiss, hornblende schist, biotite-quartz schist, muscovite-quartz schist, amphibolite, marble, limestone, quartzite, and conglomerate* (in part equivalent to Pahrump Group).
PRECAMBRIAN	ep€	**EARLIER PRECAMBRIAN METAMORPHIC ROCKS—Archean on some maps**	World Beater Complex (Porphyry)—*augen gneiss, and porphyritic granite* (south central Panamint Range). Gneiss, quartzite, and amphibolite of southwest Panamint Range. Greenish-gray schist, gray gneiss, and coarsely crystalline calcite marble (some dolomite) of Black Mountains.

NOTES

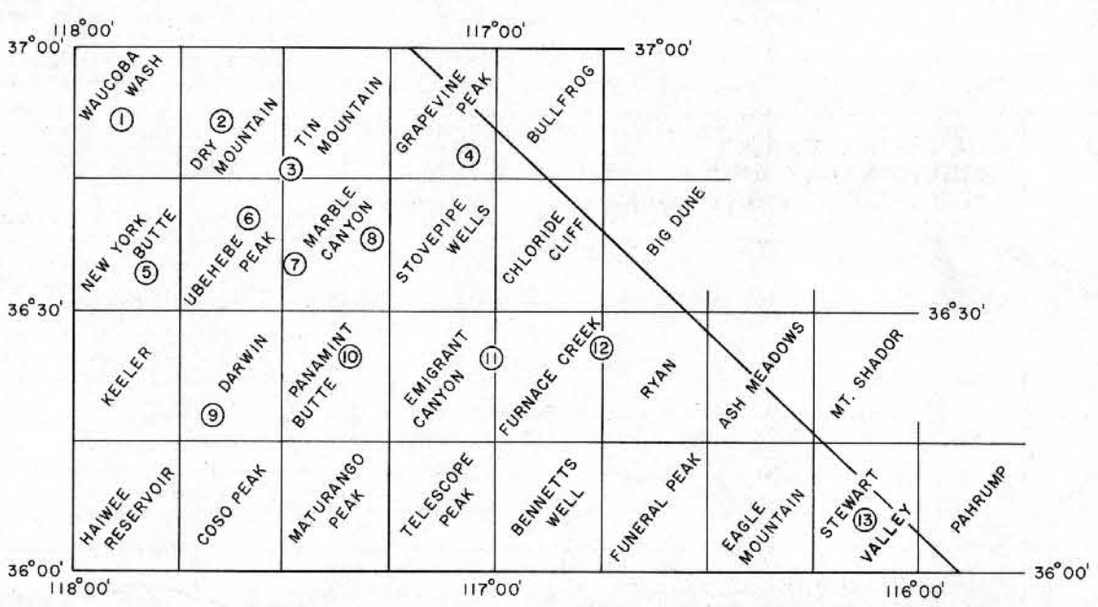
1. The basalt and basaltic andesite flows of the Coso Range may vary in age from late Pleistocene (southern Coso Range) to late Pliocene (northern Coso Range).
2. The Greenwater Volcanics as redefined by Drewes (1963). A K-Ar age date of 5.4 ± 0.2 m.y. was obtained from rhyodacite vitrophyre from the Dante's View area (Fleck, R. J., 1970, Age and tectonic significance of volcanic rocks, Death Valley area, California: Geological Society of America Bulletin, v. 81, p. 2807-2816).
3. K-Ar age date determinations made on three trachyandesite caprock flows of the Saline Range yielded ages of 2.5-3.5 m.y. A K-Ar age date of 3.5 m.y. was obtained from a trachyandesite plug (Ross, D. C., 1970, Pegmatitic trachyandesite plugs and associated volcanic rocks in the Saline Range-Inyo Mountains region, California: U.S. Geological Survey Professional Paper 614-D, p. 17).
4. Intrusive equivalent of the Greenwater Volcanics of Haefner (1972).
5. Probably includes rocks of the Artist Drive Formation.
6. K-Ar age dates of 6.3-8.2 m.y. were obtained from the "older" volcanic rocks from the Dante's View area and from near Hidden Spring (Fleck, 1970). See note 2 for complete reference.
7. The porphyritic andesite of the Coso Range appears to be identical to the porphyritic andesite of the southern Inyo Mountains, which is considered to be late Pliocene in age. However, the andesite and andesitic pyroclastic rocks of the Coso Range overlie the Plio-Pleistocene Coso Formation and may therefore vary in age from Pleistocene to Pliocene.
   Although the "older" volcanics of Drewes (1963) and the Shoshone Volcanics and Deadman Pass Volcanics of Haefner (1972) are early Pliocene in age, they were included in the Tertiary Undivided (Tv) by the compiler to distinguish them from the late Pliocene (Pv) Greenwater Volcanics of Drewes (1963) and Haefner (1972).
8. Age may vary from Pleistocene to Pliocene (see note 7).
9. Comparable rock units in the vicinity have been dated by K-Ar methods at 12-18 m.y. (Haefner, 1972).
10. A K-Ar age date of 12 m.y. was obtained from monzonite porphyry believed to be representative of the Tertiary granitic rocks of the eastern Panamint Range (Stern, T.W., Newell, M.F., and Hunt, C.B., 1966, Uranium-lead and potassium-argon ages of parts of the Amargosa thrust complex, Death Valley, California: U.S. Geological Survey Professional Paper 550-B, p. 142-147).
11. K-Ar age dates from Hunter Mountain Quartz Monzonite of 134 m.y. (New York Butte quadrangle) and 156 m.y. (Dry Mountain quadrangle) are reported by Ross, D.C., 1969, Descriptive petrography of three large granitic bodies in the Inyo Mountains, California: U.S. Geological Survey Professional Paper 601, p. 44. Two samples of biotite-hornblende quartz monzonite collected from the east side of the Argus Range have K-Ar age dates of 178 and 182 m.y. (Hall and Mackevett, 1962, p. 31).
12. Late Cretaceous age. K-Ar age date of 81 m.y. reported by Ross (1969).
13. Late Cretaceous age. K-Ar age dates of 67-87 m.y. reported by Wes Hildreth, University of California, Berkeley, written communication, 1973.

CORRELATION CHART OF PALEOZOIC FORMATIONS IN DEATH VALLEY SHEET AREA

Area / Age (State Map symbol)	① Inyo Mountains Waucoba Wash. Qd. Ross, 1967	② Southern Last Chance Range Dry Mountain Qd. Burchfiel, 1969	③ Northern Panamint Range Quartz Spring Area McAllister, 1952	④ Grapevine Mountains Reynolds [1]	⑤ Inyo Mountains Cerro Gordo Area Merriam, 1963	⑥ Inyo - Panamint Mountains Ubehebe Peak Qd. McAllister, 1956	⑦ Northern Panamint Range Goldbelt Spring Area Stadler, 1968	⑧ Southeastern Cottonwood Mountains Johnson, 1971	⑨ Southern Inyo Mountains Darwin Qd. Hall and MacKevette, 1962	⑩ Panamint - Argus Ranges Panamint Butte Qd. Hall, 1971	⑪ Panamint Range Hunt and Mabey, 1966 [2]	⑫ Furnace Creek Area McAllister, 1970	⑬ Nopah and Resting Spring Ranges Wilhelms, 1963	Area / Age (State Map symbol)
Permian (Pm)		Owens Valley Formation			Owens Valley Formation	Bird Spring(?) Formation	Owens Valley Formation	Owens Valley Formation	Owens Valley Formation	Owens Valley Formation	Unnamed formations at east foot of Tucki Mountain			Permian (Pm)
Pennsylvanian (CP)		Keeler Canyon Formation	Tihvipah Limestone		Keeler Canyon Formation	Rest Spring Shale	Keeler Canyon Formation	Keeler Canyon Formation	Keeler Canyon Formation; Rest Spr. Shale / Lee Flat Limestone	Keeler Canyon Formation; Lee Flat Limestone	Shale		Bird Spring Formation	Pennsylvanian (CP)
Mississippian (CM)	Rest Spring Shale; Perdido Formation	Rest Spring Shale; Perdido Formation; Tin Mountain Limestone	Rest Spring Shale; Perdido Formation; Tin Mountain Limestone	Unnamed Mississippian rocks —?—?—	Chainman Shale; Perdido Formation; Tin Mountain Limestone	Perdido Formation; Tin Mountain Limestone	Lee Flat Limestone—Perdido Formation; Tin Mountain Limestone	Mississippian rocks undivided	Perdido Formation; Tin Mountain Limestone	Perdido Formation; Tin Mountain Limestone	Tin Mountain Limestone and younger limestone		Monte Cristo Fm.: Bullion Limestone Mem.; Anchor Limestone Mem.; Dawn Limestone Mem.	Mississippian (CM)
Devonian (D)	Lost Burro Formation	Lost Burro Formation	Lost Burro Formation	Lost Burro Formation	Lost Burro Formation	Lost Burro Formation	Lost Burro Formation	Lost Burro Formation	Lost Burro Formation	Lost Burro Formation	Lost Burro Formation		Stewart Valley Fm.; Lost Burro Formation	Devonian (D)
Silurian (S)	Hidden Valley Dolomite	Hidden Valley Dolomite	Hidden Valley Dolomite	Hidden Valley Dolomite	Hidden Valley Dolomite	Hidden Valley Dolomite	Hidden Valley Dolomite	Hidden Valley Dolomite	Hidden Valley Dolomite	Hidden Valley Dolomite	Hidden Valley Dolomite	Hidden Valley Dolomite	Hidden Valley Dolomite	Silurian (S)
Ordovician (O) — Late	Ely Springs Dolomite	Ely Springs Dolomite	Ely Springs Dolomite	Ely Springs Dolomite	Ely Springs Dolomite	Ely Springs Dolomite	Ely Springs Dolomite	Ely Springs Dolomite	Ely Springs Dolomite	Ely Springs Dolomite	Ely Springs Dolomite	Ely Springs Dolomite	Ely Springs Dolomite	Late
Ordovician (O) — Middle	Johnson Spring Formation; Barrel Spring Formation	Eureka Quartzite	Eureka Quartzite	Eureka Quartzite	Eureka Quartzite	Eureka Quartzite	Eureka Quartzite	Eureka Quartzite	Eureka Quartzite	Eureka Quartzite	Eureka Quartzite	Eureka Quartzite	Eureka Quartzite	Middle
Ordovician (O) — Early	Mazourka Group: Badger Flat Limestone; Al Rose Formation	Pogonip Group: Antelope Valley Limestone; Lower Undiff. Pogonip	Pogonip Limestone	Pogonip Group	Pogonip Group —?—?—	Pogonip Limestone	Pogonip Limestone	Antelope Valley Ls. —?—?—	Pogonip Group —?—?—	Pogonip Group	Pogonip Group	Pogonip Group	Pogonip Formation	Early
Cambrian (Є) — Late	Tamarack Canyon Dolomite; Lead Gulch Formation	Nopah Formation: Upper Nopah Formation Undiff.; Dunderberg Shale Member	Nopah Formation	Nopah Formation; Shale member		Nopah Formation	Nopah Formation			Nopah Formation	Nopah Formation	Nopah Formation	Nopah Formation	Late
Cambrian (Є) — Middle	Bonanza King Dolomite	Bonanza King Formation	Racetrack Dolomite —?—?—	Bonanza King Formation		Racetrack Dolomite —?—?—	—?—?—			Bonanza King Formation	Bonanza King Formation	Bonanza King Formation: Banded Mountain Member; Papoose Lake Member	Bonanza King Formation	Middle
Cambrian (Є) — Early	Monola Formation; Mule Spring Limestone; Saline Valley Formation; Harkless Formation; Poleta Formation; Campito Formation	Carrara Formation; Zabriskie Quartzite; Wood Canyon Formation —?—?—		Carrara Formation; Zabriskie Quartzite; Wood Canyon Formation; Stirling Quartzite —?—?—						Carrara Formation —?—?—	Carrara Formation; Zabriskie Quartzite; Wood Canyon Formation; Stirling Quartzite; Johnnie Formation; Noonday Dolomite	Carrara Formation; Zabriskie Quartzite; Wood Canyon Formation —?—?—	Carrara Formation; Zabriskie Quartzite; Wood Canyon Formation; Stirling Quartzite; Johnnie Formation —?—?	Early
Precambrian or Cambrian (Є?)	Deep Springs Formation —?—?—													Precambrian or Cambrian (Є?)

1. Northern Grapevine Mountains, Reynolds, unpublished, Southern Grapevine Mountains, Reynolds, 1969.
2. Cambrian-Precambrian section modified slightly by compiler.

Note: –?–? = Base of formation not exposed.



INDEX TO LOCATIONS OF STRATIGRAPHIC SECTIONS

View northwestward across the southern end of Owens Valley, showing the surface of Owens Lake with the Sierra Nevada in the background. West–dipping Plio–Pleistocene Coso Formation, consisting of arkosic sandstone, lakebed sediments, and interbedded rhyolitic pyroclastic rocks was once overlain by older alluvium. The alluvium has been removed by erosion except for two small bluffs near the center of the photograph and the area near the upper right margin of the photograph. *Photo by Melvin C. Stinson, 1963.*