MAP I-592

DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

PREPARED IN COOPERATION WITH
THE CALIFORNIA DIVISION OF MINES AND GEOLOGY

GEOLOGIC MAP OF THE DAGGETT QUADRANGLE SAN BERNARDINO COUNTY, CALIFORNIA

By
T. W. Dibblee, Jr.

MISCELLANEOUS GEOLOGIC INVESTIGATIONS
MAP I-592

PUBLISHED BY THE U. S. GEOLOGICAL SURVEY
WASHINGTON, D. C.
1970

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TO ACCOMPANY MAP I-592

GEOLOGIC MAP OF THE DAGGETT QUADRANGLE, SAN BERNARDINO COUNTY, CALIFORNIA

By

T. W. Dibblee, Jr.

(Geology of area north of Mojave River previously mapped by
T. H. McCulloh (1965), but largely remapped by author)

DESCRIPTION OF THE MAP UNITS*

*Potassic and sodic-calcic (plagioclase) feldspar content of igneous rocks determined by chemical staining of sawed surface of samples by M. B. Norman.

CENOZOIC SEDIMENTARY AND VOLCANIC ROCKS

SURFICIAL SEDIMENTS

Unconsolidated, undissected sediments in valleys; thickness about 100 feet or less; in large valleys presumably gradational downward into the older valley sediments; elsewhere unconformable on other units. Age, very late Pleistocene and Recent. Composed of the following units:

River sand (Qrs).—Nearly white, well-sorted, fine to coarse sand composed mostly of quartz and feldspar grains; also some pebble and cobble gravel. Deposited by flood waters in channel of Mojave River.

Dune sand (Qs).—Nearly white, well-sorted, fine sand composed mostly of quartz and feldspar grains. Deposited by prevailing westerly winds.

Fan gravel (Qf).—Unsorted boulders and cobbles in coarse pebbly sand; derived from adjacent mountains and deposited as alluvial fans. Top surface slopes from about 400 to 200 feet per mile. Grades downslope into the alluvium.

Alluvium (Qa).—Light-gray gravel and sand. Near hills, mostly cobble- or pebble-gravel and sand; in large valleys, coarse to fine arkosic sand. Top surfaces slopes less than 200 feet per mile. West of Yermo, grades downslope through micaceous sandy silt into the clay.

Clay (Qc).—Tan, silty to argillaceous micaceous—alkaline clay at dry lake west of Yermo; mud when wet. Top surface is level.

OLDER ALLUVIUM (Qoa)

Gravel and sand of undeformed but dissected alluvial fans, derived from adjacent highlands. Generally less than 100 feet thick. Unconformity at base. Age, presumably late Pleistocene.

OLDER VALLEY SEDIMENTS

Older valley fill; dissected where elevated and locally deformed. In hills south of Nebo area, conformable on the marly limestone, but in most other places unconformable on Tertiary and pre-Tertiary formations. As much as 300 feet exposed, but maximum thickness concealed under Mojave River valley probably much greater. Age, presumably Pleistocene. In north half of sec. 22, T. 10 N., R. 2 E., yielded crude Indian artifacts(?) at surface and from lowest 20 feet in a pit (see Archeological Project, page 6, this report). Composed of the following facies:

Fanglomerate and gravel (Qof).—Gray, unbedded to poorly bedded, coarse alluvial sediments composed of unsorted to poorly sorted boulders, cobbles, and pebbles in weakly to moderately consolidated clayey, sandy matrix. In northwest part of quadrangle, some layers or lenses locally hard, calcareous. Derived mainly from pre-Tertiary and Tertiary (mostly volcanic) rocks of adjacent mountains. In places, such as east of Calico Mountains, contains a few feet of calcareous caliche at base.

Clay and marl (Qoc).—Mostly light-greenish-gray, silty clay and minor amounts of silty to pebbly sand, interbedded with white caliche marl. Probably deposited in shallow playa lake. Grades laterally into the fanglomerate and gravel.

MARLY LIMESTONE (Tl)

White, ranges from soft marl to hard limestone; in part silicified to white opaline chert; in layers as thick as 3 feet, interbedded with light-gray calcareous clay. Maximum thickness about 100 feet. Deposited in a lake. Relations with overlying and underlying formations apparently conformable. Age, presumably Pliocene, possibly as old as Miocene or as young as Pleistocene.

INTRUSIVE VOLCANIC ROCKS

Andesitic volcanic rocks; intrusive into the Mesozoic igneous rocks, Tertiary volcanic and sedimentary rocks, and the sedimentary rocks. Includes one local unit of breccia. Age, presumably Tertiary, may be in part as old as Oligocene or early Miocene and as young as Pliocene. The following units were mapped:

Intrusive andesite (Tai).—Forms large volcanic plug at Elephant Mountain, volcanic plugs and intrusive(?) masses in southeastern Calico Mountains, and two small pods in Newberry Mountains. Rock mainly andesite, but ranges to dacite, rock generally unbrecciated, hard, pink, tan, gray, or brown, massive to flow-laminated, microcrystalline to subvitreous, somewhat porous, aphanitic to porphyritic. Groundmass composed mainly of plagioclase and minor amounts of potassic feldspar and glass, and traces of iron oxides. Phenocrysts form as much as 20 percent of rock mass; most are of plagioclase, few are small biotite plates. In places rock contains a few small phenocrysts of quartz or minute needles of hornblende. Intrudes the volcanic and sedimentary rocks. Age, probably Miocene or Pliocene in northern parts of quadrangle; presumably early Miocene(?) in Newberry Mountains.

Andesite breccia or agglomerate (Taa).—Present only around north margin of pink andesite plug that forms Elephant Mountain; either intrusive volcanic breccia or extrusive agglomerate at margin of the plug. Composed of unsorted angular fragments as large as 2 feet in diameter of pink, porphyritic andesite in fragmental matrix of similar andesite. Andesite of fragments and matrix similar to that of the intrusive andesite. Age, same as the intrusive andesite at Elephant Mountain, namely Miocene or Pliocene.

Andesite porphyry (Tap).—Mainly andesite porphyry but ranges to dacite porphyry. Brownish-gray, greenish-gray to tan, massive to faintly flow-laminated, hard but somewhat porous. Composed of phenocrysts as long as 4 mm which make up from 20 to 40 percent of rock mass, in microcrystalline to subvitreous groundmass. Most phenocrysts are plagioclase (oligoclase-andesine); others are scattered small plates of biotite; rarely basaltic hornblende; quartz phenocrysts rare. Groundmass mostly plagioclase, with some potassic feldspar, glass, and traces of iron oxides. In Calico Mountains, associated with the tuff breccia as volcanic masses intrusive into it, and possible in parts as extrusive flows wedging out into it. Age, therefore, most likely Miocene, possibly (in part?) Pliocene.

SEDIMENTARY ROCKS

Stream-laid and lacustrine sedimentary deposits and a few thin tuff beds. In Calico Mountains, assemblage as thick as 3,000 feet. Northeast of Calico fault mapped by McCulloh (1965) as Barstow Formation which, in sec. 24, T. 10 N., R. 1 E., contains fragments of mammalian remains (including teeth of *Merychippus intermontanus)* of late Miocene (Barstovian) age (McCulloh, oral commun., 1954). Southwest of Calico fault unfossiliferous. In both areas conformable on the volcanic and sedimentary rocks. In Daggett Ridge area, assemblage as thick as 1,500 feet; yielded mammalian fossils of middle Miocene (Hemingfordian) age (R. H. Tedford, written commun., July 24, 1966); unconformable on the coarse sedimentary and volcanic rocks of Daggett Ridge and on Mesozoic igneous rocks. The following facies were mapped:

Conglomerate (Tsc).—In Newberry Mountains (N 1/2 sec. 10, T. 8 N., R. 1 E.), and in Calico Mountains (SW 1/4 sec. 28, T. 10 N., R. 2 E.; NW 1/4SW 1/4 sec. 23, T. 10 N., R. 1 E.; and W 1/2 sec. 13, T. 10 N., R. 1 W.) poorly bedded conglomerate

and breccia composed of rounded to subangular fragments, mostly of Tertiary andesitic volcanic rocks with few of Mesozoic granitic rocks; fragments embedded in matrix of light-brownish-gray arkosic sandstone.

Sandstone (Tss).—In Calico Mountains and Daggett Ridge areas, mostly light-gray to buff sandstone, locally greenish-gray, pink to reddish-brown; stratified, semifriable, fine- to coarse-grained, micaceous, arkosic; contains some interbedded gray to greenish-gray siltstone and shale; in places contains a few interbeds of pebble conglomerate.

Shale and sandstone (Tsh).—In Calico Mountains and north of Lead Mountain, ranges from nearly pure shale to shale and interbedded sandstone. Shale, gray to tan, thin-bedded, with platy to conchoidal fracture; micaceous, silty to argillaceous; in places contains a few thin hard layers of gray limestone or dolomite, or layers of calcareous nodules; in several places contains an occasional thin layer of white fine-grained tuff. Interbeds of sandstone similar to that described above.

Shale and siliceous shale (Tsi).—In Calico Mountains mostly shale like that described above, but commonly almost white, tuffaceous, and contains numerous thin interbeds of hard tan to grayish-brown siliceous shale or silicified tuff.

Tuff (Tst).—In Daggett Ridge area forms basal bed and a few other beds as thick as 30 feet; tuff is tan, light-gray to white, massive, semifriable, fine- to medium-grained, composed of glass shards, feldspar grains, scattered biotite flakes, and small fragments of pink to brown andesitic rocks.

Granitic conglomerate (Tsg).—Light-brownish-gray, massive to crudely bedded, friable to indurated conglomerate. Composed of poorly sorted subangular fragments of granitic rocks (mostly biotite quartz monzonite), as large as 2 feet, in matrix of coarse arkosic sandstone. In Newberry Mountains forms basal unit as thick as 1,300 feet; in Daggett Ridge area and Calico Mountains forms facies throughout the sedimentary rocks.

Upper fanglomerate of porphyry detritus (Tsf).—East of Daggett Ridge, gray, unbedded fanglomerate composed mostly of unsorted boulders, cobbles, and pebbles of Mesozoic andesitic to latitic porphyry; some of granitic rocks (mostly biotite quartz monzonite) derived from areas south of quadrangle. Unit also contains a few clasts of Tertiary andesite and basalt. Forms basal unit of the sedimentary rocks in this area, with unconformity at base in secs. 27 and 28, T. 8 S., R. 1 E.

Basal limestone (Tsl).—Present only locally at base of the sedimentary rocks in Calico Mountains and north of Lead Mountain. Bedded, locally sandy or pebbly gray limestone. As much as 70 feet exposed north of Lead Mountain.

VOLCANIC ROCKS IN SOUTHERN CALICO MOUNTAINS

Andesite and andesite breccia occurring as large lenticular masses in the sedimentary rocks, mostly extrusive but possible in part intrusive. Age, probably same as that of the sedimentary rocks, namely middle and late Miocene. Composed of the following units:

Andesite breccia near Burcham mine (Tbb).—Crudely bedded to massive brown breccia or agglomerate of unsorted angular fragments of andesite as large as 2 feet in diameter; forms thick extrusive masses that grade laterally southeastward and downdip through bedded, finer breccia into siliceous shale and shale of the sedimentary rocks. Mapped as Pliocene(?) landslide breccia by Weber (1967, p. 6–7).

Andesite north of Yermo (Tay).—Reddish- to grayish-brown, massive, porphyritic andesite; composed of phenocrysts of plagioclase, a few small plates of biotite and rarely hornblende in a microcrystalline to subvitreous groundmass of plagioclase with minor amounts of potassic feldspar, glass, and traces of iron oxides. Phenocrysts range from 5 to 25 percent of rock mass. Slightly to severely brecciated. Forms large lenticular volcanic mass in southeastern Calico Mountains that wedges out westward into the sedimentary rocks. Probably extrusive, but may be in part intrusive; associated with intrusive andesite.

COARSE SEDIMENTARY AND VOLCANIC ROCKS OF DAGGETT RIDGE

Assemblage of coarse alluvial sedimentary rocks and a few basaltic flows, mainly in Daggett Ridge area. As thick as 2,000 feet; in Daggett Ridge, unconformable on the Mesozoic igneous rocks; in Newberry Mountains, overlies the volcanic and sedimentary rocks. Referred to Rosamond Series of Hershey (1902) by Gardner (1940, p. 278–281). Unfossiliferous; age Miocene(?), probably early Miocene on basis of stratigraphic position. Composed of the following facies units:

Lower fanglomerate of porphyry detritus (Tfp).—Similar to the upper fanglomerate of porphyry detritus (Tsf) of the sedimentary rocks described above, but contains very few fragments of Tertiary andesite or basalt. May be same unit, but more likely is older because it is below rather than above unconformity at base of the sedimentary rocks northwest of Daggett Ridge.

Porphyry breccia (Tpb).—Lenticular landslide masses of shattered Mesozoic andesite or latite porphyry.

Granitic breccia (Tgb).—Lenticular landslide masses of shattered Mesozoic biotite quartz monzonite in Daggett Ridge; gray granitic breccia and fanglomerate east of Camp Rock Road.

Basalt flows (Tbu).—Similar to basalt in the volcanic and sedimentary rocks described below. Forms lenticular flows or possibly some sills. Prominent flow that forms Daggett Ridge hard, vesicular, as thick as 150 feet.

Agglomerate and tuff breccia (Tag).—Unsorted, subrounded to subangular boulders, cobbles, and smaller fragments embedded in crudely bedded, semifriable, massive, white, medium- to coarse-grained tuff and tuff breccia; nearly all clasts are of brown-weathering pink Tertiary rhyolitic vitrophyre that contains scattered phenocrysts of potassic feldspar (sanidine), sodic plagioclase, and plates of biotite.

VOLCANIC AND SEDIMENTARY ROCKS

Assemblage of extrusive volcanic, pyroclastic, and sedimentary rocks that in Calico Mountains underlie the sedimentary rocks of late Miocene age and in Newberry Mountains onlaps or buttresses against very uneven surface eroded into the Mesozoic hypabyssal and plutonic igneous rocks. Unfossiliferous; age, Tertiary, possibly middle Miocene (McCulloh, 1965), probably Oligocene or early Miocene; possibly older. In Calico Mountains, as thick as 3,000 feet, of which pyroclastic rocks were mapped as Pickhandle Formation by McCulloh (1965). In Lead Mountain area, as thick as 2,500 feet. In Newberry Mountains, upper 17,000 feet of 22,000-foot-thick assemblage exposed within quadrangle; referred to Rosamond Series of Hershey (1902) by Gardner (1940, p. 278–281). Composed of the following lithologic units:

Fanglomerate of Mesozoic detritus (Tf).—In Newberry Mountains, unbedded gray fanglomerate of unsorted subrounded fragments as large as 3 feet in diameter in friable fragmental matrix. Composed of detritus derived from Mesozoic igneous rocks (mostly andesitic to latitic porphyry or porphyry complex and biotite quartz monzonite) south of quadrangle. Uppermost unit (north of Azucar Mine) contains some detritus of Tertiary andesite and basalt. Deposited by run-off from torrential streams.

Conglomerate and breccia (Tcb).—In foothills 1 to 3 miles northwest of Daggett, as thick as 1,700 feet, mainly massive to crudely bedded, light-brownish to pinkish-gray breccia of unsorted, subangular fragments as large as several feet in diameter, mostly of Tertiary andesitic rocks with few of Mesozoic plutonic and hypabyssal igneous rock, embedded in matrix of light-gray to reddish-brown gritty sandstone; grades downward and laterally northwestward through conglomerate and some interbedded tuffaceous sandstone into tuff-breccia.

On Lead Mountain, very hard, light-gray, massive, medium- to coarse-grained arkosic sandstone with grit and subangular pebbles and cobbles of granitic rock; weathers dark-brown on surface; forms hard resistant capping as thick as 80 feet (this capping could be basal part of the Miocene sedimentary rocks). In exposure 2 miles northeast of Barstow, composed mainly of pink to gray arkosic sandstone and conglomerate with cobbles and pebbles derived from granitic rocks and Tertiary andesitic volcanic rocks.

Limestone, shale, and tuff (Tls).—In Lead Mountain area, as thick as 1,500 feet or more; deposited in a large lake or lakes. Limestone and dolomite carbonate rocks light-gray to greenish-gray, microcrystalline(?), form hard resistant strata from 1 to 5 feet thick; commonly in groups with thin intercalations of shale; in many places carbonate strata contain thick laminae, lenses, or nodules of dark gray chert from a quarter of an inch to 3 inches thick. Carbonate strata lense out southeastward near Elephant

Mountain. Intercalations of shale, tuffaceous shale, tuff, and tuffaceous sandstone, cream-white to light gray, commonly thin-bedded, grade laterally southeastward into the tuff breccia near Elephant Mountain.

Tuff breccia (Tt).—Yellowish-tan, cream-white to greenish-tan, rarely pink, bedded to massive tuff breccia; composed of pea-size devitrified pumice lapilli and (or) various amounts of poorly sorted, angular to subrounded fragments of Tertiary andesite and dacite as large as 6 inches, but generally less than 1 inch in diameter, embedded in matrix of light-colored tuff that contains grains of feldspar, quartz, and flakes of biotite. In Calico Mountains, gradational into the andesite breccia-tuff breccia and andesite or dacite breccia units. In Lead Mountain area, gradational into the limestone, shale, and tuff unit.

Tuff breccia, red (Ttr).—Similar to tuff breccia described above, but red to pink and generally with abundant large fragments of red andesite or dacite.

Andesite breccia and tuff breccia (Tat).—In Calico Mountains, mixture of andesite or dacite breccia as described below, and tuff-breccia as described above. In Lead Mountain area similar, but includes breccia of red and tan felsite as described below, and in SE 1/4 sec. 31, T. 10 N., R. 1 E., includes breccia or small landslide(?) masses of Mesozoic andesite to latite porphyry.

Andesite or dacite breccia (Tab).—In Calico Mountains, pinkish-gray, pinkish-brown to brownish-gray, massive to crudely bedded flow and flow-breccias of vitreous, felsitic or porphyritic andesite or dacite. In many places flow-breccias form bold cavernous-weathering exposures. In Lead Mountain area, mainly brecciated masses of tan felsite as described below.

Red andesite or dacite breccia (Tar).—In Calico Mountains, similar to andesite or dacite breccia described above, but mostly dark maroon-red; composed of unsorted angular fragments of dark red, slightly porphyritic andesite in somewhat porous, cavernous-weathering red matrix of fragmental andesite.

Andesite or dacite (Ta).—Medium- to dark-reddish-brown, massive, slightly porphyritic flow rock. Composed of scattered phenocrysts of plagioclase and locally a few of quartz in microcrystalline to subvitreous groundmass of plagioclase with minor amounts of potassic feldspar, glass, and traces of iron oxides. In Newberry Mountains, forms generally evenly layered flows, with fracture parting commonly parallel to top and base of flows. In Calico Mountains, forms short, thick, lenticular flows with irregular fracture; gradational into the andesite or dacite breccia as described above.

Red felsite (Trf).—Northwest of Elephant Mountain, dark maroon-red massive felsite; microcrystalline, composed mostly of plagioclase and minor amounts of potassic feldspar, possibly some quartz and glass, and traces of iron oxides. In places, is breccia with small angular fragments of lighter colored felsite in darker felsite matrix. Rock has irregular to locally platy fracture; in some places rock is brecciated. Probably a flow, flow-breccia, or possibly a sill.

Tan felsite (Tlf).—In Elephant Mountain-Lead Mountain area, similar to red felsite described above, but tan or buff; light-gray where unweathered. Probably one or several thick flows or flow-breccias; possibly in part intrusive. Rests on Mesozoic biotite quartz monzonite; overlain by the red felsite or the limestone, shale, and tuff unit.

Diabase (Td).—In Lead Mountain area and southward to Mojave River; black, massive, fine-, medium- to locally very coarse-grained diabase composed of pyroxene (augite), plagioclase (labradorite), olivine, and disseminated iron oxides. Rock disintegrates to black sand; coarse-grained rock weathers to large spheroids. Forms large intrusive masses and sills in the volcanic and sedimentary rocks.

Basalt (Tb).—In Newberry Mountains, forms evenly layered flows and possibly some sills of black, massive, microcrystalline to fine-grained basalt. Composed mainly of calcic plagioclase (commonly as minute laths), pyroxene (augite?), basaltic glass, and disseminated iron oxides (magnetite?); contains few to abundant small phenocrysts of olivine (partly serpentinized) and in places a few of plagioclase. Rock somewhat semiporous with minute interstitial vugs. Some flows vesicular or amydgaloidal with few to abundant amygdules of calcite, opal, chalcedony, and quartz. Disintegrates to black sand on weathering.

Conglomerate and sandstone (Tcs).—(Mapped as Jackhammer Formation by McCulloh, 1965). Unit as thick as 100 feet, exposed at base of sequence in eastern Calico Mountains and southwest of Lead Mountain. Composed of well-rounded cobbles and pebbles of granitic rocks and quartzite in matrix of light-gray arkosic sandstone.

MESOZOIC HYPABYSSAL AND PLUTONIC IGNEOUS ROCKS

FELSITE DIKES (f)

In northwestern part of quadrangle, forms dikes and pods intrusive into the Waterman Gneiss and quartz diorite. Rock is white, very hard but brittle, microcrystalline quartz latite felsite composed of sodic plagioclase, potassic feldspar and small amounts of quartz. Age, probably Mesozoic.

MAFIC (DIORITIC) DIKES (d)

On hill 5 miles south of Daggett, dark-gray, moderately hard, massive, fine-grained dioritic rock composed mostly of hornblende, biotite, and plagioclase; in places contain scattered phenocrysts of plagioclase. Forms dikes as thick as 7 feet in the biotite quartz monzonite. Age, presumably Mesozoic.

GRANITIC ROCKS

Massive (nongneissoid) quartz-bearing granitic rocks that range from granite to quartz monzonite. Age, presumably Mesozoic, probably Late Jurassic or Early Cretaceous. Composed of the following types:

Granite (gr).—Gray-white to buff-white in Calico Mountains; pink to pinkish-gray-white in southern part of quadrangle; ranges from granite to quartz monzonite, composed of from 30 to 40 percent quartz; 30 to 45 percent potassic feldspar; 15 to 30 percent plagioclase (oligoclase) and less than 2 percent biotite. In southern areas, potassic feldspar is pale pink.

Aplitic quartz monzonite (ap).—Light-gray, aplitic or fine-grained granitic rock composed mainly of quartz, potassic feldspar and plagioclase in nearly equal proportions, and less than 1 percent biotite. In places contains a few small phenocrysts of plagioclase.

Biotite quartz monzonite (bqm).—Light-gray, medium- to locally coarse-grained granitic rock composed of quartz, potassic feldspar and plagioclase (oligoclase-andesine) in generally equal proportions, 2 to 8 percent biotite, and a total of less than 1 percent hornblende, sphene, zircon, and iron oxides. In places contains a few phenocrysts of potassic feldspar.

QUARTZ DIORITE (qd)

Gray, massive (nongneissoid), medium-grained granitic rock ranging from quartz diorite to granodiorite. Composed of 10 to 30 percent quartz, 5 to 15 percent potassic feldspar, 40 to 60 percent plagioclase (andesine), 5 to 15 percent biotite, and a total of less than 5 percent hornblende and disseminated iron oxides. In northwestern part of quadrangle, intrusive into the Waterman Gneiss. Age, presumably Mesozoic.

HORNBLENDE DIORITE AND GABBRO (hd)

Dark-gray to black, massive (nongneissoid), medium- to locally coarse-grained dioritic rock composed mostly of hornblende and (or) biotite, and calcic plagioclase, in variable proportions and minor amounts of magnetite and secondary chlorite, epidote, quartz, and iron oxides. Forms masses engulfed in granitic rocks. Age, presumably Mesozoic.

ANDESITE TO LATITE PORPHYRY (ap)

Gray, very hard but closely fractured, massive (nonfoliated) porphyry; composed of scattered to numerous phenocrysts in nonvitreous microcrystalline groundmass. Nearly all phenocrysts are plagioclase (andesine?), with generally sharp rectangular boundaries, but many have a microcrystalline texture, and (or) are zoned with more calcic rims; some partly sericitized; in places replaced by epidote at rims. Phenocrysts commonly leached out on weathered surface. Minute plates of biotite (commonly altered to iron oxides) abundant. In a few places contains rare minute rounded phenocrysts of quartz. Groundmass is gray to dark gray, composed of plagioclase or plagioclase and potassic feldspar. In NW 1/4 sec. 21, T. 8 N., R. 1 E., some rock is aphanitic and is probably devitrified obsidian with curved, contorted flow-banding. In this quadrangle porphyry appears to be intruded by

granitic rocks and is presumably Mesozoic in age. Generally similar to and probably related to Mesozoic porphyry complex in Ord Mountains quadrangle (Dibblee, 1964) or Ord Mountain Group of Gardner (1940, p. 266–270).

PRECAMBRIAN(?) METAMORPHIC ROCKS

WATERMAN GNEISS

Intensely metamorphosed rocks of probable sedimentary origin. Section many thousands of feet thick, of which some 7,000 feet lies within quadrangle. Age, probably Precambrian, possibly Paleozoic. Named by Bowen (1954, p. 17–23) for exposures just west of quadrangle near Waterman silver mine 4 miles north of Barstow. Composed of the following rock units:

Quartz diorite gneiss (Wg).—Medium gray, medium-grained, ranges from laminated gneiss to faintly gneissoid or lineated quartz diorite; composed essentially of quartz, plagioclase (andesine), hornblende, and biotite, in variable proportions, and small amounts of secondary iron oxides, chlorite, epidote, and clinozoisite. In places contains thin lenses a few inches to several feet thick of micaceous felspathic quartzite and others of marble. Lamination of gneiss generally parallel to layers of quartzite and marble; lineation parallel to axes of folds in gneiss; ptygmatic folding rare. In many places some laminae in gneiss are incipient mylonite.

Marble (Wm).—White, massive to bedded, medium to coarsely crystalline; composed of dolomite and lesser amounts of calcite; contains grains of garnet, epidote, diopside, and forsterite. In a few places slightly greenish yellow from alteration of magnesium silicate minerals to serpentine or antigorite. Forms lenticular strata as thick as 100 feet in gneiss; only those more than 6 feet thick are shown.

SIGNIFICANT GEOLOGIC NOTATION

UNCONFORMITY

Great buttress unconformity of Tertiary System against pre-Tertiary basement terrain in Newberry Mountains (see cross-section E–E').

The assemblages of volcanic and sedimentary rocks, and coarse sedimentary rocks of Daggett Ridge, of Tertiary age, exposed in Newberry Mountains in this quadrangle and in the adjacent Newberry quadrangle (Dibblee and Bassett, 1966) form a succession with a maximum combined thickness of as much as 25,000 feet. This entire succession onlaps, with abrupt buttressing out of successively higher units within it, from east to west against a once extremely uneven, steep-sloping basement surface eroded deeply into the igneous rocks of Mesozoic age. Contact with this former basement surface is a buttress unconformity with no evidence of fault movement. This entire succession of volcanic extrusions and coarse alluvial detritus appears to have accumulated very rapidly under subsiding conditions against a mountainous basement terrain of Mesozoic rocks with topographic relief of some 25,000 feet, and slopes as steep as 70°. This must be the greatest, most abrupt onlap of a Tertiary succession of stratified deposits against the pre-Tertiary basement terrain in Mojave Desert, if not in California.

MINES

SILVER

Following data abstracted with slight modifications from Erwin and Gardner (1940), Wright and others (1953, p. 126–128), and Weber (1965, 1966, 1967).

In Calico Mountains rich silver ore was discovered in 1881. Extensive mining soon followed discoveries in many places, with peak production of silver in 1890. Mining continued until 1896, when most of the ore was mined out and price of silver dropped. Total production of silver variously estimated at 13 to 30 million dollars. All silver mines of Calico district idle since 1890's, except for occasional exploratory work or very small production in a few, as indicated in mines A through V described below.

Silver minerals of Calico Mountain mines occur in the Tertiary volcanic and sedimentary rocks and in a few places in basal part of the sedimentary rocks. In nearly all mines, minerals found in oxidized zone as chlorides and chloro-bromides of silver (cerargyrite and embolite); associated with oxides of iron and manganese, and in places carbonates of copper and lead; and traces of gold. Minerals either in veins of barite and (or) jasper, or in fracture or fault zones; less commonly in network of multitudinous fractures or as disseminations in porous volcanic rocks. Silver minerals in all mines found mostly within a few hundred feet of the surface, where ore averaged 10 to 20 ounces of silver per ton. Veins extend downward to unknown depths, but silver content decreases with depth; veins contain only small amounts of sulfides of iron, copper, and lead at lower depths in unoxidized zone.

In Calico Mountains, most of silver ore was found in series of northwest-trending veins parallel to Calico fault zone; veins on northeast side of fault and within 1 1/2 miles of fault; the vein series extends from Odessa Canyon northwestward for about 4 miles (Weber, 1967); veins generally vertical or dip steeply southwest, range from less than 2 inches to 50 feet wide, and traceable from a few feet to as much as 4,500 feet. Richest veins in southeastern part of vein series.

Silver minerals probably precipitated with associated minerals as shallow epithermal deposits from hydrothermal solutions that issued during or after late stages of Tertiary volcanism.

A. *Bismark, Humbug, Occidental, and Argentium mines.*—NE 1/4 sec. 15, SE 1/4 sec. 10, T. 10 N., R. 1 E. Silver, with chrysocolla, in shallow, thin, barite-rich veins mostly along fault trending N. 17° W., also in fractures, bedding planes, and disseminations in porous tuff breccia and the andesite or dacite breccia. Mined from several shallow shafts, numerous pits, tunnels, drifts, and stopes, to depths mostly less than 30 feet and not more than 100 feet (Wright and others, 1953, p. 131, and tab. list).

B. *Garfield-Thunderer mines.*—NW 1/4 sec. 14, T. 10 N., R. 1 E., west side of Odessa Canyon. Silver minerals, with some chrysocolla, in thin, irregular barite-rich veins along a fault(?) trending northwest and dipping steeply southwest, and in numerous fracture and breccia zones southwest of fault in the andesite or dacite breccia and tuff breccia. Mined from short adits driven into hillside, and two tunnels, one 100 feet above the other, driven along the fault; lower tunnel 4,000 feet long, upper tunnel 2,500 feet long; much of ore mined from two chambers, one in each tunnel. From 1882 to 1884 Garfield mine produced 2,782 tons of ore that yielded $345,417 in silver (Tucker and Sampson, 1940, p. 244; Wright and others, 1940, p. 130–131).

C. *Odessa mine.*—SW 1/4 sec. 14, T. 10 N., R. 1 E., west wall of Odessa Canyon. Silver ore as impregnations and some rich pockets in porous tuff breccia and andesite or dacite breccia, most along or near minor northwest-trending fault. Mined from tunnel driven northwest along fault(?), two lower tunnels 150 and 200 feet long, and several winzes (Wright and others, 1953, p. 130).

D. *Blackfoot mine.*—SE 1/4 sec. 14, T. 10 N., R. 1 E., east side of Odessa Canyon. Silver ore, with some lead carbonates, formed ore shoots as thick as 10 inches wide and as long as 400 feet, at depths less than 75 feet, in a jasper vein along minor fault that strikes west-northwest and dips 50°-75° SW. in andesite. Also some silver chlorides in bedding planes in tuff breccia southwest of vein. Numerous surface workings (Wright and others, 1953, p. 131).

E. *Alabama, Snowbird, Dietzman, and F. Carbonate mines.*—S 1/2 sec. 14, N 1/2 sec. 23, T. 10 N., R. 1 E. Silver ore in fractures and as disseminations in tuff breccia and andesite breccia. Worked from numerous trenches and short adits. Production small (Wright and others, 1953, nos. 300, 308, 311 of tab. list).

G. *Silver King and Oriental mines.*—N 1/2 sec. 22, S 1/2 sec. 15, T. 10 N., R. 1 E., on east side of Wall Street Canyon just north of Calico. Largest mines in Calico district. Silver ore mostly in two parallel barite-jasper veins as thick as 2 feet, striking northwest, dipping 70°-90° SW., in tuff breccia, red andesite breccia, and andesite of the volcanic and sedimentary rocks. Silver minerals decrease with depth, as chalcopyrite, pyrite, and tetrahedrite increase.

Mines operated from 1883 to 1886 by Silver King Mining Co., which developed about 6,000 feet of drifts along veins from inclined shaft 500 feet deep; tunnels at five levels connected with Oriental mine to northwest; mined 37,000 tons of ore averaging $36.61 per ton with gross value of $1,355,000 in silver. Operated from 1926 to 1930 by Zenda Mining Co., which sunk two vertical shafts, No. 1 shaft 340 feet deep; No. 2 shaft 542 feet southwest of No. 1 shaft and 550 feet deep, with drifts at 320-, 430-, and 530-foot levels; much ore mined but yield of silver was small; water struck at 320 feet. Owned and operated from 1952 to 1964 by

Knott's Berry Farm of Buena Park, as part of Calico ghost town historical attraction for tourists; since 1964 a state park (Tucker and Sampson, 1940, p. 247–248; Erwin and Gardner, 1940, p. 301; Wright and others, 1953, p. 129).

H. *Sioux, Falls, St. Louis Consolidated, and Lone Star Mines.*—(From north to south). W 1/2 sec. 15, T. 10 N., R. 1 E., west side of Wall Street Canyon. Silver ore in several mineralized fissures or veins probably northwestward projection of those and others at Silver King mine, strike about N. 30° W., dip 75°–85° NE., in porphyritic andesite, andesite breccia and tuff breccia. Veins extensively worked from pits, trenches, short adits, and near northwest corner of sec. 15 from three shafts with numerous drifts and stopes (Wright and others, 1953, p. 129–130, in part).

J. *Burcham (Total Wreck) mine.*—SE 1/4 sec. 16, NE 1/4 sec. 21, T. 10 N., R. 1 E. Active at intervals as late as 1941. Ore in two veins, mostly in the sedimentary rocks; Burcham (south) vein is silica and iron oxides in lacustrine shale, 3-10 feet thick, strikes N. 70° W., dips 65° SW., contains silver chloride, and some lead carbonate, with occasional lumps of galena and sphalerite, and disseminated gold. Mulcahy (north) vein is 300-500 feet north of Burcham vein, at contact of shale on south with the tuff breccia on north; 4–30 feet thick, strikes N. 45° W., dips 65° SW.; dies out to southeast and discontinuous to northwest; vein mostly iron-stained quartz with values in silver minerals and gold. Workings consist of crosscut tunnel driven N. 15° E. for 512 feet. At 104 feet from portal, tunnel intersects Burcham vein, where vein is drifted 200 feet southeast and 640 feet northwest, with three winzes 200 feet apart sunk on vein from tunnel level to depths of 250 feet, where vein is cut off by northeast-dipping reverse fault. At 410 feet from portal, tunnel intersects Mulcahy vein, where vein is drifted 500 feet northwest and 240 feet southeast. Produced both silver and gold (Tucker and Sampson, 1940, p. 242–243; Erwin and Gardner, 1940, p. 302–303; Wright and others, 1953, p. 132–133).

K. (Not shown). *Voca (Washington) mine.*—SE 1/4 SW 1/4 sec. 16, T. 10 N., R. 1 E., nearly half a mile northwest of Burcham mine. Silver ore in siliceous vein along or near fault contact between andesite breccia on northeast and shale with chert of the sedimentary rocks on southwest. Production small (Wright and others, 1953, p. 132).

L. *Waterloo and Union mines.*—SW 1/4 sec. 16, T. 10 N., R. 1 E. Exploratory work in Waterloo mine in 1950. In Waterloo mine (nearly half a mile northeast of SW corner, sec. 16), ore bodies were irregular with silver minerals in barite-jasper gangue mostly along and near contact of tuff breccia and red andesite breccia on northeast, with shale and siliceous shale or chert of the sedimentary rocks on southwest. Vein dips steeply southwest, terminated below by fault dipping northeast. Mine consists of 10,000 feet of workings from 350-foot shaft, with drifts along vein at seven levels at 50-foot intervals; vein mined laterally for about 1,100 feet and downdip to about 525 feet. Ore reported to assay 11–20 ounces. Union mine (1,200 feet northeast of Waterloo mine) consists of shaft and about 1,000 feet of workings, including drifts, along northwest-trending barite vein in the andesite breccia and tuff breccia; production small (Wright and others, 1953, p. 132; Erwin and Gardner, 1940, p. 303, in part).

M. *Lamar and Possibility mines.*—NE 1/4 sec. 17, T. 10 N., R. 1 E. Lamar mine near east line of sec. 17, Possibility mine about 1,700 feet northwest of Lamar mine. Each worked from pits and a shaft with short drifts and stopes, along Calico fault, mostly in shale of the sedimentary rocks on southwest side. No production recorded (Wright and others, 1953, p. 132).

Exploratory work by American Smelting and Refining Company of New York.—N 1/2 sec. 21, S 1/2 sec. 16, NE 1/4 sec. 17, T. 10 N., R. 1 E. (not shown on map). Properties leased by American Smelting and Refining Co. from Burcham Mining Co. and Waterloo Mining Co. in 1965–66. Mountain underlain by andesite breccia (landslide breccia of Weber, 1967) that grades downdip into chert, siliceous shale, and clay shale of the sedimentary rocks on northeast side of Calico fault; explored by about 350 core holes from 150 to 500 feet deep. Area explored extends from Burcham mine northwest about a mile to Lamar mine, and from Calico fault northeastward about 1,500 feet. Andesite breccia said to contain low-grade disseminations of silver minerals and possibly other metallic minerals. Company proposes a $7-million open-pit silver mining operation to strip 13,000 to 15,000 tons of breccia daily to depth of 400 feet along area 4,000 to 5,000 feet long by 600 to 1,000 feet wide, and to treat the ore at a mill or ore beneficiation plant to be built nearby (Los Angeles Times, Aug. 21, 1967).

N. *Langtry mine.*—Sec. 7, T. 10 N., R 1 E. Silver minerals, with lead carbonate in two veins of barite with manganese, iron oxides, and quartz; 3 to 4 feet thick, about 60 feet apart, striking northwest and dipping steeply toward each other; in shale and andesite breccia. Mine consists of about 250 feet of workings. About 200 tons of ore mined from a shallow shaft (Wright and others, 1953, p. 131–132).

Q. *La Montain mine.*—SE 1/4 sec. 5, T. 10 N., R. 1 E. Silver and lead minerals in barite vein striking N. 50° W., nearly vertical; in tuff breccia. Worked in 1950's from two shallow shafts and several open pits, for recovery of silver, lead, and barite (Weber, 1966, p. 79).

R. *Leviathan mine.*—NE 1/4 sec. 8, NW 1/4 sec. 9, T. 10 N., R. 1 E. Silver minerals in several northwest-striking nearly vertical veins of barite with jasper and hematite; in andesite breccia-tuff breccia and red andesite breccia. Northeast vein is largest, as wide as 35 feet, and extends about 3,000 feet northwestward from mine. Vein explored by four adit levels with about 1,500 feet of drifts, stopes, and other workings. Silver production not recorded (Wright and others, 1953, No. 322).

S. *Silver Bow mine.*—NW 1/4 sec. 9, T. 10 N., R. 1 E., about 1,300 feet east of Leviathan mine. Silver and lead minerals in barite vein 3 feet wide, faulted off at lower levels; in andesite breccia and tuff breccia. Explored by 230-foot 50°-inclined shaft sunk on vein and 500 feet of drifts. Small production of silver ore prior to 1925 (Wright and others, 1953, no. 334 of tab. list), and 1950's (Weber, 1966, p. 79).

T. *Silver Contact mine.*—NE 1/4 sec. 9, T. 10 N.; R. 1 E. Silver minerals in barite vein in andesite-tuff breccia. Explored by inclined shaft more than 150 feet deep, and second shaft 200 yards north inclined 55° for 65 feet. No production recorded (Wright and others, 1953, no. 335 of tab. list).

U. *Silverado, Mulcahy, Galena King and Reviere mines* (from north to south) SW 1/4 sec. 5, T. 10 N., R. 1 E. Prospects for silver and lead along northwest-trending nearly vertical veins of barite and jasper; in part along a fault. Prospected by trenches, pits, and shallow shafts. About 200 tons of ore shipped from Mulcany mine in 1934 (Wright and others, 1953, p. 100 and 103 of tab. list in part).

V. *Lead Mountain (Pacific Base Metals Co.) mine.*—S 1/2 sec. 25, N 1/2 sec. 36, T. 10 N., R. 1 W. Lead carbonate, galena, and silver chloride in barite veins with quartz and iron oxides; strikes northwest, dips 40° NE.; in tuff breccia. Prior to 1896 explored for 500 feet along strike on south side of Lead Mountain from 75-foot crosscut tunnel and 210-foot, 33° inclined shaft; from north side of Lead Mountain, 1,300-foot tunnel and 240-feet raise connect with inclined shaft. Small tonnage mined for silver-lead in 1930. Worked for barite from open cuts in 1931–33 (Tucker and Sampson, 1940, p. 345; Wright and others, 1953, nos. 261, 395 of tab. list).

GOLD

J. *Burcham mine.*—See under Silver.

W. *Azucar mine.*—NW 1/4 sec. 19, T. 8 N., R. 2 E. Gold-bearing quartz vein in shear zone in biotite quartz monzonite near small dioritic dike. Explored by 200-foot vertical shaft, a 135-foot inclined shaft with 120 feet of drifts, and adit, and shallow trenches. No production. Idle since 1945 (Wright and others, 1953, no. 67 of tab. list).

BARITE

Y. *Barium Queen mine.*—SW 1/4 sec. 22, NW 1/4 sec. 27, T. 10 N., R. 1 W. Several parallel veins of barite, with iron oxides, 1–10 feet thick, strike N. 35° W., dip 70°–90° NE., in Waterman Gneiss. Largest vein explored by 250-foot drift and six shafts 25-60 feet deep. Operated about 1915-1930; 20 carloads of barite shipped in 1930 for oil well drilling mud (Wright and others, 1953, no. 393 of tab. list).

Z. *Big Medicine prospect.*—W 1/2 sec. 35, T. 10 N., R. 1 W. Many small lenses and veinlets of barite in limestone and tuffaceous shale of the volcanic and sedimentary rocks, within an area

of about 60 acres in low hills of prominent limestone outcrops. Prospected in 1950's by scrapings and open cuts. No production recorded (Weber, 1965).

AA. *Hope prospect.*—Near NE corner sec. 35, T. 10 N., R. 1 W. Barite veins mainly in tan felsite. Worked before 1950 from shallow shaft.

BB. *Penny prospect.*—NW 1/4 sec. 23, T. 10 N., R. 1 W. Abundant veinlets of barite in tuff breccia. Prospected in 1964 from open pit.

V. *Lead Mountain mine.*—See Silver.

R. *Leviathan mine.*—See Silver. From 1957 to 1961, large tonnage of low-grade barite quarried by Oil Base, Inc., mainly from a trench along about 1,200 feet of largest barite vein and treated at mill on property for use in oil well drilling mud (Weber, 1965; 1966, p. 79).

BORATES

CC. *Old Borate (Pacific Coast Borax Co.) mines.*—NE 1/4 sec. 24, T. 10 N., R. 1 E., S 1/2 sec. 18, NE 1/4 sec. 19, T. 10 N., R. 2 E. (28 claims). Worked from 1884 to 1907; yielded nearly all of borate minerals in Calico district, about $9 million worth. Lenticular strata a few inches or feet thick of crystalline colemanite (calcium hydroborate) at two of three stratigraphic horizons in shale unit (of the sedimentary rocks of Miocene age). Colemanite-bearing strata generally dip south but deformed to many small folds with axes trending east-west. Extensive workings consists of many inclined shafts with numerous drifts, crosscuts, and excavations in colemanite-bearing strata; some workings reportedly as deep as 500 feet from surface. Many of workings now caved (Wright and others, 1953, p. 223–224; Weber, 1966, p. 71).

DD. *Union Borax mine.*—East line of NE 1/2 sec. 19, T. 10 N., R. 2 E. Active about 1900. Shaft reportedly 640 feet deep, in andesite of Yermo area, from top to bottom. Crosscut to north in shale that contains colemanite and howlite. No production recorded (Wright and others, 1953, no. 543 of tab list).

EE. (not shown). *Centennial mine.*—Center of sec. 29(?), T. 10 N., R. 2 E. (location uncertain). Active in early 1900's. Irregular lumps of colemanite in dark thin-bedded tuffaceous shale; shale strikes N. 57° E., nearly vertical, with minor folds. Mined from several open cuts and shallow underground workings. Reportedly yielded 600–700 tons of colemanite (Wright and others, 1953, no. 537 of tab. list).

FF. (not shown). *Western Minerals Co. mines.*—Center of E 1/2 sec. 22, T. 10 N., R. 1 E. northwest side of Odessa Canyon. Worked from 1897(?) to 1907. Bedded shale and sandstone, 25–30 feet thick, of the sedimentary rocks (Barstow Formation) reportedly averaged 10 percent anhydrous boric acid, and contained stringers of howlite and celestite. Beds dip gently northwest, with minor folds. Workings consist of numerous shallow tunnels, drifts, excavations and several winzes with appended drifts. Yielded less than 500 tons of 95 percent boric acid (Wright and others, 1953, p. 225).

GG. *American Borax Co.*—Sec. 25, T. 10 N., R. 1 W. Six claims north of Lead Mountain. Worked in 1900–1907. Gray shale, one interval 15–20 feet thick contained 8–14 percent anhydrous boric acid (no borates visible megascopically). Shale strikes N. 60° E., dips steeply northwest. Worked from inclined shaft sunk on borate shale to reported depth of 400 feet, with about 1,000 feet of drifts; also several open cuts. Production small (Wright and others, 1953, p. 225).

HH. *Gem (Columbus) mine.*—N 1/2 sec. 10, T. 8 N., R. 1 E. Lenses of colemanite a few inches thick, and thin strata of limestone, chert and tuff, in thin-bedded shale of the sedimentary rocks. Strata strike west, dip steeply south (overturned northward). Colemanite-bearing shale reported to have contained 8-30 percent boric acid; probably mined out. Explored and mined probably in 1890's or 1900's from shallow pits and trenches, and from three shafts, deepest 150 feet, with drifts at 50-foot and 100-foot levels (Wright and others, 1953, p. 225 in part).

BENTONITE

JJ. *"Soapstone" mine.*—NE 1/4 SE 1/4 sec. 12, T. 9 N., R. 1 W., near Nebo. White bentonite or clay in tuff and tuff breccia of the volcanic and sedimentary rocks, dips about 45° S. Small tonnage mined, probably in 1930's from two shallow shafts and open pits.

KK. *G.S. Gunn bentonite quarry.*—SE 1/4 NW 1/4 sec. 22, T. 10 N., R. 2 E. Bed of white tuff or bentonite 2–4 feet thick, in nearly flatlying gray clay or clay shale of the sedimentary rocks, a few feet below basal caliche bed of the fanglomerate and gravel unit of the older valley sediments. Small tonnage quarried before 1950; several thousand tons quarried and stockpiled just south of quarry in 1963–64.

ARCHEOLOGICAL PROJECT
SAN BERNARDINO COUNTY MUSEUM ARCHEOLOGICAL DIGGINGS

Project under direction of Ruth D. Simpson, 1964–67. Crudely chipped fragments of chert and jasper believed to be Indians artifacts found scattered in Pleistocene fanglomerate and gravel of the older valley sediments in sec. 22, T. 10 N., R. 2 E. Similar objects being recovered from a pit located about 1,500 feet south, 2,000 feet east of NW corner sec. 22, just west of G. S. Gunn bentonite quarry (KK on map). Pit about 20 feet square, 15–20 feet deep, being dug with hand tools in lowest 20 feet of fanglomerate and gravel, to basal 7-foot bed of white caliche. Fanglomerate and gravel unit here composed mostly of detritus derived from Tertiary rocks (mostly andesitic volcanic rocks) of Calico Mountains to west, embedded in hard indurated matrix of gritty clay. Age estimated to be more than 50,000 years, probably more than 100,000 years, on basis of degree of induration, regional deformation, uplift and dissection of this fanglomerate and gravel unit. If the chipped fragments are man-made artifacts, they would be probable earliest evidence of man in North Ameriva (R. D. Simpson, San Bernardino County Museum, oral commun., 1966).

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