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UNITED STATES DEPARTMENT OF THE INTERIOR

NAMES AND DEFINITIONS OF THE GEOLOGIC UNITS OF CALIFORNIA

GEOLOGICAL SURVEY BULLETIN 826

UNITED STATES DEPARTMENT OF THE INTERIOR
Ray Lyman Wilbur, Secretary

GEOLOGICAL SURVEY
George Otis Smith, Director

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NAMES AND DEFINITIONS
OF THE
GEOLOGIC UNITS OF CALIFORNIA

COMPILED BY
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PREFACE

By T. W. Stanton

In Bulletin 769, "The geologic time classification of the United States Geological Survey," by M. Grace Wilmarth, secretary of the committee on geologic names, it was announced that Miss Wilmarth had in preparation a more extended compilation which will form a stratigraphic lexicon of the United States, containing definitions of all the geologic formations that have been named and described in this country. Work on this compilation is making good progress and has now reached a stage where it is possible to give geologists a sample of the lexicon, which will be locally useful and at the same time give them an opportunity to make helpful criticisms both of the character of the material to be included in the larger work and of the form in which it is presented.

It happens that California is almost completely isolated from the other States in its stratigraphic development and that the great local variations in sedimentation within its borders, epecially in Tertiary time, have caused the naming of an unusual number of formations. Less than half a dozen of the formations named in California extend into Oregon and Washington, and the number that come into eastern California from Nevada is not much larger. It is therefore thought desirable to issue the "Names and definitions of the geologic units of California" as a separate publication. Its compactness will make it more acceptable than the larger complete lexicon to stratigraphers whose work is temporarily or habitually restricted to California.

In the text that follows names of provincial and local series, groups, formations, members, and lentils are given under a single alphabetic arrangement. The terms just mentioned have had varied meanings in common English usage and even in geologic literature, but in tnis paper and in other publications of the United States Geological Survey they are used with the technical definitions indicated by the following quotations from the rules of nomenclature and classification of formations published in the Twenty-fourth Annual Report:

In all classes of rocks the cartographic units shall be called *formations*. * * *

When, for scientific or economic reasons, it is desirable to recognize and map one or more specially developed parts of a varied formation, such parts shall be called *members*, if they have considerable geographic extent; or if their distribution is more limited they shall be described in some appropriate term, such as *lentil*.

All sedimentary formations shall receive distinctive designations. The most desirable names are binomial, the first part being geographic and the other lithologic (e. g., Dakota sandstone, Trenton limestone, etc.). * * * When the formation consists of beds differing in character, so that no single lithologic term is applicable, the word "formation" should be substituted for the lithologic term. [In actual practice it is customary to interpret this last statement rather broadly and to use the lithologic term if one lithologic type is dominant in a formation which has two or more kinds of sediment, such as sandstone with thinner beds of shale, or shale with thinner beds of sandstone and limestone.]

The name by which an igneous rock is designated upon the map may consist of two parts: (1) The petrographic designation, (2) a local term. * * * The local importance of igneous masses often renders the use of geographic terms in connection with the petrographic names highly advantageous; * * * e. g., Butte granite. * * *

Within the systems smaller aggregates of formations may be recognized, which shall be called *series*, and these may be divided into subordinate *groups* of formations. Groups may also be constituted without the recognition of series. These minor aggregates should be formed so as to express the natural relations of the formations of the particular province rather than to conform with divisions recognized elsewhere, though they may often prove to have a wider distribution. * * * When different provinces show a distinct development, provincial names may be used for series and groups. For example: In the Gulf province the lower Cretaceous is called the Comanche series, which is made up of the Washita, Fredericksburg, and Trinity groups, while in the Pacific province the lower Cretaceous has a different development, both lithologically and faunally, and is called the Shasta series.

In the compilation of this work Miss Wilmarth has had the full cooperation of John M. Nickles, of the Geological Survey library, who promptly furnishes the committee on geologic names with all important references to formation names found in the course of his bibliographic work on the current geologic literature of North America. All the names pertaining to California recorded by Mr. Nickles up to December 1, 1930, are included in this paper.

The names here defined fall into three categories:

1. Names printed in black-face type have been approved by the chief geologist on recommendation of the committee on geologic names for use in publications of the United States Geological Survey.

2. Names in quotation marks have been abandoned, after consideration, either as synonyms of names in good standing or as ill defined, or as not needed for some other reason.

3. All other names (printed in ordinary type) have not received consideration for use in Geological Survey publications.

The definitions are either literal quotations of the original definitions or digests in which the words of the author cited are used. If the original definition differs from that in current use additional quotations or digests are given to show the changes made. The descriptions and definitions have been abbreviated as much as is consistent with clearness. The quotations and digests are printed in smaller type, but the small-type matter includes some comments by the compiler, indicated by brackets.

The age designation given with the geographic distribution as the first item beneath the name is the present accepted age classification. Areas north of the latitude of San Francisco are classed as northern California, and those south of that latitude as southern California. The other areal terms are self explanatory.

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NAMES AND DEFINITIONS OF THE GEOLOGIC UNITS OF CALIFORNIA

Compiled by M. Grace Wilmarth

Abrams mica schist.

Pre-Cambrian (?): Northern California (Trinity and Shasta Counties).

O. H. Hershey, 1901 (Am. Geologist, vol. 27, pp. 225–245). *Abrams mica schist.*—Is composed of thin folia of muscovite of dull colors (gray, light brown, yellow, and dull red) separated by irregular layers of white quartz, representing the original laminae. Very highly siliceous throughout. Is of sedimentary origin, being originally a series of argillaceous sandstone beds, in part finely laminated. Thickness about 1,000 feet in upper Coffee Creek section, but may be much thicker at Bully Choop, to the south. Named for Abrams post office, in upper Coffee Creek region.

According to J. S. Diller (unpublished manuscript on Weaverville quadrangle) the Abrams mica schist is 5,000 feet thick.

Alameda formation.

Pleistocene: Western California (San Francisco region).

A. C. Lawson, 1914 (U. S. Geol. Survey Geol. Atlas, San Francisco folio, No. 193). Yellow sandy clay, of very uniform fine texture, which without much change in character passes into beds that carry marine shells. Intercalated with these marine deposits are nonpersistent beds of gravel of fluviatile origin, the conditions indicating delta formation alternating with marine or estuarine deposition. Thickness several hundred feet. Unconformably underlies San Antonio formation and unconformably overlies Campus formation. Named for fact that it is well developed at Alameda.

Alamitos zone.

A petroliferous zone, about 670 feet thick, in the Fernando group of the Long Beach field, Los Angeles Basin, southern California. Is lower than the Wilbur zone and higher than the Brown zone. Includes the Booth zone. Named for discovery well Alamitos No. 1.

Amargosan series.

C. [R.] Keyes, 1923 (Pan-Am. Geologist, vol. 40, pp. 52, 78). "This title is proposed for the thick succession of volcanics and conglomerates best exposed in the Amargosa Desert and in Furnace Canyon near Death Valley, and believed to be Early Tertic in age." In Nevada divided into Greenwater volcanics above and Grapevine conglomerate below. Stratigraphically unconformably above Zunian series and unconformably below Furnacean series.

Named for exposures in Amargosa Desert, Nye County, southwestern Nevada.

Anzar phase (of Santa Lucia series).

Paleozoic (provisionally): Southern California (San Benito County).

P. F. Kerr and H. G. Schenck, 1925 (Geol. Soc. America Bull., vol. 36, pp. 470, 471, map). "A metamorphic phase probably produced by serpentinization of the basic phase of the igneous intrusion. * * * There is a small area of red chert and granite associated with schist and gneiss west of the San Andreas fault in the vicinity of Anzar Lake. The chert appears to be Franciscan and the serpentinized schist and gneiss an alteration of the granite; all are now confused in their relations because of faulting. In the accompanying stratigraphic column they are included as the *Anzar phase of the Santa Lucia series.* Further study might show that the rocks of this limited region are either (1) entirely Franciscan, (2) a slight variation of the Santa Lucia, or (3) a separate series."

Arlington formation.

Mississippian: Northern California (Taylorsville and Lassen Peak regions).

J. S. Diller, 1892 (Geol. Soc. America Bull., vol. 3, pp. 370–394). *Arlington beds.*—Slates and sandstones with traces of conglomerate, 5,700 feet thick. "No fossils, but as they lie beneath Shoo Fly beds at one end and are associated with Silurian slates at the other, they are regarded as probably belonging to the upper Paleozoic." Older than Shoo Fly beds and younger than Taylor[s]ville slates.

J. S. Diller, 1908 (U. S. Geol. Survey Bull. 353). *Arlington formation.*—Chiefly fine gray thin-bedded sandstone, with some shale, in part silicified, and a few beds of conglomerate. In lower member yellowish shales prevail and grade up into the shaly and thin-bedded greenish-gray sandstone of the middle member, which is well exposed in bold escarpment of Arlington Heights. In upper member, which is well exposed about Crystal Lake, slaty gray shales are most abundant, with local conglomerates and highly silicified red jaspery portions near the top. Measured thickness 5,700 feet. Is separated from overlying Shoo Fly formation by a great thickness of Taylor meta-andesite. Is younger than Taylorsville formation.

Named for Arlington Heights, Plumas County, which is composed of the formation and where the middle member is well exposed.

Arrastre quartzite.

Probably Lower Cambrian: Southern California (San Bernardino County).

F. E. Vaughan, 1922 (California Univ. Pub., Dept. Geol. Sci. Bull., vol. 13, No. 9, pp. 344, 351, 352–365, map). The oldest sedimentary rocks positively identified as such in the region. Quartzites and quartzose schists, chiefly thin bedded, in beds less than 6 inches thick. Differs from Saragossa quartzite in that it contains no beds up to 5 and 10 feet thick of pure quartzite, no pure saccharoidal quartzite, no coarse angular grits, pebble conglomerate, or cross-bedding. No fossils found. Grades into Furnace limestone above. Floor on which it was laid down has been destroyed by granite intrusions.

Named for Arrastre Creek, San Bernardino County.

Ashton zone.

A zone in the lower part of the Fernando group in the Huntington Beach oil field of Orange County, southern California. Consists of 1,200 to 2,000 or more feet of sticky brown shale, sandy shales, sands, and hard shells. Some producing wells have penetrated it to a depth of at least 1,750 feet, according to S. H. Gester.

Asphalto lake bed.

Pliocene: Southern California (northwestern part of Kern County).

J. G. Cooper, 1894 (California Acad. Sci. Proc., 2d ser., vol. 4, p. 168). A small fresh-water deposit of fossiliferous blackish marl, about 40 miles southeasterly from the Kettleman lake bed, 18 miles northwest of Buena Vista Lake, and 1,100 feet above sea level.

Probably named for exposures at or near Asphalto, a village near McKittrick, Kern County.

"Atascadero" formation.

Upper Cretaceous: Southern California (San Luis Obispo region).

H. W. Fairbanks, 1904 (U. S. Geol. Survey Geol. Atlas, San Luis folio, No. 101). Thick and thin bedded sandstone with a small amount of conglomerate and shale. Thickness 3,000 to 4,000 feet. The local representative of the Chico group. Represents all of the Chico deposits present in the area. Unconformably underlies Vaquero[s] sandstone and unconformably overlies Knoxville. Named for exposures along Atascadero Creek, San Luis Obispo County.

Replaced by Chico formation.

Atlas formation.

Quaternary (?): Southern California (Kern County).

A. C. Lawson, 1906 (California Univ. Pub., Dept. Geology Bull., vol. 4, pp. 431–462). Ancient alluvium, made up of angular fragments of rocks of the bedrock complex, including schists, quartz diorite, granite, quartz, and arkose, well cemented. Older than Tank volcanics.

Derivation of name not stated and not known.

Atolia quartz monzonite.

Jurassic (?): Southern California (Randsburg quadrangle, Kern and San Bernardino Counties).

C. D. Hulin, 1925 (California State Min. Bur. Bull. 95, pp. 33–42, map). Intrudes Rand schist and the undifferentiated Paleozoic series of El Paso Mountains, which may be in part Carboniferous. Unconformably underlies middle Miocene sediments (Rosamond series). Is the undoubted correlative of the plutonic rocks of the Sierra Nevada and is probably of late Jurassic age. Named for exposures at and around Atolia, San Bernardino County.

"Auriferous slate series."

A descriptive term used in folios and other early reports on the Gold Belt region of northern California, to include the Mariposa slate and Calaveras formation, and in contradistinction to the "Superjacent series," a descriptive term applied to the Cretaceous, Tertiary, and Quaternary deposits of the region.

"Auriferous slates."

Term in common use by Whitney (Geological Survey of California) and subsequent writers for undifferentiated Paleozoic and Mesozoic strata in the Sierra Nevada.

Avenal sandstones.

Eocene: Southern California (Diablo Range).

F. M. Anderson, 1905 (California Acad. Sci. Proc., 3d ser., vol. 2, pp. 164–168). *Avenal sandstones.*—A great thickness of sandstone, exposed along the canyon of Canoas Creek with a thin basal bed of conglomerate, 6 to 10 feet thick, resting upon the Lower Cretaceous shales. The upper 400 feet consists of very fossiliferous concretionary sandstones, below which occur thin-bedded sandstone. The Avenal wells at Tar Springs are drilled to penetrate these sands, which are exposed at Tar Springs on the east and at Sulphur Springs on the Zapata Chino Creek to the west. Underlie Kreyenhagen shales.

F. E. von Erstorff, 1930 (Am. Assoc. Petroleum Geologists Bull., vol. 14, No. 10, pp. 1321–1336). The 500 feet of sandstone underlying Kreyenhagen shale in canyon of Canoas Creek is the Domengine sandstone, of upper middle Eocene age. The type locality of the Domengine is north of Coalinga.

Bagley andesite.

Lower (?) Jurassic: Northern California (Redding quadrangle).

J. S. Diller, 1906 (U. S. Geol. Survey Geol. Atlas, Redding folio, No. 138). "Includes the lavas and pyroclastics of a succession of volcanic eruptions of similar general character. It is commonly filled with an abundance of small phenocrysts of plagioclase, and rarely also with dark grains in a greenish groundmass." Is composed chiefly of andesitic tuff, sometimes coarse, almost agglomeratic, but generally fine and stratified, with occasional traces of marine fossils. More than three-fourths of the Bagley Mountain area is occupied by tuff. The lavas are most abundant near the summit, and the whole mass has a thickness of about 1,000 feet. "Both areas [Bagley Mountain and along Pit River] of the Bagley andesite lie practically on the border between the Potem and Modin formations but do not necessarily indicate an unconformity. These areas represent centers of greater accumulation of volcanic material near points of eruption during the beginning of the Potem epoch. Between the two points the contemporaneous sediments contain some detritus from both centers, but apparently the greater portion comes from a different source. For this reason the intermediate sediments were included in the Potem."

Baird shale.

Mississippian: Northern California (Redding region).

H. W. Fairbanks, July, 1894 (Am. Geologist, vol. 14, p. 28). Black siliceous shale, probably 500 feet thick, the lowest horizon recognized at the United States fisheries on McCloud River. Fauna considered by J. P. Smith to be analogous to the Waverly, but stratigraphic position is higher. The shales outcrop most prominently on west side of the river just above Baird post office where they are in places highly metamorphosed by dikes of diabase and diabase porphyrite.

J. P. Smith, September–October, 1894 (Jour. Geology, vol. 2, pp. 588–612). *Baird shale.*—Black siliceous shales 500 feet thick. Older than McCloud limestone and younger than Sacramento formation [Kennett formation].

According to J. S. Diller (U. S. Geol. Survey Geol. Atlas, Redding folio, No. 138, 1906) the Baird shale overlies the Bragdon formation and underlies the McCloud limestone.

"Balaklala rhyolite."

Jurassic (?): Northern California (Redding quadrangle).

J. S. Diller, 1906 (U. S. Geol. Survey Geol. Atlas, Redding folio, No. 138). A succession of irregular lava flows and tuffs which have been so compressed and folded as to render very obscure the original layered arrangement of the mass. Thickness about 500 feet. Clearly underlies the Kennett limestone and shale and penetrates and overlies the Copley metaandesite. Named for fact that it forms the hills about the Balaklala mine.

Later work by L. C. Graton (U. S. Geol. Survey Bull. 430, pp. 81–85, 1910) proved these rocks to be intrusive alaskite porphyry and the same as the so-called "Bully Hill rhyolite." Both geographic names have therefore been discarded as unnecessary. This porphyry cuts rocks as young as Pit shale (Middle and Upper Triassic).

Bald Peak basalt.

Pliocene: Western California (San Francisco region).

A. C. Lawson and C. Palache, 1902 (California Univ. Pub., Dept. Geology Bull., vol. 2, map at end). Top formation of Berkeleyan series [Berkeley group]. Forms large part of Bald Knob, east of Berkeley.

Barstow formation.

Miocene (upper): Southern California (San Bernardino County).

O. H. Hershey, 1902 (Am. Geologist, vol. 29, pp. 369–370). *Barstow series.*—A thin valley formation made under arid conditions. Occurs at several points in Mohave River Valley, notably along the railroad about 1½ miles east of Barstow [San Bernardino County]. Type section near Barstow consists of—

1. Stratified hard brown material due to arid conditions but composition not determined. Persistent over considerable area. 20 feet.
2. Yellow and light-gray silt. 4 feet.
3. Stratified fine gravel and sand of dull red color and containing red lava fragments. 15 feet.
4. Structureless bed of white tuff with angular and subangular fragments of various other rock species embedded in it. 20 feet.

Is extensively developed on low hills on north side of valley between Barstow and Daggett. Unconformably overlies Rosamond and Escondido series. Extensively eroded. Overlain unconformably by Quaternary.

J. C. Merriam, 1915 (Pop. Sci. Monthly, vol. 86, pp. 252–254). The term *Barstow formation* is used for the beds containing the Upper Miocene vertebrate fauna.

J. C. Merriam, 1919 (California Univ. Pub., Dept. Geology Bull., vol. 11, No. 5, pp. 441–448). *Barstow formation or group.*—Mainly bluish gray to yellowish brown, slightly indurated strata, composed largely of fine arkose with a considerable percentage of volcanic ash. In an earlier publication (California Univ. Pub., Dept. Geology Bull., vol. 6, p. 168, 1911) the writer referred to the fauna of Barstow syncline as the Mohave fauna, this name being considered mainly a geographic designation. Later, in order to avoid confusion with other Tertiary faunas occurring in the Mohave area, the name Barstow has been used for this faunal assemblage, and Barstow formation for the beds containing the Upper Miocene or Barstow fauna. This formation comprises the uppermost of the five divisions [of the Rosamond series] in the Barstow syncline, described by Baker [California Univ. Pub., Dept. Geology Bull., vol. 6, 1911] as fossiliferous tuff member, and any other beds which may be recognized as representing the horizontal or vertical extension of the same depositional unit. The limits of the Barstow formation may be found to correspond with those of the fossiliferous tuff member, or they may include a greater range of sediments above and below. It is possible that the Barstow fauna occurs in all of the strata of the Barstow syncline. It is also possible that the lowest strata of that section will be discovered to contain a faunal assemblage much older than the particular Upper Miocene assemblage known as the fossiliferous tuff. The resistant breccia member immediately below the fossiliferous tuff in Baker's Barstow syncline section seems to contain a representation of the Barstow fauna and may ultimately be included in the Barstow formation. Should the resistant breccia be recognized as a distinct formation the name Barstow group may be used for the sequence of formations. Excepting marine deposits of Eocene age, the oldest Tertiary rocks in the Mohave area of which the age is certainly known are included in the Barstow formation. Fauna [listed] is distinctly older than Ricardo fauna. Assigned to Upper Miocene.

"Basement complex."

"Basement complex" and "Bedrock complex" are descriptive terms that have been rather loosely applied in the literature to the basement rocks of a region, whether they are or are not of complex structure.

Bass Mountain diabase.

Mississippian: Northern California (Redding quadrangle).

J. S. Diller, 1906 (U. S. Geol. Survey Geol. Atlas, Redding folio, No. 138). Nonporphyritic dark, somewhat greenish compact lava, occasionally vesicular and more frequently fragmental. Is contemporaneous and partly interbedded with the upper part of the Bragdon formation. Named for fact that it forms southern slope of Bass Mountain.

Bautista beds.

Pleistocene: Southern California (San Jacinto quadrangle).

C. Frick, 1921 (California Univ. Pub., Dept. Geology Bull., vol. 12, pp. 283–288). The Bautista beds occur in the Bautista Badlands or Bautista Creek area. They have yielded vertebrate fossils, and were evidently accumulated in part in a playa-like lake, as a series of fine, worked-over fanglomerates and clays derived from low highlands of the immediate north and east.

Bear River series.

Miocene: Northern California (Humboldt County).

W. Stalder, 1915 (California State Min. Bur. Bull. 69, pp. 447–449). Conglomeratic sandstones and conglomerate, resting on arenaceous bands and yellowish sandstones of medium texture, poorly cemented, underlain by 300 feet of shales of nodular character containing a little interbedded limestone and some glauconitic sand. Very fossiliferous at south fork of Bear River. Thickness 750 feet. Assigned to upper Miocene. Underlies Wild Cat series and overlies Rainbow series (post-Franciscan).

"Bedrock complex." See "*Basement complex*."

"Bedrock series."

A descriptive term used in folios and other early reports on the Gold Belt region of northern California, to include the Jurassic, Triassic, and Carboniferous formations, in contradistinction to "Superjacent series," which included the Cretaceous, Tertiary, and Quaternary deposits. The term has also been applied to the basement rocks of any region.

Bell oil zone.

Name applied to oil-bearing zone, about 370 feet thick, in the Santa Fe Springs field, Los Angeles County. Is capped by Foix oil zone and in turn caps the Meyer zone. Top lies at depth of 3,650 to 3,850 feet. Basal bed consists of 30 to 50 feet of sticky brown shale.

"Bend formation."

Middle and Lower Jurassic: Northern California (Gold Belt region).

J. S. Diller, 1892 (preliminary proof-sheet edition of Lassen Peak folio, U. S. Geol. Survey Geol. Atlas) and 1895 (published Lassen Peak folio, No. 15). The Bend formation contains some limestone but is composed chiefly of slates, sandstones, and conglomerates and crops out along the western arm of the great bend of Pit River. Isolated areas of the limestone are exposed near the stage road 1 mile west of Montgomery Creek, and the slates and sandstones form the upper part of the north slope of Cedar Creek 4 miles west of Round Mountain. Jurassic fossils. Rests on Cedar formation and is overlain by Chico formation.

H. W. Fairbanks, July, 1894 (Am. Geologist, vol. 14, p. 27). "The Bend formation, then, consisting of slates and argillaceous limestone, embraces as far as is known the Lower and Middle Jura."

J. P. Smith, October, 1894 (Jour. Geology, vol. 2, p. 611). The Bend formation was named by J. S. Diller (U. S. Geol. Survey Geol. Atlas, Lassen Peak sheet, 1892), to include all the Jurassic deposits of the region of the Big Bend of Pit River. In a later publication Mr. Diller (Bull. Geol. Soc. America, vol. 4, 1893, p. 221) says that the Pit River Jura corresponds to the Mormon sandstone, Middle Jura, of the Taylorsville region. About 6 miles west of Big Bend, in Big Canyon, H. W. Fairbanks discovered fossils in shaly limestones which, on examination by the writer, proved to be Jurassic and probably equivalent to the Hardgrave sandstone, Lower Jura, of Indian Valley.

Includes Potem and Modin formations.

Berkeley group.

Pliocene: Western California (San Francisco region).

A. C. Lawson and C. Palache, 1902 (California Univ. Pub., Dept. Geology Bull., vol. 2, p. 375, map). The entire series of rocks, volcanic and sedimentary, from the base of the Orindan formation to the crest of Frowning Ridge, is here named the *Berkeleyan series*, and the interval in question is regarded as having a break in its accumulation dividing it into Upper and Lower Berkeleyan. The Upper Berkeleyan includes Bald Peak basalt, Siestan formation, Grizzly Peak andesite, and several other unnamed formations. The Lower Berkeleyan includes the Trampan and Orindan formations and a great thickness of unnamed igneous and sedimentary formations. The Berkeleyan series is unconformably overlain by the Campan series and unconformably underlain by the Monterey series.

A. C. Lawson, 1914 (U. S. Geol. Survey Geol. Atlas, San Francisco folio, No. 193). *Berkeley group* includes rocks between the top of the Orinda formation and the base of the Campus formation. Divided into (descending order) Bald Peak basalt, Siesta formation, and Moraga formation. Rests with probable unconformity on Orinda formation and is unconformably overlain by Campus formation.

Named for occurrence east of Berkeley.

"Berkeleyan series." See *Berkeley group.*

Bicknell sandstone.

Upper Jurassic: Northern California (Taylorsville region).

J. S. Diller, 1892 (Geol. Soc. America Bull., vol. 3, pp. 370–394). Light-gray or bluish-gray sandstone, sometimes tufaceous above. Thickness 500 feet. Is older than Hinchman tuff and younger than Mormon sandstone.

J. S. Diller, 1908 (U. S. Geol. Survey Bull. 353). Chiefly red and gray sandstone associated with some dark shales and tuffaceous beds. Brownish-red sandstone forms the earliest part of the formation. The middle portion is composed of compact fine dark-gray sandstone interbedded with black shaly beds. The upper part consists of tuffaceous gray sandstone. Thickness 500 to 1,300 feet. Overlies, probably conformably, the Mormon sandstone and grades into the overlying Hinchman sandstone. Greatest development on southeast slope of Mount Jura, Plumas County.

Named for Bicknell's ravine, Mount Jura, near Taylorsville.

"Bicknell tuff."

Name applied by A. Hyatt (Geol. Soc. America Bull., vol. 3, p. 407, 1892) to the tuffaceous sandstone forming the upper member of the Bicknell sandstone of Diller.

Big Blue serpentinous member.

Miocene: Southern California (Diablo Range and Coalinga district).

R. Anderson and R. W. Pack, 1915 (U. S. Geol. Survey Bull. 603). The upper member of the Vaqueros formation, locally known as the Big Blue but in this report called the Big Blue serpentinous member, is formed largely of small flakes of serpentine, which make up a fine-grained, compact, tough shale, slightly bluish when fresh but weathering to various shades of red, yellow, and brown, owing to oxidation of the iron. Locally this shale becomes sandy, but through most of its extent it is remarkable for being little else than a compacted mass of serpentine dust, flakes, and pebbles. With the shale are conglomerates formed almost entirely of serpentine boulders, the largest of which are huge blocks many feet in diameter. Thickness 40 to 1,000 feet. In the report on the Coalinga district (U. S. Geol. Survey Bull. 398, 1910) the Big Blue was tentatively included in the Santa Margarita formation. Named for exposures in the Big Blue Hills.

The Vaqueros sandstone being now restricted to the lower part, or *Turritella inezana* zone, of the Vaqueros of earlier reports, the Big Blue, according to B. L. Clark, becomes a member of the overlying *Turritella ocoyana* zone and is older than Santa Margarita formation.

Bixby zone.

A petroliferous zone, about 2,400 feet thick, forming the lower part of the Fernando group in the Long Beach field of the Los Angeles Basin. Named for fact that the Shell Bixby No. 1 well has been producing from this sand.

Blackhawk breccia.

Pleistocene: Southern California (San Bernardino County).

A. O. Woodford and T. F. Harriss, 1928 (California Univ. Pub., Dept. Geol. Sci. Bull., vol. 17, pp. 267, 279–283). *Blackhawk breccia.*—Chiefly made up of limestone blocks, usually only a few inches or at most a few feet in diameter, but at mouths of Blackhawk and Miles Canyons more or less brecciated limestone, hundreds of feet across, are mapped as part of the formation, because they seem to be landslide blocks inextricably involved in the breccia. The basal part of the formation consists of alternating beds of limestone breccia and sandstone. The greater part of the material is spread out over the desert at the foot of the mountains. The formation is of land-slip origin. Thickness 100 to 600 feet. Includes *Heights fanglomerate* of Vaughan, 1922. Assigned to Pleistocene. Typically developed at mouth of Blackhawk Canyon.

Black Mountain basalt flow.

Tertiary or Quaternary: Southern California (western El Paso Range, eastern Kern County).

C. L. Baker, 1912 (California Univ. Pub., Dept. Geology Bull., vol. 7, pp. 121–142). *Black Mountain basalt flow.*—Olivine basalt, both vesicular and compact. Thickness more than 100 feet. Of post-Miocene Tertiary age and younger than Rosamond series.

C. D. Hulin, 1925 (California State Min. Bur. Bull. 95, pp. 20–61). *Black Mountain basalt* is both intrusive and extrusive. Intrudes Rosamond series and Red Mountain andesite. Named for widespread basalt flows on Black Mountain, 7 miles west of El Paso Peaks, Kern County, where they unconformably overlie Tertiary sediments. It seems probable they are very late Pliocene or early Pleistocene.

Black Mountain volcanics.

Probably Upper Triassic or Jurassic: Southern California (San Diego County).

M. A. Hanna, 1926 (California Univ. Pub., Dept. Geol. Sci. Bull., vol. 16, No. 7, pp. 187–246). Chiefly volcanic, including agglomerates, although in certain places sediments are present. Contains rather massive conglomerates, quartzites, shales, massive andesitic agglomerates, trachytic and andesitic flows, and tuffs. All metamorphosed. Thickness more than 2,000 feet. Oldest rocks exposed in La Jolla quadrangle. Rest on intrusive rocks, and nowhere is basement exposed. Unconformably overlain by Chico Cretaceous. No fossils. Well developed on Black Mountain, in northern part of La Jolla quadrangle.

Blue Canyon formation.

Mississippian: Northern California (Colfax quadrangle).

W. Lindgren, 1900 (U. S. Geol. Survey Geol. Atlas, Colfax folio, No. 66). Black and fissile clay slates and dark-gray fine-grained quartzitic sandstones; only one occurrence of conglomerate noted in the formation; a few limestone lenses and some chert occur in it in eastern part of area, including "a belt of gray or brown chert referred to as the Duncan chert." Corresponds to lower part of Calaveras formation. Few fossils not diagnostic, but formation assigned to Carboniferous. Underlies Relief quartzite. Oldest formation exposed in Colfax quadrangle. Named for exposures at village of Blue Canyon, Placer County.

According to later work by H. G. Ferguson (Am. Inst. Min. and Met. Eng. Tech. Pub. 211, p. 4, 1929), two formations (Tightner below and Kanaka above), composed of interbedded sedimentary and igneous rocks, are now discriminated between the Relief quartzite and the Blue Canyon formation.

"Blue chert series."

Devonian (?): Northwestern California (Klamath Mountains).

O. H. Hershey, 1906 (Am. Jour. Sci., 4th ser., vol. 21, pp. 58–66). A great series of black shales, limestones, and blue cherts, 5,000 feet thick, of which 3,000 feet is chert. Is presumed to be Devonian, because similar rocks elsewhere in Klamath region carry Devonian fossils. Is thoroughly intruded by dioritic and diabasic materials. Unconformably overlain by volcanic rocks. Must be pre-Bragdon. Named for its most characteristic constituent, blue chert.

Bodega diorite.

Jurassic? (pre-Franciscan): Western California (Marin County).

V. C. Osmont, 1904 (California Univ. Pub., Dept. Geology Bull., vol. 4, p. 43). Bodega Peninsula is made up almost wholly of this rock, which is a biotite diorite. The east shore of Bodega Bay, however, is entirely Franciscan. Point Reyes Peninsula, to the south, is composed largely of this diorite and granite. There are two varieties, one biotite diorite and the other quartz diorite. Best exposures of this diorite occur on ocean side of Bodega Peninsula, at south end, where it forms steep cliffs 50 to 80 feet high.

Bodega Bay deposits.

Quaternary: Western California (Marin County).

V. C. Osmont, 1904 (California Univ. Pub., Dept. Geology Bull., vol. 4, p. 76). *Bodega Bay deposits.*—At Bodega Bay similar deposits [to those described as Tomales Bay deposits] occur on both sides of the bay, but only in small patches, most of them having been removed by erosion. Near Bodega Point on the bay side is a remnant resting upon a wave-cut shelf just about at high-water mark and extending up 113 feet above it, consisting principally of diorite sands and occasional pebbles showing very indistinct horizontal stratification and cross-bedding. On the ocean side of the peninsula occasional still smaller patches, some 20 to 30 feet thick, may be seen resting upon a very evenly worn diorite surface, which at a point about 3 miles south of the mouth of Salmon Creek dips gently toward the north and passes under the beach and eolian sands. On eastern side of bay is a broad, flat terrace, about one-fourth of a mile in width and some 75 to 90 feet above sea level at its back. In most places only a thin veneer of gravel covers this terrace, but at one point on shore, at north end of bay, a remnant of gravel some 50 feet thick rests on worn Franciscan surface, which is here only 20 feet above sea level. It is composed chiefly of Franciscan pebbles and loosely coherent sands showing cross-bedding. Is somewhat distorted and dips slightly to north.

Bolinas sandstone.

Jurassic (?): Western California (San Francisco region).

R. Arnold, March, 1902 (Science, new ser., vol. 15, table on p. 416). Bolinas sandstone (volcanics), 2,000 feet thick. A division of the Franciscan. [Shown in table as underlying Sausalito cherts and overlying volcanics that are younger than Calera limestone.]

A. C. Lawson, February, 1903 (Geol. Soc. America Bull., vol. 13, pp. 544–545). [Same as above.]

A. C. Lawson, 1914 (U. S. Geol. Survey Geol. Atlas, San Francisco folio, No. 193). [Maps the Franciscan rocks of Bolinas Ridge, also of shore of Bolinas Lagoon and shore of Bolinas Bay (all in Marin County), as undifferentiated sandstones of the Franciscan group, with radiolarian chert lentils of undetermined horizons, but in other parts of the region the rocks between the Sausalito chert and the Calera limestone are mapped as the upper part of the Cahil sandstone.]

Bolsa zone.

An oil-producing zone, 600 to 800 feet thick, in the Huntington Beach oil field of Orange County. Consists of sands, sandy shales, and thin sands. Its top lies at a depth of about 1,914 feet.

Bonita sandstone.

Jurassic (?): Western California (San Francisco region).

R. Arnold, 1902 (Science, new ser., vol. 15, table on p. 416). Bonita sandstone, 1,400 feet thick, top formation of the Franciscan. [Shown in table as overlying San Miguel cherts and unconformably underlying Knoxville.]

A. C. Lawson, 1903 (Geol. Soc. America Bull., vol. 13, table on pp. 544–545). [Same as above.]

A. C. Lawson, 1914 (U. S. Geol. Survey Geol. Atlas, San Francisco folio, No. 193). Massive, obscurely bedded sandstone of dark greenish-gray color and medium texture, with subordinate amounts of shale and conglomerate. Thickness about 1,400 feet. Top formation of Franciscan group. Conformably overlies Ingleside chert.

Named for exposures at Point Bonita, on the north shore of the Golden Gate, San Francisco County.

Booth zone.

A petroliferous zone, about 270 feet thick, included in the Alamitos zone of the Fernando group. Named for San Martinez Booth No. 1 well, in Long Beach field, Los Angeles Basin.

Bouquet Cañon breccia.

Probably Miocene: Southern California (30 miles north of Los Angeles).

A. O. Woodford, 1925 (California Univ. Pub., Dept. Geol. Sci. Bull., vol. 15, No. 7, p. 212). "*Bouquet Cañon breccia.*—There may well be correlatives of the San Onofre ["breccia facies of Temblor formation"] north of the San Gabriel Mountains. A suggestion of this is given by a specimen of fine schist breccia furnished by Prof. F. P. Vickery and Mr. S. W. Harris. This is from lower Bouquet Cañon, 30 miles north of Los Angeles and 5 miles northeast of Saugus. It may be Miocene. The rock is made up of 1–4 cm. fragments of white quartz, quartz-muscovite schist, hornblende-epidote schist (hornblende close to karinthine), etc., in a carbonate cement, almost without fine clastic grains."

Bragdon formation.

Mississippian: Northwestern California (Klamath Mountains region).

O. H. Hershey, 1901 (Am. Geologist, vol. 27, pp. 236, 238). Upper slates or Bragdon formation. The latest of the formations included in the "Auriferous Slate series." Consists of 2,000 feet of alternating thin-bedded slates and thick-bedded blue quartzites; no limestone. Similar to Mariposa slates. Tentatively assigned to Jurassic.

According to J. S. Diller (U. S. Geol. Survey Geol. Atlas, Folio 138, 1906) the Bragdon formation is 2,900 to 6,000 feet thick in the Redding quadrangle, underlies the Baird formation, unconformably overlies the Kennett formation, and is of Mississippian age.

Named for exposures in Bragdon Gulch and vicinity of Bragdon, Weaverville quadrangle.

Bridalveil granite.

Probably Cretaceous: Northern California (Yosemite region).

H. W. Turner, 1899 (Jour. Geology, vol. 7, p. 154). *Bridal Veil granite.*—Fine-grained white granite, occurring in drainage of Bridalveil Creek, on Horse Ridge, and at many other points in Yosemite Park.

Forms brink of Bridalveil Fall.

Briones sandstone.

Miocene (upper): Western California (San Francisco region).

A. C. Lawson, 1914 (U. S. Geol. Survey Geol. Atlas, San Francisco folio, No. 193). Prevailingly light-colored to whitish well-washed sandstone, in some places pebbly or conglomeratic, and in general of coarser texture than the lower sandstones of the Monterey group, of which it is the top formation. Thickness 2,300 feet. Very fossiliferous. [Fossils listed.] Includes the nonpersistent Hercules shale member. Overlies Rodeo shale and unconformably underlies San Pablo formation. Named for exposures in Briones Hills, Contra Costa County.

The fauna of the Briones sandstone is now generally considered to be younger than the Monterey fauna, and the formation is now excluded from the Monterey group.

Brock shale.

Upper Triassic: Northern California (Redding quadrangle).

J. S. Diller, 1906 (U. S. Geol. Survey Geol. Atlas, Redding folio, No. 138). "The Brock shale conformably overlies the Hosselkus limestone in Brock Mountain, whence the name, and has a thickness of about 400 feet. In the lower 300 feet or more adjoining the limestone the shales are dark, somewhat calcareous, and frequently contain *Halobia*. Above these come sandy shales, gray and reddish in color and characterized locally by *Pseudomonotis subcircularis*." Is overlain, probably unconformably, by the Modin formation. [Is approximate equivalent of Swearinger slate.]

Brown zone.

A petroliferous zone, about 250 feet thick, in the Fernando group of the Long Beach field, Los Angeles Basin. Lies lower than Alamitos zone and higher than Bixby zone. Named for fact that Petroleum Midway Brown No. 1 well is thought to be the discovery well of this zone.

"Bully Hill rhyolite."

Jurassic(?): Northern California (Redding quadrangle).

J. S. Diller, 1906 (U. S. Geol. Survey Geol. Atlas, Redding folio, No. 138). In Bully Hill region [Shasta County] the rhyolite is arranged in flows alternating with tuffs dipping southeastward beneath the Pit shales, but in places it cuts the lower portion of the Pit shales and envelops its fragments. For convenience all the rhyolites erupted in the Redding quadrangle during the deposition of the Pit shales are included under the term Bully Hill rhyolite, though they represent a considerable range of time. Bedded tuffs, composed largely of crystal fragments of quartz and feldspar, with a smaller proportion of glass and pumice particles replaced by quartz, are common among the Pit shales and are locally associated with sheets of rhyolite. Thickness about 500 feet.

Later work by L. C. Graton (U. S. Geol. Survey Bull. 430, pp. 81–85, 1910) proved this formation to be intrusive alaskite porphyry and the same as the so-called "Balaklala rhyolite." Both geographic names have therefore been discarded as unnecessary. The rock cuts formations as young as the Pit shale (Middle and Upper Triassic).

"Bully Hill volcanics."

J. S. Diller, 1905 (Am. Jour. Sci., 4th ser., vol. 19, pp. 380–385). Lavas interstratified with tuffs and shales. Of late Carboniferous and early Triassic age.

Butano sandstone.

Oligocene? (may be Eocene): Southern California (Santa Cruz Mountains).

J. C. Branner, J. F. Newsom, and R. Arnold, 1909 (U. S. Geol. Survey Geol. Atlas, Santa Cruz folio, No. 163). Massive brown and buff sandstones with conglomerate at base. Thickness about 2,100 feet. No fossils found. Conformably underlies San Lorenzo formation, and believed to overlie Eocene limestone unconformably, but sequence is concealed.

Named for exposures on Butano Ridge, San Mateo County.

Butte gravels.

Eocene (middle): Northern California (Sutter County).

Howel Williams, 1929 (California Univ. Pub., Dept. Geol. Sci. Bull., vol. 18, pp. 112–129). *Butte gravels.*—Coarse gravels, composed of rounded, chiefly very siliceous pebbles, with sandy intercalations and thin beds of massive sandstone and siliceous limestone. Thickness 450 to 1,200 feet. Overlie White Ione sands, usually with minor disconformity, but occasionally with erosion unconformity. Are overlain by Sutter formation, in some places with sharp contact, in other places almost insensible gradation. Fossils 700 feet above Ione sands are assigned by B. L. Clark to Meganos (middle Eocene) age. Present at Marysville Buttes.

"Button beds."

Miocene: Southern California (Kern County).

F. M. Anderson, 1905 (California Acad. Sci. Proc., 3d ser., vol. 2, p. 170). The first sandy beds below the Monterey shale at Temblor. Included in Temblor beds. Thickness 100 feet. Named for the great numbers of small discoidal sea urchins (*Astrodapsis*) that characterize them. [See also under *Temblor formation.*]

Cabezon fanglomerate.

Quaternary: Southern California (San Bernardino Mountains).

F. E. Vaughan, 1922 (California Univ. Pub., Dept. Geol. Sci. Bull., vol. 13, No. 9, pp. 344, 387–392, map). A fanglomerate deposited in Bear and Holcomb Valleys. Differs from older Coachella fanglomerate in being more uniform and massive, of yellowish color, and in lying nearly horizontal. The largest area in Bear Valley is the broad flat between Rathbone Creek and Erwin Lake, where material is almost wholly unsorted angular and subangular quartzite brought down from Sugarloaf Mountain to southeast. Holcomb Valley is nearly surrounded by flat ridges of fanglomerate. Those on the south and east sides are particularly conspicuous and consist of limestone, granite, and quartzite from surrounding hills. The fanglomerate in Bear and Holcomb Valleys is only a local representative of a widespread deposition during the third cycle of erosion. The Cabezon fanglomerate is older than the Heights fanglomerate and younger than the Coachella fanglomerate.

Named for Cabezon Station, Riverside County.

Cable formation (or lake beds).

Quaternary (?): Southern California (Kern County).

A. C. Lawson, 1906 (California Univ. Pub., Dept. Geology Bull., vol. 4, pp. 431–462). *Cable formation* (also *Cable lake beds*).—Fresh-water lake beds, of well-stratified limestones, cherts, gravels, clays, and fine light-colored volcanic tuff. Named for town of Cable, Kern County. Older than Tehachapi formation and younger than Tank volcanics.

Cache Lake beds.

Pliocene: Northern California (Lake County).

G. F. Becker, 1888 (U. S. Geol. Survey Mon. 13, p. 219). Fresh-water gravels, sand, and calcareous beds of Pliocene age, 1,000 feet thick. Occur east of Clear Lake, about the north fork of Cache Creek. Deposited in extinct Cache Lake, which overlapped Clear Lake.

Cactus granite.

Probably late Jurassic: Southern California (San Bernardino Mountains).

F. E. Vaughan, 1922 (California Univ. Pub., Dept. Geol. Sci. Bull., vol. 13, No. 9, pp. 344, 364–365, map). Medium coarse-grained intrusive granite, pinkish to yellowish gray.

Named for Cactus Flat, San Bernardino County.

Cahil sandstone.

Jurassic (?): Western California (San Francisco region).

A. C. Lawson, 1914 (U. S. Geol. Survey Geol. Atlas, San Francisco folio, No. 193). Prevailingly massive, obscurely bedded sandstone of dark greenish-gray color and medium texture. Includes lenses of pebbly conglomerate and beds of dark shale. Includes, 500 feet above base, a conspicuous foraminiferal limestone—the Calera limestone member—60 feet thick, which is overlain by 2,000 feet of beds belonging to the Cahil formation. On the summit of Fifield Ridge a thin lens of obscurely fossiliferous impure limestone occurs in the Cahil sandstone several hundred feet above the Calera limestone. This limestone is apparently not persistent and probably nowhere exceeds 10 feet in thickness. Thickness of Cahil sandstone approximately 2,560 feet. Basal formation of Franciscan group. Underlies Sausalito chert.

Named for exposures on Cahil Ridge, San Mateo County.

Calaveras formation (also **group**).

Mississippian: Northern California (Calaveras and neighboring counties).

H. W. Turner, 1893 (Am. Geologist, vol. 11, pp. 307–324, 425). "The term 'Calaveras formation' as used by the United States Geological Survey on the geological maps of the Gold Belt [then in preparation] includes all of the Paleozoic sedimentary rocks of the Sierra Nevada." Is characterized by large masses of associated greenstone. Includes slate, conglomerate, and limestone, associated with igneous rocks of apparently the same age as the inclosing sedimentary rocks. Unconformably underlies the Mesozoic Mariposa slates. "So far as yet known is chiefly lower Carboniferous, but may extend down into the Devonian. It is not intended to include in it the Silurian beds described by Mr. Diller nor the upper Carboniferous strata of Genesee Valley, called by Mr. Diller the Robinson beds."

Two of the United States Geological Survey maps of the Gold Belt referred to by Turner were published in 1894 (Folios 3 and 11), and others followed later. These folios describe the Calaveras formation as consisting of a conformable series, 4,000 feet or more thick, of black micaceous clay slate, argillaceous schist, quartzite, chert, and mica schist, with lenses of limestone and some beds of conglomerate, all associated and in part interbedded with igneous rocks. Is lower formation of the "Auriferous slate series."

Named for prominent development in Calaveras County.

Calera limestone member.

Jurassic (?): Western California (San Francisco region).

R. Arnold, 1902 (Science, new ser., vol. 15, table on p. 416). Calera limestone, foraminiferal, 60 feet thick. [Shown in table as overlain by volcanics that are older than Bolinas sandstone and underlain by volcanics that are younger than Pilarcitos sandstone.]

A. C. Lawson, 1903 (Geol. Soc. America Bull., vol. 13, table on pp. 544–545). [Same as above.]

A. C. Lawson, 1914 (U. S. Geol. Survey Geol. Atlas, San Francisco folio, No. 193). *Calera limestone member.*—Gray compact foraminiferal limestone resembling lithographic limestone and containing lenses of chert. Occurs in lower part of the Cahil sandstone, the basal formation of the Franciscan group. Thickness averages about 60 feet.

Named for exposures in the sea cliffs at the lower end of Calera Valley, San Mateo County.

"California sandstone." See "*San Francisco sandstone.*"

"Campan group" and "Campan series." See *Campus formation.*

Campito sandstone.

Lower Cambrian: Eastern California (Inyo Range).

E. Kirk, 1918 (U. S. Geol. Survey Prof. Paper 110). Chiefly sandstone, which on fresh fracture is a dense fine-grained grayish rock with conspicuous fine dark lines that indicate highly complex cross-bedding. Weathers reddish brown to dark purplish red. Associated with this sandstone are some bands of very dense lighter-colored quartzitic sandstone separated by thin layers of siliceous slate, which occur as partings in the dense sandstone. Upper third of formation is somewhat more slaty and includes zones curiously speckled by ferric oxide. Remarkable cross bedding at several horizons. Rests unconformably on Deep Spring formation and appears to grade into overlying closely related Silver Peak group, the upper limit of the Campito being placed at the lowest horizon at which fissile calcareous shales and fairly pure masses of limestone appear. Thickness of formation 3,200 feet. Named for prominent exposures on Campito Mountain.

Campus formation.

Pleistocene: Western California (San Francisco region).

A. C. Lawson and C. Palache, 1902 (California Univ. Pub., Dept. Geology Bull., vol. 2, p. 398, map). *Campan series.*—Interbedded fresh-water deposits and volcanic lavas and tuffs. Thickness 800 feet. Includes rhyolite tuff and other tuffs, agglomerate, conglomerates, andesites, basalt flows, clays, some sandstone and limestone, and the Pie Knob andesite. Unconformably overlies Berkeleyan series. Named because of its occurrence within the limits of the university campus, Berkeley [on a hill behind the area now covered with buildings].

A. C. Lawson, 1914 (U. S. Geol. Survey Geol. Atlas, San Francisco folio, No. 193). *Campus formation,* originally named Campan. Rests unconformably on Moraga and Siesta formations of the Berkeley group.

Camulos formation.

C. [R.] Keyes, 1925 (Pan-Am. Geologist, vol. 43, p. 316). [Name proposed for lower part of Arnold's Fernando formation, or probably for the same beds that Kew in 1921 named Pico formation.]

Named for the railway hamlet of Camulos, a few miles directly west of Saugus Junction, in Santa Clara Valley.

Cantua sandstone member.

Eocene: Southern California (north of Coalinga region).

R. Anderson and R. W. Pack, 1915 (U. S. Geol. Survey Bull. 603, pp. 33, 59–63, map). A huge lens of massive medium to fine grained gray concretionary sandstone and interbedded clay shale that forms the lower and major part of the Martinez (?) formation within a small area. Maximum thickness at least 4,500 feet. Rests unconformably on Moreno formation. Is overlain by and in places grades laterally into dark clay shale that composes the rest (400 to 1,100 feet) of the Martinez (?) formation. Named for fact that it reaches its greatest development at the head of the western branches of Cantua Creek, Fresno County.

According to B. L. Clark, 1921 (Jour. Geology, vol. 29), these beds belong to his Meganos group and are younger than the Martinez.

Cape Horn slate.

Mississippian: Northern California (Colfax quadrangle).

W. Lindgren, 1900 (U. S. Geol. Survey Geol. Atlas, Colfax folio, No. 66). The characteristic rocks are fissile typical clay slates, almost black when fresh and weathering to a gray or silvery-white color. Small limestone lenses are found below Cape Horn, in Bear River Canyon west of Dutch Flat, and in the canyon of the South Fork of Yuba River south of Relief; they are ordinarily only a few feet thick. Meager fossils not diagnostic as to age. The formation corresponds to part of Calaveras formation and is assigned to the Carboniferous. Overlies Relief quartzite and underlies Delhi formation. Named for occurrence at Cape Horn, overlooking North Fork of American River, in Placer County.

Capistrano formation.

Upper Miocene (?): Southern California (between Santa Ana and Oceanside).

A. O. Woodford, 1925 (California Univ. Pub., Dept. Geol. Sci. Bull., vol. 15, No. 7, pp. 169, 184, 216–217). "*Capistrano formation.*—The light-colored Monterey shale is everywhere overlain by thin-bedded dark-gray shale, the contact being nearly or quite conformable. This shale and the associated sandstone cover a large synclinal area centering about Capistrano. Mica is prominent in the gray shale, and Foraminifera and other organisms are common both in it and in the sometimes abundant small limestone nodules or lenses. The shale rarely contains beds of fine sandstone, which is usually high in quartz and sometimes highly feldspathic. At the top of the formation this sandstone predominates. Occasionally the gray shale has white partings which resemble the Monterey. * * * The Capistrano beds may properly belong with the Monterey, but because of their different lithology and the local development of breccia at or near their base, they are here distinguished as a separate formation. The shales are practically identical with those which unconformably overlie the Monterey in the near-by Huntington Beach oil field, and which are commonly called Fernando Pliocene." Thickness 1,200 feet. Classified as upper Miocene (?), as unconformably (?) overlying Monterey shale, and as unconformably overlain by San Mateo formation (Pliocene?). Suggests correlation with San Pablo formation (upper Miocene), but "fossil evidence is inconclusive," and the beds may be lower Pliocene. [Mapped.]

Named for development around Capistrano, Orange County.

"Caribou formation."

Mississippian: Northern California (Plumas County).

J. S. Diller, 1892 (preliminary proof-sheet edition of Lassen Peak folio of U. S. Geol. Survey Geol. Atlas). *Caribou formation.*—Northwest of Caribou Bridge [Plumas County, in southeastern part of Lassen Peak quadrangle] a series of slates and sandstones, with a heavy mass of fossiliferous limestone, forms for several miles the crest of the divide between Mosquito and Yellow Creeks. The limestone is of Carboniferous age and one of the most widely distributed strata yet recognized by fossils in northern California. It forms a prominent hill near Bass's ranch on Stillwater and on McCloud River opposite the United States fishery, as well as near Gazelle, northwest of Mount Shasta. Is younger than Grizzly formation and older than Spanish formation.

J. P. Smith, 1916 (California State Min. Bur. Bull. 72, pp. 28, 29). "The Caribou limestone of the Taylorsville region of Plumas County, with *Fusulina cylindrica*, is mapped under the Carboniferous heading."

In the published Lassen Peak folio (No. 15) these rocks were mainly included in the Calaveras formation.

Carmelo series.

Eocene (?): Western California (Carmelo Bay region, southwest coast of San Mateo County).

A. C. Lawson, 1893 (California Univ. Pub., Dept. Geology Bull., vol. 1, pp. 1–59). Several hundred feet of thick-bedded conglomerates of dark color and thin-bedded tawny sandstones with some argillaceous shales. No fossils at Carmelo Bay, but the series appears to be identical with the coal-bearing sandstones of Malpaso Canyon, about 2 miles distant, which carry coal and appear, from the fragmentary fossils found, to be of Tejon (Eocene) age. Overlain unconformably by Miocene Monterey series, and unconformably underlain by Santa Lucia granite.

H. J. Hawley (Geol. Soc. America Bull., vol. 28, p. 225, 1917) and P. D. Trask (California Univ. Pub. Dept. Geol. Sci. Bull., vol. 16, p. 142, 1926) regard these rocks as of Chico age.

Carquinez (spelling adopted by U. S. Geographic Board). See "*Karquinez.*"

"Carrizo" formation.

Miocene (lower and middle or upper): Southern California (Imperial and San Diego Counties).

J. P. Smith, 1910 (Jour. Geology. vol. 18, No. 3, chart opp. p. 226). *Carrizo formation*, sandstones with *Pecten carrizoensis* and *P. cerrosensis*. Of upper Miocene age. Older than San Diego.

W. S. W. Kew, 1914 (California Univ. Pub., Dept. Geology Bull., vol. 8, pp. 39–46, map). [Called Carrizo formation on map; no text heading; throughout description called *Carrizo formation* and *Carrizo Creek formation*.] At type locality divided, on lithologic and biologic grounds, into lower division and upper division, both of which are well exposed there, but only remnants remain to indicate their former extent. The upper division is about 2,000 feet thick in Carrizo Valley and consists of fine-grained muddy sandstone and shale. It extends north along west side of Salton Sea to Santa Rosa Mountains, which is the most northerly limit of the beds in this region. The lower division consists of about 200 feet of more or less coarse arkosic sandstone, locally conglomeratic, underlain by a coarse angular conglomerate of subaqueous origin and reddish color. The total thickness of the formation is probably 2,500 feet. It rests on the eroded surface of the basement complex or, in places, on a flow of andesite.

J. P. Buwalda and W. L. Stanton, 1930 (Science, new ser., vol. 71, pp. 104–106). *Carrizo formation* is Miocene or lower Pliocene.

W. P. Woodring, 1931 (Carnegie Inst. Washington Pub. 418, pp. 1–25). "Carrizo formation" of Kew (preoccupied) included the marine Imperial formation (late lower Miocene) and at least the basal part of the overlying nonmarine deposits of upper or middle Miocene age, here named Palm Spring formation.

Name is preoccupied. See also "*Carrizo Creek beds*" and *Imperial formation*.

Named for exposures in broad valley of Carrizo Creek immediately north of Coyote Mountain, Imperial County.

"Carrizo Creek beds."

Miocene (lower and middle or upper): Southern California (Imperial County).

C. R. Orcutt, 1890 (California State Min. Bur. Tenth Ann. Rept., p. 915). *Carrizo Creek oyster beds*.—Shales and clays of light-brown or pinkish color, through which Carrizo Creek has been cut. Tentatively assigned to Miocene. [Inadequate definition.]

T. W. Vaughan, 1917 (U. S. Geol. Survey Prof. Paper 98, pp. 355–386). "The fauna of Carrizo Creek is related to Pliocene and post-Pliocene faunas of Florida and the West Indies and can scarcely be older than lower Pliocene."

W. S. W. Kew, 1920 (U. S. Geol. Survey Press Bull. 447, June, 1920). "These beds are known as the Carrizo Creek beds, from their extensive outcrops on Carrizo Creek, but can also be seen along the west side of the valley around Coyote Mountain, at Yuha Buttes, and at Superstition Mountain, as well as at San Felipe Valley, west of the Salton Sea, and at places north of San Gorgonio Pass, in Riverside County. Remnants of these beds rest on the crystalline rocks at elevations as high as 2,000 feet above the present level of the valley. The Carrizo Creek beds consist mainly of tan-colored well-bedded sandy shales or silts, but include small amounts of sandstone and clayey shale. At some places, as on Carrizo Creek, they contain numerous marine fossils, the remains of animals that lived probably in Pliocene time."

See also "*Carrizo*" *formation*, W. S. W. Kew, 1914.

In 1926 (California Acad. Sci. Proc., 4th ser., vol. 14, p. 434) G. D. Hanna named these beds Imperial formation. In 1931 (Carnegie Inst. Washington Pub. 418, pp. 1–25) W. P. Woodring divided them into Palm Spring formation above (nonmarine) and Imperial formation (restricted) below (marine).

Carson Creek formation.

Age (?): Northern California (Calaveras County).

F. A. Moss, 1927 (Eng. and Min. Jour., vol. 124, pp. 1010–1011). In the Carson Hill area the oldest rocks constitute a sedimentary and volcanic series at least 5,000 feet thick, to which I have given the local name of the "*Carson Creek formation*." It is best exposed west of Carson Hill. Sediments in lower part are chiefly conglomerates with a few thin partings of sandstone. Near bottom is a series of hornblende-dacite lava flows and rhyolite tuffs 900 to 1,700 feet thick. Upper part of formation is slate, mostly tuffaceous, with several lenses of limestone and beds of andesitic crystal tuff. At top is a thick and massive bed of andesitic tuff, in places containing much admixed sediment.

Catalina facies of Franciscan series.

Jurassic (?): Southern California (Catalina Island).

A. O. Woodford, 1924 (California Univ. Pub., Dept. Geol. Sci. Bull., vol. 15, No. 3). *Catalina metamorphic facies of the Franciscan series.* [Mapped.] "On Catalina Island off the coast of southern California, and in San Pedro Hill on the adjacent mainland, are areas of unusual metamorphic rocks similar to those forming part of the Franciscan series farther north. These rocks are schistose, are of variable grain, and made up largely of various combinations of the minerals quartz, albite, muscovite, chlorite, epidote, glaucophane, crossite, actinolite, and lawsonite. * * * The new term Catalina metamorphic facies indicates the absence of unmetamorphosed materials. * * * The Catalina facies is probably unconformably beneath the Chico, and it has a close lithologic resemblance to the schists of north Berkeley and the Tiburon Peninsula mapped by A. C. Lawson (1914) as Franciscan. These facts taken together suggest correlation with the Franciscan series. The quartz schists would then be metamorphosed radiolarian cherts, the quartz-albite schists former arkoses derived from a region of quartz diorites, and the remaining types former basic igneous rocks. Soda basalts of the type analyzed by Ransome from the Point Bonita Franciscan may be represented. At this time, however, the correlation can be made only in the most general sense, indicating merely that these rocks belong to a great and perhaps heterogeneous group now called the Franciscan series. It may be that these metamorphic rocks belong to an ancient group which extends northward unconformably beneath the typical Franciscan."

A. O. Woodford, 1925 (California Univ. Pub., Dept. Geol. Sci. Bull., vol. 15, No. 7, pp. 163, 172, 225). *Catalina facies of Franciscan series.*—Half of Catalina Island is a complex of albitic, amphibolic, chloritic schists, quartz schist, serpentine, etc., and there is a small area of similar rocks exposed in San Pedro Hill on the mainland. They are especially characterized by abundance of albite and by presence of the unusual minerals glaucophane, crossite, and lawsonite.

Catalina schist breccia.

Lower (?) Miocene: Southern California (southeast end of Catalina Island).

A. O. Woodford, 1925 (California Univ. Pub., Dept. Geol. Sci. Bull., vol. 15, No. 7, pp. 211–212). "*Catalina schist breccia.*—At the southeast end of Catalina Island small areas of schist and quartzite breccia with sandy matrix are involved in the volcanic rocks. As indicated by W. S. T. Smith, it is difficult to determine whether these are contemporaneous with the volcanics or inclusions in them. The breccia blocks are sometimes exclusively subrounded quartzite and gray porphyry. Sometimes glaucophane and other schists are also present, making a rock very similar to the San Onofre sandy breccia." [This description is under the center heading "Doubtful correlatives of the San Onofre facies" of the Temblor formation of Monterey series.]

Cathedral Peak granite.

Probably Cretaceous: Yosemite National Park.

F. C. Calkins, 1930 (U. S. Geol. Survey Prof. Paper 160, pp. 126–127, map). A coarsely prophyritic rock, in which biotite is more abundant than hornblende. The distinguishing feature of the granite is that it contains unusually large phenocrysts of feldspar. Included in Tuolumne intrusive series, in which it is next younger than the Half Dome quartz monzonite and next older than the Johnson granite porphyry.

Named from fact that it composes Cathedral Peak and most of the Cathedral group or range in Yosemite National Park.

Cedar formation.

Upper Triassic: Northern California (Lassen Peak region).

J. S. Diller, 1892 (preliminary proof-sheet edition of Lassen Peak folio of U. S. Geol. Survey Geol. Atlas) and 1895 (published Lassen Peak folio, No. 15). Although there are slates and sandstones, with occasional traces of conglomerate, the principal stratum of the Cedar formation is limestone, which forms conspicuous ledges on the road a few miles west of Buzzard's Roost. This limestone is rich in Triassic fossils, which clearly show it is the same horizon as the Hosselkus limestone of Genesee Valley. Named for exposure on Cedar Creek, along the toll road between Redding and Round Mountain, where it is overlain by the Bend formation.

H. W. Turner, April, 1894 (Am. Geologist, vol. 12, pp. 229–249). The Cedar formation includes the Hosselkus limestone and underlying slates [meaning the Swearinger slate, which is now known to overlie the Hosselkus limestone].

Cedarville series.

Miocene: Northeastern California (Modoc County).

R. J. Russell, 1928 (California Univ. Pub., Dept. Geol. Sci. Bull., vol. 17, No. 11, pp. 402–416, map). *Cedarville series.*—A series of andesitic rocks, at least 7,500 feet thick, divided into (1) Upper Cedarville (andesitic tuffs, agglomerates, intercalated flows, and about 5 per cent of nonvolcanic sediments); (2) andesitic lava flows 150 to 500 feet thick; and (3) Lower Cedarville (3,700 feet of andesitic agglomerates, tuffs, conglomerates, intercalated flows, and about 5 per cent of nonvolcanic sediments). The Upper Cedarville contains fossil flora considered by Chaney to be of Mascall (Upper and Middle Miocene) age. [Mapped over large part of Warner Range, west of Cedarville.]

Centinela gravels.

Pleistocene: Southern California (Baldwin Hills, Los Angeles County).

A. J. Tieje, 1926 (Am. Assoc. Petroleum Geologists Bull., vol. 10, No. 5, p. 510). "The [post-Palos Verdes] alternating [fresh-water] blue-clay and gravel beds, however, of trench 10 may be correlated with a series of marine gravels which carry a fauna of still more warm-water aspect than that of the Palos Verdes strata and which may be tentatively styled the Centinela gravels, since they were exposed south of Centinela Creek, in trench 6. On the other hand, these Centinela gravels may represent a new submergence of the Baldwin Hills region."

Chanac formation.

Pliocene: Southern California (Tejon Hills, Fresno County).

J. C. Merriam, J. P. Buwalda, and B. L. Clark, 1916 (California Univ. Pub., Dept. Geology Bull., vol. 10, pp. 111–115). *Chanac formation.*—Mammal-bearing beds, 400 to 600 feet thick, apparently of terrestrial origin. Consist of angular sands and coarser angular materials; the particles mainly rhyolitic, and display white, yellow, and striking reddish-brown colors in exposures; not sharply bedded. Should be termed fanglomerates. [Fossils described.] Of early Pliocene or latest Miocene age. In southern part of Tejon Hills the Chanac fanglomerates rest on old crystalline rocks without observed discordance. Exposed along Chanac Creek.

H. W. Hoots, 1929 (U. S. Geol. Survey Bull. 812, pp. 275, 291). *Chanac formation* is equivalent to Tulare, Etchegoin, and Jacalitos formations but is geographically separated from them.

Chico formation (also **group**).

Upper Cretaceous: California and Oregon.

W. M. Gabb, 1869 (California Geol. Survey Paleontology., vol. 2, p. xiv, as reported by J. D. Whitney from an unpublished paper by Gabb, and footnote by Gabb on p. 129). One of the most extensive and important members of the Pacific coast Cretaceous. Is extensively represented in Shasta and Butte Counties; also in foothills of Sierra Nevada as far south as Folsom; on eastern face of Coast Ranges bordering Sacramento Valley; at Martinez; and in Oristamba Canyon, in Stanislaus County. It includes all of the known Cretaceous of Oregon and the extreme northern portion of California and is the coal-bearing formation of Vancouver's Island. It underlies Martinez group and overlies Shasta group, but the Martinez group "may eventually prove to be worthy of ranking only as a subdivision of the Chico group." Typical localities are Chico Creek [Butte County, Calif.], Pence's ranch, and Tuscan Springs.

The Chico rocks consist of sandstones, shales, and conglomerates of marine origin, having a maximum thickness of 21,000 feet and characterized by an Upper Cretaceous fauna. In the Diablo Range the Chico is of very great thickness and becomes a group, divided into Moreno formation above and Panoche formation below.

"Chico-Tejon series."

A term introduced by C. A. White (U. S. Geol. Survey Bull. 51, pp. 11–14, 1889) to include all the Upper Cretaceous and Eocene rocks of California, because they were then believed to constitute an unbroken series of sediments without unconformities, but they are now known to contain several unconformities.

Cierbo group.

Miocene (upper): Western California (Mount Diablo region).

B. L. Clark, 1921 (Jour. Geology, vol. 29, pp. 586–614). "The use of the name San Pablo for the upper Miocene series of deposits on the west coast makes it necessary to dispense with the term San Pablo within the group. The name Cierbo is therefore used in this paper in referring to the middle group of the San Pablo series. The type section of the Cierbo is in the south side of the Cañada del Cierbo, near Carquinez Straits." These marine beds are recognized only in the general region of San Francisco Bay, where they lie disconformably below the Santa Margarita group and rest disconformably on the Briones group.

Same as San Pablo formation.

Claremont shale.

Miocene (middle): Western California (San Francisco region).

A. C. Lawson, 1914 (U. S. Geol. Survey Geol. Atlas, San Francisco folio, No. 193). Bituminous shale. In Sobrante anticline it is in part soft and distinctly shaly or chalky and in places contains a large admixture of fine detrital material, but in Berkeley Hills it is notably cherty, consisting of beds of hard flinty chert alternating at regular intervals with partings of shale. Thickness 250 to 1,000 feet. A formation of Monterey group. Underlies Oursan sandstone and overlies Sobrante sandstone. Named for exposures on Claremont Creek, Concord quadrangle.

Clear Creek greenstone.

Mississippian(?): Northwestern California (Klamath Mountains region).

O. H. Hershey, 1901 (Am. Geologist, vol. 27, pp. 226, 233, 238). The foundation rock of the basin of Trinity River between Trinity Center and Lewiston, the Trinity Mountains, and the ridges eastward to the Sacramento River. Provisionally assigned to the Jurassic. Is made up of a variety of deposits of a volcanic nature, but all having something in common, so that it appears over wide areas as a massive fine-grained dull-green rock. Much of it is of a detrital character, chiefly diabasic tuffs and ashes, although in places it is brecciated and occasionally it has a conglomerate structure. In large part is extrusive. Was deposited on land. Thickness more than 1,000 feet. Is associated with Bragdon slates [Mississippian]. Rests unconformably on Devono-Carboniferous rocks.

Probably named for exposures on or near Clear Creek, Shasta County.

Clear Creek series.

Mississippian (?): Northwestern California (southern part of Klamath Mountains).

O. H. Hershey, 1903 (Am. Geologist, vol. 31, pp. 231–245). Volcanic materials, such as andesite and rhyolite lavas and tuffs, intruded by dikes of diorite, diabase, and rhyolite porphyry, all altered. Thickness 200 to 2,000 feet. Associated with Bragdon formation [Mississippian].

Clear Creek volcanic series.

Triassic (?): Northwestern California (Trinity and Shasta Counties).

O. H. Hershey, 1904 (Am. Geologist, vol. 33, pp. 248–256, 347–360). Lavas and tuffs, which grade into the overlying Pit shales by interstratification. Assigned to the Triassic.

According to J. S. Diller (Am. Jour. Sci., 4th ser., vol. 19, pp. 380–385, 1905) the Clear Creek volcanics of Hershey are pre-Bragdon and in part at least pre-Middle Devonian.

Clear Lake sediments.

Pleistocene: Northern California (Lake County).

W. H. Dall and G. D. Harris, 1892 (U. S. Geol. Survey Bull. 84, pp. 201–202). The body of water in which these Cache Lake beds were laid down overlapped the area at present occupied by Clear Lake, with which Dr. G. F. Becker shows its geologic history has been continuous. The later andesite overlies the Cache Lake deposits and also underlies the Clear Lake sediments.

Clipper Gap formation.

Mississippian: Northern California (Colfax quadrangle).

W. Lindgren, 1900 (U. S. Geol. Survey Geol. Atlas, Colfax folio, No. 66). A highly compressed sequence of black clay slates and dark argillaceous sandstones. Bodies of limestone abundant but usually lenticular. Bluish or grayish chert is also common and so closely connected with the limestone as to suggest strongly its derivation from that rock by a process of silicification. Contains lower Carboniferous fossils. Corresponds to upper part of Calaveras formation. Overlies Delhi formation. Is top formation of Carboniferous age in area. Named for exposures at village of Clipper Gap, Placer County.

Coachella fanglomerate.

Miocene (middle or upper): Southern California (San Bernardino Mountains).

F. E. Vaughan, 1922 (California Univ. Pub., Dept. Geol. Sci. Bull., vol. 13, No. 9, pp. 344, 386–387, 391, map). *Coachella fanglomerate.*—A clastic rock having all characteristics of a fanglomerate. For most part the fragments are angular and show little sorting, but material varies somewhat throughout the mass. Greater part of mass is light-gray and dark purplish-gray, rather persistent coarse gravel and subangular polygenetic pebbles 2 inches to a foot in diameter, probably derived from the old rocks to north. In places it consists mostly of sharply angular fragments varying in size up to 3 feet across. The fragments are of porphyry, granite, and, largely, basalt. To the east this fanglomerate dips beneath more recent (Cabezon) fanglomerate, which differs from it in being more uniform and massive, of yellowish color, and in lying nearly horizontal. The Coachella fanglomerate rests on old schists and gneisses. Is younger than Deep Canyon fanglomerates.

Named for Coachella Valley, Riverside County, near which it occurs.

Coahuila silt.

Pleistocene: Southern California (Imperial County).

G. D. Hanna, 1926 (California Acad. Sci. Proc., 4th ser., vol. 14, No. 18, p. 435). "The Yuha Reefs are followed by an enormous thickness of silt deposited in the fresh waters of the ancient Lake Coahuila, an appropriate name for which is the 'Coahuila silt.' It is exposed where the San Diego-El Centro highway crosses New River, about a mile west of El Centro. The total thickness of these silts is not known, but they contain fresh water fossils to the base of the exposure indicated."

"Coalinga beds."

Pliocene and Miocene: Southern California (Fresno and Kings Counties).

F. M. Anderson, 1905 (California Acad. Sci. Proc., 3d ser., vol. 2, pp. 174–185). The series of beds unconformably underlying the Etchegoin formation and resting unconformably on all underlying formations, the youngest of which is the Monterey shale. Includes (descending order):

Sands, etc. 1,300 feet.
Tamiosoma bed (oyster bed). 20 feet.
Sands and shales. 600+ feet. (Includes the "Rainbow beds.") [See p. 177 of book cited.]
Reef bed. 15–50 feet.
Basal sands and gravels. 120–250 feet.

F. M. Anderson, 1908 (California Acad. Sci. Proc., 4th ser., vol. 3, pp. 1–40). "It is now proposed to restrict the name Coalinga beds to the lower portion of a series that is unconformably related to the older members of the Miocene." The Santa Margarita beds of the San Luis folio are clearly related to the

Coalinga beds. Overlain, generally conformably, by Etchegoin formation, and underlain, in places unconformably, by Monterey shales. The "Reef bed" of former report is properly a part of the Temblor beds.

The "Coalinga beds" as originally described included rocks belonging to the Jacalitos formation, Santa Margarita(?) formation, Maricopa shale, and Vaqueros sandstone of subsequent reports. The restricted definition applied to essentially the same rocks that were called Santa Margarita(?) formation in United States Geological Survey Bull. 398, descriptive of the Coalinga district.

Named for exposures north, northwest, and west of Coalinga, Fresno County.

Coast complex.

Pre-Franciscan (possibly pre-Cambrian): Southern California (northwestern part of Monterey County).

B. Willis, 1900 (Geol. Soc. America Bull., vol. 11, p. 419). Crystalline rocks, chiefly metamorphic, including marble, quartzitic schists, mica schists, gneisses, and intrusive granite. The marbles and schists are of sedimentary origin. The gneisses may be partly or wholly igneous. Occurs at base of geologic column in the Coast Ranges. Is long pre-Cretaceous. May be Paleozoic. Is the "basement complex" of Fairbanks.

Same as Santa Lucia series of Willis.

Coast Range complex.

A name that has been applied by some geologists to the pre-Franciscan rocks of the Coast Ranges of southern California.

Coldwater sandstone member.

Eocene: Southern California (Los Angeles County).

W. S. W. Kew, 1924 (U. S. Geol. Survey Bull. 753). The top sandstone of the Tejon formation in parts of Los Angeles County is locally known as the "*Coldwater sandstone*."

N. L. Taliaferro, 1924 (Am. Assoc. Petroleum Geologists Bull., vol. 8, pp. 789–802). *Coldwater member of Tejon formation.*—West of Sespe Canyon, in the heart of an anticline along Coldwater Creek, and again to the north along the southern flank of the Topatopa Mountains, there are about 400 to 500 feet of hard white sandstones with intercalations of light pink, pale green, and grayish shales. The sandstones carry a dwarfed estuarine fauna of Eocene age. These beds have heretofore been included with the Sespe, but since they are fossiliferous and also differ lithologically from the typical Sespe they should be included in the Tejon as the Coldwater member.

P. F. Kerr and H. G. Schenck, 1928 (Geol. Soc. America Bull., vol. 39. p. 1091). *Coldwater sandstone*, top member of Tejon formation, is about 2,500 feet thick near Matilija, Ventura County. It is characterized by white friable arkose sandstone interbedded with reddish sandy shale and massive hard ledges composed of numerous shells of *Ostrea idriaensis* Gabb. Has been traced more than 40 miles along Santa Ynez Range westward from type locality in Coldwater Canyon.

Colfax formation.

Upper Jurassic: Northern California (Gold Belt region).

J. P. Smith, 1910 (Jour. Geology, vol. 18, charts opp. pp. 217, 221). "Tuffs and shales of the Gold Belt with *Perisphinctes colfaxi*." Of Portland (Upper Jurassic) age. Overlies Mariposa formation [restriction of Mariposa] and is shown as older than Knoxville formation.

R. W. Goranson, 1924 (Am. Jour. Sci., 5th ser., vol. 8, p. 162). "The Mariposa formation (of the Auriferous slates) of the Sierra Nevada is divided into two parts, the lower part being the Mariposa slate and the upper the Colfax series of the Gold Belt. * * * The tuff beds of Colfax contain *Perisphinctes colfaxi*, and the same beds near Nashville, Amador County, contain *Simbirskites* sp."

Is the upper part of the Mariposa slate as used by United States Geological Survey.

Concord formation.

Oligocene: Western California (San Francisco Bay region).

B. L. Clark, 1918 (California Univ. Pub., Dept. Geology Bull., vol. 11, pp. 54–111.) Chiefly fine grayish sandstone, becoming finer and more shaly near top, and including at the base a thin layer (6 inches) of conglomerate, the boulders of which are composed mainly if not entirely of tuff, sandstone, and shale apparently derived from the immediately underlying Oligocene beds. Thickness about 250 feet. On the south side of Sobrante anticline, in the Concord quadrangle, it disconformably overlies Kirker tuff and unconformably underlies Sobrante sandstone [restricted definition, and only upper part of Lawson's Sobrante sandstone] of the Monterey group. Included in San Lorenzo series. Is the lower part of the Sobrante sandstone as defined by Lawson, the name Sobrante being restricted by the author to the upper 80 to 100 feet of Lawson's Sobrante.

Conejo volcanics.

Miocene: Southern California (west end of Santa Monica Mountains).

N. L. Taliaferro, 1924 (Am. Assoc. Petroleum Geologists Bull., vol. 8, pp. 800–801). "One of the most important centers of Miocene volcanism in the State lies in the western end of the Santa Monica Mountains. This region is often referred to as the Conejo Mountains, and the name Conejo volcanics is here applied to all the series of volcanic and intrusive rocks occurring in that region." These volcanic rocks and the interbedded Miocene sediments probably aggregate 15,000 feet in thickness.

"Contra Costa lake bed."

Pliocene: Western California (San Francisco Bay region).

J. G. Cooper, 1894 (California Acad. Sci. Proc., 2d ser., vol. 4, p. 169). Lies chiefly on the northeast slope of the hills west of San Pablo Creek, forming the boundary between Contra Costa and Alameda Counties in that part of its course about 4½ miles northeast of the State University.

Contra Costa County Miocene.

A term that has been applied in the earlier literature to the Miocene deposits of Contra Costa County, which are now divided into several named formations.

Copley meta-andesite.

Devonian or older: Northern California (Redding quadrangle).

J. S. Diller, 1906 (U. S. Geol. Survey Geol. Atlas, Redding folio, No. 138). Includes a great mass of lava made up of many separate volcanic flows of considerable variety and sheets of tuffs more or less distinctively bedded but generally so compressed as to develop slaty cleavage. Is generally pale green on weathered surface, but darker green and compact on fresh, somewhat shaly fracture. Thickness about 1,000 feet. Is overlain by Kennett limestone (Middle Devonian) and is oldest formation exposed in Redding quadrangle. In places the Bragdon formation rests on it. Named for its occurrence in the vicinity of Copley.

Corral Hollow shales.

Jurassic(?): Western California (Alameda County).

C. F. Tolman, jr., 1915 (Nature and science on Pacific coast, p. 45, San Francisco, Elder & Co.). A subdivision of Franciscan series. Contain massive beds of crumpled and folded cherts and, especially in vicinity of serpentine intrusions, lawsonite, chlorite, and glaucophane bearing schists that seem to be peculiar to Franciscan series. Older than Oakridge sandstone and underlain by dense blue sandstone of the Franciscan.

Courtney granite.

Mesozoic: Northern California (Trinity County).

O. H. Hershey, 1900 (Science, new ser., vol. 11, pp. 130–132). The granite of Mount Courtney batholith. A near-by batholith is composed of entirely different granite.

"Coyote Mountain clays."

Miocene (lower): Southern California (Imperial County).

G. D. Hanna, 1926 (California Acad. Sci. Proc., 4th ser., vol. 14, No. 18, p. 435). "Above the Latrania sands there are enormous deposits of clay, the peculiar properties of which may make it of commercial value at some future time. * * * I would propose that they be called '*Coyote Mountain clays.*' They are extensively developed over wide areas, but the type locality has been selected in the foothills bordering the southeast slope of Coyote Mountain. Above these clays, and interbedded with them near the top to some extent are extensive deposits of oyster shells for which the name 'Yuha Reefs' has been selected." Assigned to Pliocene, probably middle or upper Pliocene. [Included in upper part of "Carrizo Creek beds." See under Imperial formation.]

See W. P. Woodring, 1931, under *Imperial formation.*

Cozy Dell shale member.

Eocene: Southern California (Ventura County).

P. F. Kerr and H. G. Schenck, 1928 (Geol. Soc. America Bull., vol. 39, p. 1090). *Cozy Dell shale member.*—The rhythmically bedded fossiliferous marine green micaceous shale and sandstone that is typically exposed in Cozy Dell Canyon, on east side of Ventura River, and forms middle member of Tejon formation. Thickness 2,500± feet. Underlies Coldwater sandstone member and disconformably overlies Matilija sandstone member.

Crescent City beds.

Miocene and Pliocene: Northwestern California (Del Norte County).

J. S. Diller, 1902 (U. S. Geol. Survey Bull. 196, pp. 31–35). "Somewhat similar beds [to those northward and southward from Point St. George, Del Norte County, which consist of soft yellowish and gray shaly sandstones and whitish shales full of Miocene fossils] occur by the wharf at Crescent City (Crescent City beds), and among their fossils Dr. [W. H.] Dall recognizes *Pecten parmeleei* and *Terebratalia hemphilli,* species heretofore known only from the southern California Pliocene. It is probable that these soft Miocene and Pliocene beds have a wide extent under the Pleistocene of the low, broad coastal plain extending from Smith River to a point 3 miles south of Crescent City."

Cuesta diabase.

Lower Cretaceous: Southern California (San Luis Obispo region).

H. W. Fairbanks, 1904 (U. S. Geol. Survey Geol. Atlas, San Luis folio, No. 101). Geologically related intrusive masses and sheets of pre-Chico age occurring upon opposite sides of the long area of Toro shale which extends from vicinity of Cuesta Pass on the south to the northern edge of the quadrangle. Other diabases occur in the area.

Named for exposures near Cuesta and Cuesta Pass, San Luis Obispo County.

Cuyama formation.

Tertiary (Pliocene?): Southern California (Cuyama Valley).

W. A. English, 1916 (U. S. Geol. Survey Bull. 621, pp. 191–215). Nonfossiliferous yellow and pink clays, sand, and gravel, in large part of nonmarine origin. Thickness 250 to 600 feet. Rest on eroded edge of Santa Margarita formation and older beds. Crop out only in Cuyama Valley. Overlain by Quaternary terrace gravels.

Cuyamaca basic intrusive.

Probably pre-Cretaceous: Southern California (Cuyamaca region, San Diego County).

F. S. Hudson, 1922 (California Univ. Pub., Dept. Geol. Sci. Bull., vol. 13, No. 6, pp. 181, 192–207, map). Chiefly gabbros, norites, and basic diorites. Three units mapped—(1) hypersthene diorite, (2) augite diorite, and (3) norite, gabbro, etc. Cuts Julian schist and Stonewall quartz diorite.

Named for the three peaks of Cuyamaca Mountains.

Deadman Island beds.

Pleistocene: Southern California.

J. P. Smith, 1910 (Jour. Geology, vol. 18, chart opp. p. 217). Name applied to lower part of San Pedro formation, Los Cerritos beds being applied to upper part of the San Pedro.

Deep Canyon fanglomerate.

Quaternary: Southern California (San Bernardino Mountains).

F. E. Vaughan, 1922 (California Univ. Pub., Dept. Geol. Sci. Bull., vol. 13, No. 9, pp. 344, 384–385, and map). Detrital rocks, consisting largely of angular and subangular boulders derived from older rocks to north. Contain notable proportion of rounded material and many strata of sandstone comparable to that in Hathaway formation. Rest on basalt, of probably early Quaternary age, on both sides of Deep Canyon. Across upturned and eroded edges of the fanglomerate and basalt later fanglomerate has been deposited. Is older than Coachella fanglomerate and younger than Pipes fanglomerate.

Named for Deep Canyon, Riverside County.

Deep Spring formation.

Pre-Cambrian: Eastern California (Inyo Range).

E. Kirk, 1918 (U. S. Geol. Survey Prof. Paper 110). About 1,600 feet of sandstones and dolomitic limestones, unconformably underlying the Campito sandstone and unconformably overlying the Reed dolomite. Named for exposures along west side of Deep Spring Valley in canyons north of Antelope Spring.

Dekkas andesite.

Middle Triassic: Northern California (Redding quadrangle).

J. S. Diller, 1906 (U. S. Geol. Survey Geol. Atlas, Redding folio, No. 138). Is generally a dark-gray lava that is more or less porphyritic, but not conspicuously so to the naked eye. It includes a great mass of lava made up of many separate overlapping volcanic flows and sheets of tuff more or less distinctly bedded, irregularly conformable, and dipping eastward. Along eastern border of the quadrangle these rocks are overlain conformably by and to a small extent are interbedded with the bottom part of the Pit shales. Overlies Nosoni formation and underlies Bully Hill rhyolite. Thickness approximately 1,000 feet. Named for exposures along Dekkas Creek.

Delhi formation.

Mississippian: Northern California (Colfax quadrangle).

W. Lindgren, 1900 (U. S. Geol. Survey Geol. Atlas, Colfax folio, No. 66). Chiefly a peculiar dark-brown or black hard rock so fine grained as to be almost flinty and rarely showing either stratification or schistosity. The rock often has a chertlike appearance but contains less silica than the normal chert. The peculiar petrographic character is probably due to regional metamorphism. Very few lenticular limestone masses occur in it. In a few places the rock shows marked schistosity and resembles a dark siliceous clay slate. The formation corresponds to part of Calaveras formation. Overlies Cape Horn slate and underlies Clipper Gap formation. Typical exposures near the Delhi mine, Nevada County.

Delmar sand.

Eocene: Southern California (San Diego County).

M. A. Hanna, 1926 (California Univ. Pub., Dept. Geol. Sci. Bull., vol. 16, No. 7, pp. 187–246). Sandstones, shales, and some beds, composed almost wholly of oysters, that might be considered limestone, but usually the matrix surrounding the shells is argillaceous rather than calcareous. The sandstones are both coarse grained and fine grained and grade into arenaceous shales. They are of prevailingly brown color but often have a tinge of green, while a few beds have a reddish and purplish cast. Many of the shales are well stratified, but others grade into shaly sands. Bedding is irregular. Cross-bedding is prominent in many places. Upper part contains more sand than lower part, and the sands are of darker color than the overlying Torrey sand, into which the

Delmar sand grades. Thickness more than 200 feet. Is basal division of La Jolla formation in La Jolla quadrangle. Rests unconformably on Chico Cretaceous. Named for excellent exposures in sea cliff at town of Delmar, San Diego County.

Diamond Peak quartzite.

Carboniferous (Pennsylvanian?): Northern Nevada and Inyo County, Calif.

Arnold Hague, 1883 (U. S. Geol. Survey Third Ann. Rept., pp. 253, 268). Massive vitreous quartzite of grayish-brown color, passing near the summit into brown and green shales and schists, and with firmly cemented conglomerate at base. A narrow belt of blue limestone about 500 feet above the base of the formation contains Carboniferous fossils. Thickness 3,000 feet. Overlies White Pine shale and is overlain by Lower Coal Measures. Named for exposures on flanks of Diamond Peak, Eureka district, Nev.

The age of the typical Diamond Peak quartzite remains to be determined. The formation, with a thickness of 3,500 feet, has been identified by E. Kirk (U. S. Geol. Survey Prof. Paper 110, 1918) in the Inyo Range, Calif., where it is separated from the underlying White Pine shale by 500 to 1,000 feet of limestone carrying Pennsylvanian fossils.

Domengine formation.

Eocene (middle): Southern California (Diablo Range).

F. M. Anderson, 1905 (California Acad. Sci. Proc., 3d ser., vol. 3, pp. 167–168). *Domijean sands*.—Chiefly yellow sands. Thickness 350 to 1,200 feet. Greatest development in vicinity of Domijean ranch. Overlies Kreyenhagen shales and unconformably underlies Temblor beds. Correlated with a part of Tejon formation.

B. L. Clark and R. B. Stewart, 1925 (Geol. Soc. America Bull., vol. 36, p. 227). *Domengine horizon (middle Eocene)*, a newly recognized division of the Eocene of California. Contains a new fauna in beds stratigraphically below those containing a typical Tejon (upper Eocene) fauna and above those of Meganos age. A part of this horizon was formerly considered by the senior writer to be Meganos, but in one locality it was called Tejon. A number of species are common to the Meganos and likewise to the Tejon, but, taken as a whole, the fauna is distinctive.

R. L. Nelson, 1925 (California Univ. Pub., Dept. Geol. Sci. Bull., vol. 15, pp. 399–402 and map). Divides the Eocene of Ventura County into (descending order):

- Upper Eocene:
  - Tejon formation.
- Middle Eocene:
  - Domengine formation (gray shale interbedded with conglomerate and brown sandstone).
  - Santa Susana formation (fine-grained sandstone and shale, fossiliferous).
- Lower Eocene:
  - Martinez group (three subdivisions).

"The name Domengine was proposed by F. M. Anderson and is now used by B. L. Clark for the upper part of his Meganos group."

F. E. von Estorff, 1930 (Am. Assoc. Petroleum Geologists Bull., vol. 14, No. 10, pp. 1321–1336). The 500 feet of sandstone underlying typical Kreyenhagen shale in canyon of Canoas Creek is the Domengine sandstone, of upper middle Eocene age, and the sandstone unconformably underlying Kreyenhagen shale is Temblor sandstone, of lower middle Miocene age, the Vaqueros sandstone (of lower Miocene age) being absent.

Included in Meganos formation.

Named for development in vicinity of Domijean or Domengine ranch, in the NE. ¼ sec. 17, north of Coalinga, Fresno County.

Domijean sands. See *Domengine formation*.

Duncan chert.

Mississippian: Northern California (Colfax quadrangle).

W. Lindgren, 1900 (U. S. Geol. Survey Geol. Atlas, Colfax folio, No. 66, p. 2). "From Duncan Peak there extends across the North Fork of American River to the vicinity of Monumental Hill a belt of gray or brown chert, referred to as the Duncan chert. It is well exposed in the canyons near Canada Hill and in the canyon of the main river. This chert is in all probability not of clastic origin and may have been derived from limestone by a process of silicification." Included in Blue Canyon formation.

Eden beds.

Pliocene (lower): Southern California (San Jacinto quadrangle, Riverside County).

C. Frick, 1921 (California Univ. Pub., Dept. Geology Bull., vol. 12, pp. 283–288). Deposits containing a considerable collection of vertebrate fossils (including species of *Pliohippus*), through which they are correlated with middle of Etchegoin formation, and the Rattlesnake, Thousand Creek, and Snake Creek formations. The beds occur in the Eden region, San Jacinto quadrangle. Assigned to the upper part of the lower Pliocene.

El Capitan granite.

Probably Cretaceous: Yosemite National Park.

F. C. Calkins. 1930 (U. S. Geol. Survey Prof. Paper 160, pp. 121–122, map). Light-colored biotite granite of moderately coarse and in part obscurely porphyritic texture, but along eastern margin it passes from a porphyritic to a nonporphyritic rock. Is one of the oldest intrusive rocks in Yosemite region.

Named from fact that it forms greater part of El Capitan, Yosemite National Park.

"Escondido series."

Oligocene (?): Southern California (Los Angeles County).

O. H. Hershey, April, 1902 (California Univ. Pub., Dept. Geology Bull., vol. 3, pl. 1, map). [*Escondido series* and *Escondido lava* are the titles of two blocks on the map, lying between the Rosamond series below and Tejon (?) sandstone above.]

O. H. Hershey, 1902 (Am. Geologist, vol. 29, pp. 349–372). *Escondido series*.—Marine sediments and contemporaneous interbedded lava flows of Eocene (?) age occurring near the head of Escondido Canyon [Los Angeles County]. The type section is in Tick Canyon. Slightly younger than Rosamond series.

W. S. W. Kew, 1924 (U. S. Geol. Survey Bull. 753, pp. 38, 52). Hershey's "Escondido series" is tentatively correlated with the Sespe formation and mapped as Sespe (?) formation. No fossils found. Is overlain unconformably by Mint Canyon formation. Name is preoccupied.

Esmeralda formation.

Miocene (upper): Southern Nevada and Inyo County, Calif.

H. W. Turner, 1900 (Am. Geologist, vol. 25, pp. 168–170; U. S. Geol. Survey Twenty-first Ann. Rept., pt. 2, pp. 197–208). *Esmeralda formation*.—Fresh-water lake deposit, consisting of sandstones, shales, and lacustral marls, with local development of breccia and conglomerate on a large scale; rhyolitic and basaitic lavas and tuffs at top in some places, also layers of rhyolitic and andesitic tuff lower down in the formation. Thickness 14,800 feet. Overlain by rhyolitic and andesitic eruptive rocks. Named for development in Esmeralda County, Nev. [before the county was subdivided].

S. H. Ball, 1907 (U. S. Geol. Survey Bull. 308), mapped the "Siebert lake beds" (now abandoned for Esmeralda formation, the older name) in Inyo County, eastern California.

Etchegoin formation.

Pliocene (middle and upper): Southern California (Sunset, Midway, Coalinga, Mount Diablo, and Salinas Valley districts).

F. M. Anderson, 1905 (California Acad. Sci. Proc., 3d ser., vol. 2, pp. 178–192). *Etchegoin beds*.—Divided into Etchegoin sands, which compose the lower two-thirds of the formation, and San Joaquin clays, which compose the upper one-third. The *Etchegoin sands* consist of unconsolidated sands and gravels, in many places characterized by a blue or bluish-gray color. They vary in thickness from 1,200 to 2,500 feet. Are commonly coarse in texture and often pebbly, forming beds of conglomerate. One fossil horizon occurs near bottom and another some distance above. [Fossils listed.] The *San Joaquin clays* are about 1,500 feet thick. At a distance they present a banded appearance, from the zones of color seen in the different strata, some of which have a width of 200 or 300 feet. The clays are conformably overlain by the fresh-water Tulare formation. "The Etchegoin beds overlie in turn all of the older formations of the region, resting upon each respectively with a distinct nonconformity." The next older rocks are the Coalinga beds.

R. Arnold and R. Anderson, 1908 (U. S. Geol. Survey Bull. 357, pp. 46–55). In accordance with Mr. [F. M.] Anderson's statements and on the basis of the reasons stated below, the Etchegoin formation is mapped and described in the present paper as the succession of slightly consolidated beds of sand, gravel, and clay, interbedded with occasional indurated beds, occurring on the summit and flanks of Anticline Ridge and on the southeast end of Joaquin Ridge north of Coalinga, above the base of the hill-forming sandstone beds (referred to for convenience as the *Glycymeris* zone), and below the beds described as the Paso Robles formation. Strata in other portions of the Coalinga district are referred to the Etchegoin formation on the basis of paleontologic correlation with the beds on Anticline Ridge. The *Glycymeris* zone is underlain by clay that is classed in the Jacalitos formation and is overlain by a thick succession of bluish-gray sand beds interbedded with dark-gray sand. An unconformity occurs below the *Glycymeris* zone in the synclinal basin north of White Creek. Although in most places the Etchegoin appears to rest conformably on the Jacalitos formation, in other places it overlaps the Jacalitos. It is overlain by the Tulare formation, with possible unconformity. Thickness over 3,600 feet in the southern part of the district; 1,700 feet in oil field north of Coalinga; 1,100 feet in White Creek basin. [Fossils listed. The formation includes marine, brackish-water, and fresh-water deposits.]

Named for exposures in the vicinity of Etchegoin ranch, 20 miles northeast of Coalinga, in NW. ¼ sec. 1, T. 19 S., R. 15 E., Fresno County.

Etchegoin sands.

Pliocene: Southern California.

F. M. Anderson, 1905 (California Acad. Sci. Proc., 3d ser., vol. 2, pp. 178–192). [Name applied to lower two-thirds of Etchegoin formation. See description under *Etchegoin formation.*]

Eureka quartzite.

Ordovician (Middle?): Northern Nevada and Inyo County, Calif.

Arnold Hague, 1883 (U. S. Geol. Survey Third Ann. Rept., pp. 253, 262). Compact vitreous quartzite, of white and blue color, passing into reddish tints at base; indistinctly bedded. Thickness 500 feet. Unconformably overlain by Lone Mountain limestone and underlain by Pogonip limestone. Named for development at Eureka, Nev.

This formation has been mapped by S. H. Ball (U. S. Geol. Survey Bull. 308, 1907) in Inyo County, Calif.

Fant meta-andesite.

Lower Jurassic: Northern California (Taylorsville region).

J. S. Diller, 1908 (U. S. Geol. Survey Bull. 353). Altered andesitic flows and tuff conglomerate; of greenish to reddish-brown color. Thickness more than 150 feet. Is younger than Hardgrave sandstone and older than Thompson limestone.

Named for an unidentified locality near Taylorsville.

Fernando group.

Pliocene and lower Pleistocene: Southern California (Los Angeles and Ventura Counties).

G. H. Eldridge and R. Arnold, 1907 (U. S. Geol. Survey Bull. 309, pp. 22–28). *Fernando formation.*—A variable series of conglomerates, sandstones, and arenaceous clays; thickness 1,500 to 6,000 feet and possibly several thousand feet more. Fernando is a term applied by Homer Hamlin a number of years ago, on unpublished maps, to include the siliceous shale skirting the sides of the San Fernando Valley, Los Angeles County, which is the general equivalent of all post-Modelo and pre-Saugus beds in the Santa Clara province. Unconformably overlies Modelo formation in Santa Clara district and Puente formation in Puente Hills region and Los Angeles district. Unconformably underlies Pleistocene sand and gravel.

W. S. W. Kew, 1924 (U. S. Geol. Survey Bull. 753). *Fernando group.*—Restricted to post-Miocene beds and divided into two formations, the Saugus formation (2,000 feet thick) above and the Pico formation (4,000 feet thick) below. Both of these formations are present at the Fernando type locality, and they are separated by an unconformity. Unconformably overlain by Pleistocene terrace deposits and rests unconformably on Modelo formation. Fossils indicate that it is of lower Pliocene, upper Pliocene, and lower Pleistocene age.

Foix oil zone.

Name applied to 180 to 185 feet of sandy shales and interbedded sands, shales, and shells, the basal 20 to 40 feet of which consists of sticky brown shale, in the Santa Fe Springs field, Los Angeles County. It directly overlies the Bell oil zone. Named for Foix No. 1 well, which yields oil at a depth of 3,500 feet.

Foreman formation.

Upper Jurassic: Northern California (Taylorsville region).

J. S. Diller, 1892 (Geol. Soc. America Bull., vol. 3, pp. 370–394). Sixteen hundred feet of slates and sandstones with several beds of conglomerate. Plants identified by Fontaine as "clearly Mesozoic and most probably Rhaetic." Regarded as older than Hardgrave sandstone and younger than Trail beds. [Later proved to be much younger than Hardgrave sandstone.]

J. S. Diller, 1908 (U. S. Geol. Survey Bull. 353). A succession of shale, sandstone, and conglomerate in which the sediment is for the most part derived from rocks which are not clearly volcanic. Shales often slaty and with pencil structure, and range in color from dark carbonaceous with traces of leaves through gray, which predominates, to shades and tints of red and yellow. Most of sandstones are very fine, decidedly shaly, and of reddish-brown and gray colors. Conglomerate less abundant than the shale and sandstone. Overlies, probably unconformably, Hinchman sandstone, and in places unconformably overlaps Mormon sandstone and even Robinson and Peale formations. [Fauna determined to be not earlier than Middle Jurassic.]

Named for exposures at Foreman and in Foreman's Ravine, northeast of Taylorsville, Plumas County.

Franciscan formation (group, where subdivided).

Jurassic(?): Western California.

A. C. Lawson, 1895 (Am. Geologist, vol. 15, p. 347; U. S. Geol. Survey Fifteenth Ann. Rept., p. 415). *Franciscan series.*—Several thousand feet of sedimentary and volcanic rocks with which are associated various basic intrusives, notably peridotite serpentines. Is of either Cretaceous or Jurassic age. Includes foraminiferal limestones, great formations of peculiarly bedded radiolarian cherts, and certain highly crystalline schists. The San Francisco sandstone is the dominant sedimentary formation of the series. In vicinity of San Pedro Point a basal formation of conglomerates, coarse grits, sandstones, shaly sandstones, shales, and argillaceous limestones is exposed.

The Franciscan rocks, which attain a thickness of several thousand feet, are usually treated as a formation, but in the San Francisco folio (No. 193) of the Geologic Atlas of the United States they were divided into five named and mapped formations, in descending order, Bonita sandstone, Ingleside chert, Marin sandstone, Sausalito chert, and Cahil sandstone, the Cahil including the Calera limestone member. The broader term "San Francisco sandstone" is no longer used. The intrusive serpentine is not a part of the formation. The Franciscan rests unconformably on granite and is unconformably overlain by the Knoxville formation.

Named for extensive exposures at San Francisco.

Furnace limestone.

Upper Cambrian (?), Ordovician (?), and Mississippian (?): Southern California (San Bernardino Mountains).

F. E. Vaughan, 1922 (California Univ. Pub., Dept. Geol. Sci. Bull., vol. 13, No. 9, pp. 344, 352–365, map). White to nearly black coarsely crystalline limestone, 4,500 feet or more thick. Grades downward into Arrastre quartzite and grades upward into Saragossa quartzite. Is intruded by granites. No fossils found. Probably Upper Cambrian and Ordovician.

A. O. Woodford and T. F. Harriss, 1928 (California Univ. Pub., Dept. Geol. Sci. Bull., vol. 17, p. 270). Fossils collected close to top of Furnace limestone are pronounced by G. H. Girty to be probably Carboniferous, and more probably Mississippian than Pennsylvanian or Permian. "Thus a Mississippian (?) age is suggested for at least a part of the Furnace formation."

Named for Furnace Canyon, San Bernardino County, which is cut in the formation.

Gabilan limestone.

Pre-Jurassic (?): Western California (San Francisco Bay region).

G. F. Becker, 1888 (U. S. Geol. Survey Mon. 13, pp. 128, 181). In the Gavilan Range [spelled Gabilan by U. S. Geographic Board], some 60 miles south of Bay of San Francisco, the lowest sedimentary formation encountered is in part limestone, which at points is very crystalline. Associated with it are rocks of Archean gneiss type. "It is possible that it is a member of the Knoxville series much more metamorphosed than usual, but it appears more probable that it is a remnant of some older formation which has perhaps undergone repeated metamorphism."

Is of pre-Franciscan age, and in the San Francisco region it occurs as inclusions in the quartz diorite that has been called "Montara granite," of late Jurassic (?) age. (See also under *Sur series*.)

Gavilan. See *Gabilan limestone*.

Genesee Valley limestone and shales.

Triassic: Northern California (Sierra Nevada).

J. P. Smith, 1910 (Jour. Geology, vol. 18, chart opp. p. 220). *Genesee Valley limestone and shales.*—Triassic. Older than Sailor Canyon shales [restriction (?) of Sailor Canyon formation], and overlies Paleozoic.

J. S. Diller (U. S. Geol. Survey Bull. 353, 1908) mapped the Triassic rocks of Genesee Valley region as Swearinger slate and Hosselkus limestone. Name probably derived from occurrence in Genesee Valley east of Genesee, Plumas County.

"Golden Gate series."

Jurassic (?): Western California.

H. W. Fairbanks, 1895 (Jour. Geology, vol. 3, pp. 416–426). Jasper, sandstone, shale, slate, and large bodies of fine-grained greenish eruptives. Extends from Santa Barbara County northwestward through Coast Ranges to Klamath Mountains. Unconformably overlain by Knoxville beds and rests unconformably on crystalline basement complex.

Is same as Franciscan formation.

Named for development on the north and south shores of the Golden Gate.

Gosnell shale zone.

A part of Pico formation in the Ventura field, Ventura County, southern California. Thickness 75 to 2,000 feet. Lies approximately 3,000 feet below surface.

Grapevine conglomerates.

C. [R.] Keyes, 1923 (Pan-Am. Geologist, vol. 40, pp. 52, 79). Conglomerate, 500 feet thick, unconformably beneath Greenwater volcanics, and composing lower formation of Amargosan series (of Early Tertic age) in Nevada.

Named for good exposures around base of Grapevine Range, on east side of Death Valley, Inyo County, Calif.

Greenwater volcanics.

C. [R.] Keyes, 1923 (Pan-Am. Geologist, vol. 40, pp. 52, 79). "Term restricted to the tuffs and basalt flows associated with the borate deposits of Death Valley, and are presumably of Early Tertic age." Thickness 4,000 feet. Composes upper formation of Amargosan series in Nevada. Unconformably below Redhill sandstones and unconformably above Grapevine conglomerates.

Derivation of name not stated, but probably derived from exposures at or near Greenwater, east of Death Valley, in Inyo County, Calif.

Grizzly formation.

Silurian? (may be Ordovician): Northern California (Taylorsville region).

J. S. Diller, 1892 (Geol. Soc. America Bull., vol. 3, pp. 370–394). *Grizzly quartzite*, 400 feet thick. Oldest formation in Taylor[s]ville region. Tentatively assigned to Silurian(?). Is older than Montgomery limestone of Niagara age.

J. S. Diller, 1892 (preliminary proof-sheet edition of Lassen Peak folio, No. 15, of U. S. Geol. Survey Geol. Atlas). "*Grizzly formation.*—Within the area represented on the [Lassen Peak] map it is composed chiefly of slates, but in Mount Grizzly, near Taylor[s]ville, where the formation has its greatest development, there are besides slates both quartzite and limestone. The last is of special interest in being Silurian, the oldest fossiliferous rock yet discovered in California." [The limestone is the Montgomery limestone, of Niagaran age, which is treated as a distinct formation, overlying the Grizzly formation.]

J. S. Diller, 1908 (U. S. Geol. Survey Bull. 353). *Grizzly formation.*—Gray, well-defined but thin-bedded quartzite overlain by lentils of [Montgomery] limestone and interstratified with shaly, often siliceous slate (argillite) having irregular cleavage. The beds of quartzite range in thickness from 5 to about 20 feet and run out into shale in a short distance. The shale beds are generally thicker than the quartzite and for the most part greenish gray to drab, although sometimes black and more or less flinty, but not much altered. The lighter colored shales are often sandy and constitute the prevailing portion of the formation, although beds of well-marked quartzite are usually present and frequently predominate. The coarser beds of quartzite are near base of formation and are about 200 feet thick. Thickness of formation 400 to 1,000 feet. On eastern slope of Grizzly Mountains, near the northern end, quartzite prevails immediately beneath a lentil of [Montgomery] limestone, but north of Montgomery Creek shales occupy the corresponding position, and as the section does not continue below the tunnel it does not disclose the coarser beds lying at the bottom of the Grizzly quartzite horizon. Is overlain in places conformably by Montgomery limestone, but in most places is unconformably overlain by Taylorsville formation. Rests on ancient metarhyolite.

As the Grizzly formation underlies the Montgomery limestone, of Niagaran age, it may be either Silurian or Ordovician.

Named for exposures on eastern and northeastern slopes of Grizzly Mountains, Plumas County.

Grizzly quartzite. See *Grizzly formation.*

"Grizzly Peak andesite."

Pliocene: Western California (San Francisco region).

A. C. Lawson and C. Palache, 1902 (California Univ. Pub., Dept. Geology Bull., vol. 2, p. 379, and map). A thick accumulation of lava flows which for the most part are of a different petrographic type from the underlying basalts and should be classed as andesites. Though of rather varied character, they are grouped together under the name Grizzly Peak andesite. As mapped they include certain subordinate flows of basalt and intercalations of tuff. There are two rather distinct facies of the andesite—the lower one a medium-textured holocrystalline rock, the upper a dense compact rock, frequently glassy, with a prevailingly porphyritic habit, aggregating 175 to nearly 300 feet. As mapped the Grizzly Peak andesite rests on rhyolite tuff and is overlain by the Siestan formation. As mapped it forms Grizzly Peak, in the Berkeley Hills.

A. C. Lawson, 1914 (U. S. Geol. Survey Geol. Atlas, San Francisco folio, No. 193). [The *andesite of Grizzly Peak* is included in the Moraga formation, according to the definition of Moraga, and as mapped.]

Half Dome quartz monzonite.

Probably Cretaceous: Yosemite National Park.

F. C. Calkins, 1930 (U. S. Geol. Survey Prof. Paper 160, p. 126, map). Name proposed by H. W. Turner, in unpublished manuscript. Medium-grained light-gray rock; contains nearly equal amounts of biotite and hornblende. Chiefly nonporphyritic, but in part obscurely porphyritic. Included in Tuolumne intrusive series, in which it is next younger than the Sentinel granodiorite, and next older than the Cathedral Peak granite.

Named from fact that it composes Half Dome, in Yosemite National Park.

Hall City limestone.

Carboniferous: Northern California (Klamath Mountains).

J. S. Diller, 1903 (Am. Jour. Sci., 4th ser., vol. 15, pp. 342–362). [Mentions (but does not describe or locate in the section, except to say that it belongs to the southwestern Carboniferous belt) the *Hall City limestone.* On a later page reference is made to the Hall City mines, to which one of these Carboniferous limestones extends.]

Hambre sandstone.

Miocene (middle): Western California (San Francisco region).

A. C. Lawson, 1914 (U. S. Geol. Survey Geol. Atlas, San Francisco folio, No. 193). Medium-textured slightly ferruginous sandstones with some sandy shales. Thickness 1,200 feet. A formation of the Monterey group. Conformably underlies Rodeo shale and conformably overlies Tice shale. Named for exposures along Arroyo del Hambre, Contra Costa County.

Hardgrave sandstone.

Lower Jurassic: Northern California (Taylorsville region).

J. S. Diller, 1892 (Geol. Soc. America Bull., vol. 3, pp. 370–394). Red sandstone, 450 feet thick, older than Thompson limestone and younger than Foreman beds. [Now known to be much older than Foreman beds.]

J. S. Diller, 1908 (U. S. Geol. Survey Bull. 353). Varies from fine shaly sandstone to conglomerate and is almost wholly of a tuffaceous character. The most common color is red, ranging from brick-red to dull brown, but much of it is gray, and the two colors are intermingled irregularly in the same bed. Bedding generally well marked. Thickness 450 feet. Is next younger than Trail formation. Is separated from overlying Thompson limestone by the Fant meta-andesite. Is limited in its distribution within the Taylorsville region almost exclusively to the slope of Mount Jura, east of Taylorsville. One belt lies along western base of Mount Jura.

Named for exposures on Hardgrave's ranch, near Taylorsville.

Hathaway formation.

Upper Pliocene or lower Quaternary (mapped as Pliocene): Southern California (San Bernardino Mountains).

F. E. Vaughan, 1922 (California Univ. Pub., Dept. Geol. Sci. Bull., vol. 13, No. 9, pp. 344, 375, 376–378, 384, map). A series of land-laid deposits. Bulk of formation is rather fine for fanglomerate. Upper 1,800 feet consists of light bluish-gray sandstone containing many streaks of angular pebbles derived from igneous and metamorphic rocks to north. This sandstone grades downward into light-gray shale containing hard calcareous streaks, of which 800 feet is exposed in small canyon just west of San Gorgonio River and base not seen. Total thickness unknown. In places overlain, in angular discordance, by a basalt flow. In other places overlain by Deep Canyon fanglomerate or by Cabezon fanglomerate; and in still other places by Heights fanglomerate. Is younger than Lion sandstone and older than Pipes fanglomerate.

Named for Hathaway Creek, Riverside County, on and near which it is exposed.

Hay Fork beds.

Miocene: Northwestern California (Trinity County).

J. S. Diller, 1902 (U. S. Geol. Survey Bull. 196, pp. 43–44). [Describes deposits near town of Hay Fork, Trinity County, consisting of sandstones and shales, locally associated with coal, and probably extending for 10 miles nearly east and west, with a width of about a mile. Contain Tertiary fossils and are probably of upper Miocene age. In one place casually alludes to them as the *Hay Fork beds.*]

J. S. Diller, 1903 (Am. Jour. Sci., 4th ser., vol. 15, pp. 342–362). [Describes upper Miocene beds of Hay Fork region and throughout the text calls them the *Hay Fork beds.*] "Formed in an estuary near sea level."

"Headlight porphyry."

A name that has been locally applied to a granodiorite porphyry, of probably earliest Cretaceous age, in Trinity County.

Heights fanglomerate.

Quaternary: Southern California (San Bernardino Mountains).

F. E. Vaughan, 1922 (California Univ. Pub., Dept. Geol. Sci. Bull., vol. 13, No. 9, pp. 344, 392–393, map). Several areas of fanglomerate are found in this region which were laid down under the same conditions as obtain at the present day, but they have been uplifted and are undergoing dissection. Banning Heights is floored with such an accumulation which overlies schists and granite, the Hathaway shales and sandstones, and the Cabezon fanglomerate. In Hog Cañon, Little San Gorgonio Creek, and Cherry Cañon there is an extensive fanglomerate at same general elevation as Banning Heights. It is of the same sort of material and bears same relationships to surrounding topography. On north side of range there are several areas of fanglomerate which are probably of about same age as those described above.

A. C. Woodford and T. F. Harriss, 1928 (California Univ. Pub., Dept. Geol. Sci. Bull., vol. 17, pp. 279–283), state that Heights fanglomerate of Vaughan is included in their Blackhawk breccia. See under *Blackhawk breccia.*

Named for Banning Heights, Riverside County, which it floors.

Hercules shale member.

Miocene (upper): Western California (San Francisco region).

A. C. Lawson, 1914 (U. S. Geol. Survey Geol. Atlas, San Francisco folio, No. 193). Bituminous shale, 500 feet thick, forming a member of the Briones sandstone. Named for Hercules station, on San Pablo Bay.

Hinchman sandstone.

Upper Jurassic: Northern California (Taylorsville region).

J. S. Diller, 1892 (Geol. Soc. America Bull., vol. 3, pp. 370–394). *Hinchman tuff* consists of 500 feet of greenish or gray sandrock, composed in many places of lapilli. Overlies the Bicknell sandstone.

J. S. Diller, 1908 (U. S. Geol. Survey Bull. 353). *Hinchman sandstone* consists of 500 to 1,000 feet of coarse tuffaceous sandstone and conglomerate of andesitic material, with some shaly beds. Unconformably overlain by Foreman formation and grades into underlying Bicknell sandstone.

Named for exposures at Curtice Cliff, in the lower part of Hinchman Ravine, Plumas County.

Hinchman tuff. See *Hinchman sandstone.*

Horsetown formation.

Lower Cretaceous (Shasta series): California and Oregon.

C. A. White, 1885 (U. S. Geol. Survey Bull. 15, pp. 19–32). [See definition under *Knoxville formation.*]

J. S. Diller and T. W. Stanton, 1894 (Geol. Soc. America Bull., vol. 5, pp. 435–464). [See explanation under *Knoxville formation.*]

The Horsetown formation has a maximum thickness of 6,000 feet. It overlies the Knoxville formation and underlies the Chico formation. The upper part may be of early Cenomanian age, and therefore Upper Cretaceous, but the United States Geological Survey classifies the unit as Lower Cretaceous.

Named for exposures at Horsetown, Shasta County. Also well exposed on North Fork of Cottonwood Creek.

Hosselkus limestone.

Upper Triassic: Northern California (Taylorsville and Redding region).

J. S. Diller, 1892 (Geol. Soc. America Bull., vol. 3, pp. 370–394). Fossiliferous limestone, 140 feet thick, considered to be younger than Swearinger slate and older than Trail beds.

J. S. Diller, 1908 (U. S. Geol. Survey Bull. 353). Dark-blue to light-gray limestone, thin bedded, in some places decidedly slaty; fossiliferous. Thickness 140 feet. Well developed in Redding region, where upper part is lighter colored and more massive and contains a spirifer-like shell, and lower part is thinner bedded and darker, with small coiled forms. Conformably overlain (not underlain, as originally assumed) by Swearinger slate, and unconformably underlain by Robinson formation. In Redding region it is separated from the Robinson horizon by 1,000 feet of andesitic and rhyolitic lavas, which are overlain by 1,500 feet of shales, sandstones, and tuffs of Triassic age.

Named for fact that it forms prominent ledges on divide between Genesee Valley and Hosselkus Creek, a mile northeast of Hosselkus ranch, in Plumas County.

Hosselkus series.

G. H. Ashley, 1923 (Eng. and Min. Jour.-Press, vol. 115, pp. 1106–1108), proposed *Hosselkus series* as a geographic name for the Upper Triassic series.

Hull meta-andesite.

Upper Jurassic: Northern California (Taylorsville region).

J. S. Diller, 1908 (U. S. Geol. Survey Bull. 353). Greenish to reddish meta-andesite resembling Fant meta-andesite. Prevailing type is greenish and essentially nonporphyritic; occasionally in Little Grizzly Creek region it is decidedly amygdaloidal. Is only partially crystalline. Much of it is in more or less well-defined sheets representing lava flows and tuff. In places is decidedly slaty. It penetrates Mormon sandstone and Foreman formation. Most likely erupted near close of Jurassic.

Named for exposures east of the Hull diggings (called Taylor diggings on Taylorsville map).

Hyampom lake beds.

Miocene: Northwestern California (Trinity County).

J. S. Diller, 1902 (U. S. Geol. Survey Bull. 196, pp. 41–43). "Near the mouth of the canyon [where Hay Fork enters] the coal-bearing series, which for convenience we will call the *Hyampom beds*, has an exposed thickness of 250 feet, the upper 100 feet being conglomerate and the lower portion sandy, containing here and there concretions. Some of the sandstones are rather hard, strike N. 85° E., with a dip of 30° SE., and contain coaly beds. Near the base of the series is 25 feet of conglomerate, and the bottom portion, about 30 feet in thickness, is not exposed." Limited to Hyampom Valley, 3 or 4 miles in length and of less breadth. Rest unconformably on underlying beds. Flora identified by F. H. Knowlton as upper Miocene.

Imperial formation.

Miocene (late lower): Southern California (Imperial County).

G. D. Hanna, 1926 (California Acad. Sci. Proc., 4th ser., vol. 14, No. 18, pp. 434–435). "There appears to be good reason to suspect that more than one Pliocene formation is represented on the flanks of Coyote Mountain [which he says is also called Carrizo Mountain]. Very little reason exists for the placing of the coral reef, the lowermost exposed fossiliferous stratum, with the great oyster reefs of the upper part. For a long time the deposits about Coyote Mountain have been called 'Carrizo Creek' beds, or 'Carrizo' formation; the latter was proposed definitely in 1914 by Kew, but F. E. Vaughan has shown that these names are inapplicable because of prior use elsewhere. This is to be regretted, but it seems that current usage demands a different name. Since we are unable as yet to correlate definitely any of the fossil-bearing strata with any named formation elsewhere, I would propose that it be known as the 'Imperial formation' in the future. The type locality should be taken as the coral reef exposed in Alverson Cañon, on the south side of the mountain. This coral reef has a distinctive fauna. It is succeeded by about 200 feet of very fossiliferous calcareous sandstones for which I would propose the name 'Latrania sands.' * * * Above the Latrania sands are enormous deposits of clay [which he names Coyote Mountain clays]. * * * Above the clays and interbedded with them near the top to some extent are extensive deposits of oyster shells for which the name 'Yuha Reefs' has been selected. * * * According to the above nomenclature, Conrad's fossil mollusks came from the Yuha Reefs. Kew echinoderms are from the Latrania sands; and Vaughan's corals from the Imperial formation. It is believed that further work will necessitate further subdivision rather than a consolidation of the above formations." [According to the foregoing quotation the name Imperial formation was proposed as a substitute for "Carrizo Creek beds," but as defined it was also restricted to the coral reef forming the basal part of the "Carrizo Creek beds."]

W. P. Woodring, 1931 (Carnegie Inst. Washington Pub. 418, pp. 1–25), redefined *Imperial formation* in the broad sense, restricting it to marine deposits, and dividing it into an upper or siltstone member (1,400± feet thick) and a basal conglomerate member (a few inches to 700 feet thick). He correlated the basal conglomerate member with the "Imperial formation" of Hanna in the narrow sense, and the siltstone member with the "Latrania sands," "Coyote Mountain clays," and the interbedded "Yuha Reefs" of Hanna. He assigned his Imperial formation to late lower Miocene, and his overlying Palm Spring formation (nonmarine) to middle or upper Miocene.

Indian conglomerate.

Eocene: Southern California (southern part of Santa Ynez quadrangle, Santa Barbara County).

R. N. Nelson, 1925 (California Univ. Pub., Dept. Geol. Sci. Bull., vol. 15, No. 10, pp. 344, 350–352, pl. 46, and map). Rudely sorted pebbles and boulders, up to 1 foot in diameter, in coarse-grained sandstone matrix, firmly cemented. In Indian Canyon, where the formation is over 500 feet thick, the conglomerate is in beds 8 feet thick, or less, separated by massive, thick-bedded sandstones which sometimes attain an aggregate thickness of 25 feet. Near its base, in places, are lenses of sandstone. A characteristic feature is the large percentage of acid porphyry pebbles. Varies in thickness from 25 feet in Mono Creek to 500 feet in Indian Canyon. Rests, with probable unconformity in places at least, on Cretaceous rocks, and is conformably overlain by Mono shale. Is best developed in Indian Canyon, whence its name.

"Indio" formation.

Miocene (middle or upper): Southern California (Riverside County).

J. P. Buwalda and W. L. Stanton, 1930 (Science, new ser., vol. 71, pp. 101–106). *Indio formation.*—Several thousand feet of strongly folded and erosionally beveled terrestrial deposits, consisting of clays, probably playa deposits, arkosic sandstones and fanglomerates with considerably worn fragments in subequal thicknesses. Form entire exposed section in Indio Hills. Type section along a northeast-southwest line through the Indio Hills about 2 miles northwest of Thousand Palm Canyon. At all localities overlies the marine Carrizo formation, probably unconformably. No fossils, but stratigraphic relations to Carrizo formation and well-indurated character of Indio formation indicate a probable age not greater than middle Miocene and not less than lower Pliocene—in short, approximately middle Neocene.

Preoccupied in Eocene of Texas.

Ingleside chert.

Jurassic (?): Western California (San Francisco region).

A. C. Lawson, 1914 (U. S. Geol. Survey Geol. Atlas, San Francisco folio, No. 193). Radiolarian chert, prevailing dull brownish red, especially in its thicker and more evenly bedded portions, but also includes some yellow and green rock and locally rock of other colors. Contains thousands of thin beds of earthy shale. In many places the rock is true jasper. Maximum thickness about 530 feet. Is overlain by Bonita sandstone and underlain by Marin sandstone. Next to top formation of Franciscan group.

Named for exposures in the San Miguel Hills, east of Ingleside, San Francisco County.

Inyo marble.

Lower Cambrian: Eastern California (Inyo Range).

H. G. Hanks, 1886 (California State Min. Bur. Sixth Ann. Rept., pt. 1, p. 25). The Inyo marble caps White Mountain. Is a dolomite of finest quality, as pure and white as the finest Carrara marble. Is found at numerous localities in the Inyo Range from White Mountain south 100 miles or more.

The rocks that cap White Mountain are mapped by E. Kirk (U. S. Geol. Survey Prof. Paper 110, pl. 1, 1918) as of Lower Cambrian age.

Inyo series.

Middle and Lower Triassic: Southern California (Inyo Range).

J. P. Smith, 1910 (Jour. Geology, vol. 18, table opp. p. 217). The Inyo series includes black limestone of Inyo Mountains (*Parapopanoceras* beds), of Middle Triassic age, and gray limestones of Inyo Mountains (*Meekoceras* beds), of Lower Triassic age.

G. H. Ashley, 1923 (Eng. and Min. Jour.-Press, vol. 115, pp. 1106–1108), proposed *Inyo series* as a geographic name for the Lower Triassic series.

Inyoan series.

Lower Triassic: Southeastern California and Nevada.

C. [R.] Keyes, 1923 (Pan-Am. Geologist, vol. 40, pp. 52, 59, 79). "In southwest Nevada and the adjoining parts of California Early Triassic sedimentation is important. The Inyoan series, as it may be called, of the Death Valley region attains a thickness of 1,200 to 1,500 feet and is characterized by a well-defined fauna. * * * The section consists mainly of Early Triassic shales, of which five subdivisions are easily differentiated." Composes all the Early Triassic of Nevada and is divided into five unnamed formations in descending order, 10 feet of limestones, 800 feet of shales, 15 feet of limestones, 400 feet of shales, and 100 feet of conglomerate. The name Koipatoan series is given to the Middle Triassic and Staran series to the late Triassic.

Named for Inyo County, Calif.

Ione formation.

Eocene: Northern California (Gold Belt region).

W. Lindgren, 1894 (U. S. Geol. Survey Geol. Atlas, Sacramento folio, No. 5). "During the Neocene period the auriferous gravels accumulated on the slope of the Sierra Nevada, and at the same time there was deposited in the gulf then occupying the Great Valley a sedimentary series consisting of clays and sands to which the name Ione formation has been given." The largest development occurs south of American River. The strata form characteristic flat-topped hills and consist of a succession of light-colored clays and white or yellowish-white sandstone. Is usually overlain by a few feet of reddish Pleistocene gravel and rests on Chico formation.

H. W. Turner, 1894 (Am. Geologist, vol. 13, pp. 229–249). Ione formation consists of white shales, clay, and sand of Miocene age. It is best developed in Amador and Calaveras Counties, where it is separable into

1. Ione clay rock or tuff 100+ feet.
2. Ione sandstone 100+ feet.
3. White clay and sand beds containing coal seams 860+ feet.

Howel Williams, 1929 (California Univ. Pub., Dept. Geol. Sci. Bull., vol. 18, No. 5, pp. 112, 124). *Ione sands.*—Very siliceous sands with anauxite; usually pure white, but often stained brown, pink, or purple. Thickness 100 to 150 feet. Underlie Butte gravels, with minor disconformity, occasionally with erosion unconformity. Overlie Marysville formation with minor disconformity. The term Ione is applied to these sands in the sense adopted by Dr. V. T. Allen, who has permitted this brief advance statement of his work. "Previous to Allen's work the term had been used so widely to include deposits of very different lithology and often of different ages that it had long since lost all accurate connotation. Allen has redefined the term, restricting it to the quartz-anauxite sands of the Meganos." His work indicates clearly that this peculiar lithological unit is of surprising uniformity throughout a wide belt along the foothills of the Sierra Nevada, and that it probably represents a single persistent horizon. He has shown that the Ione sands are probably the age equivalents of the "Bench gravels" of the Sierra, and that they were chiefly derived by the erosion of an intensely weathered granitic series. The formation is often characterized by strong current bedding.

V. T. Allen, 1929 (California Univ. Pub., Dept. Geol. Sci. Bull., vol. 18, No. 14, pp. 347–419). *Ione formation restricted* to lower two members of type section—that is, to the white clay and sand beds containing coal seams and the overlying white or red sandstone. The upper clay rock or rhyolite tuff formerly included is now considered to probably be Miocene and is here excluded. It is separated from underlying Ione formation restricted by an extensive erosion period. The lower clays of the Ione were not formed from rhyolitic tuffs, as heretofore supposed. As here restricted the formation is a lithologic unit serviceable in mapping and valuable in correlation, and it can be traced for more than 200 miles. The work of writer lends support to belief that the Ione is contemporaneous with the white quartz gravels of Sierra Nevada. The Ione is composed of delta deposits formed at the mouths of many westward-flowing streams. The presence of marine fossils in upper part shows that it accumulated on the shores of an Eocene sea. From 1913 to 1916 R. E. Dickerson made valuable contributions to our knowledge of the Ione by finding Eocene marine fossils in it. He designated the Ione as the *Siphonalia sutterensis* zone, which he considered the uppermost part of Tejon Eocene. He concluded the Ione is the marine or estuarine equivalent of the auriferous gravels of Sierra Nevada. In 1921 B. L. Clark referred Dickerson's uppermost Eocene *Siphonalia sutterensis* zone to the Meganos Middle Eocene. This reference applied especially to the marine Ione, such as Dickerson described from Oroville Table Mountain and Marysville Buttes, but not to the type section. Perhaps the latter was excluded because of its limited fauna and poor preservation of the forms obtained.

Named for exposures at Ione, Amador County, where it overlies Mariposa slate. It has been described as younger than Tejon, as equivalent to upper part of Tejon, and as older than Tejon and equivalent to Meganos formation.

"Ione clay rock or tuff." See under *Ione formation*, H. W. Turner, 1894.

"Ione sandstone." See under *Ione formation*, H. W. Turner, 1894.

Jacalitos formation.

Pliocene (lower): Southern California (Coalinga region).

R. Arnold and R. Anderson, 1908 (U. S. Geol. Survey Bull. 357). Sand, gravel, clay, and sandstone, 1,600 to 3,600 feet thick, with a characteristic fauna. Underlies, in places probably unconformably, the major beds of blue sand that are characteristic of the lower part of the Etchegoin formation, but the Jacalitos also includes a great thickness of blue-sand beds at its summit in the southeastern part of the Kreyenhagen Hills. Unconformably overlies Santa Margarita formation. Named for exposures both north and south of Jacalitos Creek, and in the Jacalitos Hills, Fresno County.

Johannesburg gneiss.

Archean: Southern California (Randsburg quadrangle, Kern and San Bernardino Counties).

C. D. Hulin, 1925 (California State Min. Bur. Bull. 95, pp. 21–23, 28, map). Consists of a variety of rock types, the majority of them gneisses. In no case do they show true schistose cleavage. The most characteristic type represented may be termed a hornblende-plagioclase gneiss, which shows a fine parallel banding of light and dark constituents. Another type, consisting entirely of coarsely crystalline black hornblende, may be termed a hornblende gneiss. Interbedded with these varying types of gneisses occur rather important quantities of a massive and quite coarsely crystalline white marble in beds 1 to 20 feet thick. In places thin layers of light-colored gneiss are intercalated with the limestone. A subordinate amount of quartzite, which may be massive or coarsely banded, is interbedded with the marble and the gneisses. The formation is predominantly if not entirely of sedimentary origin and probably marine. The hornblende gneisses, however, may be derived from igneous rocks. A thickness of approximately 2,500 feet outcrops, but neither top nor bottom was seen. Believed to unconformably underlie Rand schist. Is assigned to Archean. Named for exposures 2 miles north of Johannesburg, Kern County.

Johnson granite porphyry.

Probably Cretaceous: Yosemite National Park.

F. C. Calkins, 1930 (U. S. Geol. Survey Prof. Paper 160, pp. 127–128, map). The most centrally located, most siliceous, and youngest rock of the Tuolumne intrusive series. Is next younger than Cathedral Peak granite. Its major portion resembles an aplite, but it is distinguished by widely scattered phenocrysts of microcline. A part of the mass has the texture of a more typical granite porphyry.

Named from fact that it forms Johnson Peak, Yosemite National Park.

Johnson gravels.

Miocene: Northern California (Taylorsville region).

J. S. Diller, 1892 (Geol. Soc. America Bull., vol. 3, pp. 371–394). Auriferous gravels of fluviatile origin, containing Miocene plants. Lie at altitude of 5,000 to 5,600 feet. Turner has traced these gravels south of the fortieth parallel, through the Cascade mine to vicinity of Haskell Peak, where they have an elevation of 7,000 feet. The southerly inclination of the pebbles, the northerly slope of the deposits, and the distribution of pebbles containing Jurassic fossils afford strong evidence that the stream by which the gravels were laid down flowed from the vicinity of Haskell Peak northward across Genesee Valley and the northern arm of Indian Valley to the Mountain Meadows. Lie unconformably on upturned edges of the massive Jurassic and Triassic formations, and although not in contact with the valley alluvium (Pleistocene) their unconformity due to erosion is well marked. [Derivation of name not stated.]

In subsequent publications Mr. Diller did not use this name, but described the gravels simply as auriferous gravels.

Julian group.

Triassic, Carboniferous, or older: Southern California (San Diego County).

F. J. H. Merrill, 1914 (Geology and mineral resources of San Diego and Imperial Counties, pp. 11–12, California State Min. Bur.). Metamorphic formations of mica schists, slates, quartzites, and limestone, the first especially well exposed near Julian and the latter occurring in small areas at several points. Age uncertain. May be Triassic, Carboniferous, or older.

Named for exposures near Julian, San Diego County.

Julian schist. (Sedimentary.)

Triassic or late Paleozoic, or both: Southern California (Cuyamaca region, San Diego County).

F. S. Hudson, 1922 (California Univ. Pub., Dept. Geol. Sci. Bull., vol. 13, No. 6, pp. 181, 182–190, map). *Julian schist.*—Quartz-mica schists, quartz two-mica schists, quartz-muscovite schists, and some thin-bedded quartzites. The metamorphosed product of shales, fine clayey sandstones, and nearly pure quartz sandstones, with subordinate layers of basic volcanic rock. Thickness more than 6,600 feet.

Named for village of Julian, San Diego County, which occurs in midst of the mass.

Kagel fanglomerate.

Quaternary: Southern California (San Gabriel Mountains).

M. L. Hill, 1930 (California Univ. Pub., Dept. Geol. Sci. Bull., vol. 19, No. 6, pp. 141, 144). *Kagel formation.*—The younger and topographically lower Quaternary fanglomerate, in which Kagel Canyon is being dissected. Composed of subangular and poorly sorted fragments of gneiss and granitic rocks up to 2 feet in diameter. Is not so brown in color as the older Lopez fanglomerate. Overlies Saugus formation with angular unconformity.

Kalorama member (of Las Posas formation).

Pleistocene: Southern California (Ventura County).

E. D. Pressler, 1929 (California University Pub., Dept. Geol. Sci. Bull., vol. 18, No. 13, pp. 325–345). *Kalorama member* (also *Kalorama horizon*).—Lower part of Las Posas formation. Contains a marine Pleistocene fauna, but of cooler water than overlying Long Canyon member. Correlated with Saugus formation. Is of approximately same age as or slightly older than Lower San Pedro Pleistocene.

Derivation of name not stated.

Kanaka formation.

Mississippian: Northern California (Colfax region).

H. G. Ferguson, 1929 (Am. Inst. Min. and Met. Eng. Pub. 211, p. 4). *Kanaka formation.*—Chiefly interbedded dark-colored slates and chloritic greenstones (the latter largely andesitic tuffs and breccias), with a cherty member [200 to 300 feet thick] toward middle of formation, and a basal conglomeratic member [200 to 350 feet thick]. Contains some beds that are interpreted as flows, and possibly in part intrusive sheets, of andesite and dacite. Thickness of formation probably nearly 2,000 feet. Conformably underlies Relief quartzite and overlies, probably unconformably, Tightner formation. Named for exposures in valley of Kanaka Creek, Sierra County. Extends from Oregon Creek to South Yuba.

"Karquines series."

"Karquinez series."

Eocene: Western California.

R. Arnold, 1902 (Science, new ser., vol. 15, p. 416), and A. C. Lawson, 1903 (Geol. Soc. America Bull., vol. 13, p. 545). Includes Tejon (2,100 feet thick) and Martinez (2,200 feet thick), or all of the Eocene of western California.

A local geographic name synonymous with Eocene series in this region. Probably named for occurrence at Carquinez Bay, Carquinez Point, or Carquinez Strait, connecting Suisun and San Pablo Bays, California. (Carquinez is spelling adopted by U. S. Geographic Board.)

"Keddie formation."

Pennsylvanian: Northern California (Lassen Peak and Taylorsville regions).

Name used in preliminary proof-sheet edition of Lassen Peak folio of Geologic Atlas of the United States, 1892, for rocks forming "a narrow belt upon the northeast slope of the Keddie-Dyer ridge," in Plumas County. In the published Lassen Peak folio (No. 15), by J. S. Diller, 1895, the area is mapped as Robinson formation.

Kennett formation.

Middle Devonian: Northern California (Redding region).

J. P. Smith, 1894 (Jour. Geology, vol. 2, pp. 591–593, 598). *Kennett limestones and shales.*—A thick series of dark contorted siliceous shales, with occasional masses of limestone that contain Devonian fossils, probably Middle Devonian. Exposed between Squaw and Backbone Creeks, about 4 miles west of Kennett, on Sacramento River. Compose the Sacramento formation (H. W. Fairbanks MS.). "We do not know the age of the rocks immediately underlying the Baird shales, but the siliceous shales of the Sacramento River lie some distance below them and are probably in part of Carboniferous age."

According to J. S. Diller (U. S. Geol. Survey Geol. Atlas, Folio 138, 1906) the Baird shale is underlain by the Bragdon formation (Mississippian), which rests unconformably on the Kennett formation.

Kern River formation.

Pliocene: Southern California (Kern River region).

F. M. Anderson, 1905 (California Acad. Sci. Proc., 3d ser., vol. 2, pp. 187–188, 191). *Kern River beds.*—Mainly sands and sandy clays, dipping gently west. The locality is on Kern River, 2 to 6 miles east of Oil City, Kern County. The entire thickness of the strata exposed along the river aggregates about 3,000 feet, of which the lower two-thirds belongs to the Miocene. Toward the base they become very fossiliferous. [Lists many fossils.] The most complete and most typical fauna of the Lower Miocene of California interior is that of the Kern River beds on the southeastern border of the San Joaquin Valley.

F. M. Anderson, 1911 (California Acad. Sci. Proc., 4th ser., vol. 3, pp. 95, 111). *Kern River group*.—Green and brown beds, gravels, sands, and clays, almost without fossils, but includes the Kern oil measures. Well exposed 1 or 2 miles east of Kern River oil field and elsewhere. Beds of gravel and conglomerate and frequently large boulders are characteristic of the group. Is a terrigenous rather than an organic deposit. Called Kern River group because the productive oil measures of the Kern River district are confined to it. The oil measures make up about half of the stratigraphic volume of the beds. Unconformably overlies Temblor group. Assigned to Neocene. [Now classified as Pliocene.]

J. B. Stevens, 1924 (Am. Assoc. Petroleum Geologists Bull., vol. 8, No. 1, p. 33). *Kern River series*.—Gravel, sand, and clay, 2,000 feet thick. Is unconformably overlain by alluvium and terrace deposits and unconformably underlain by Monterey group (Miocene). Probably includes at base equivalent of Santa Margarita Miocene. Rest of formation assigned to Pliocene.

L. S. Fox, 1929 (Am. Assoc. Petroleum Geologists Bull., vol. 13, No. 2, p. 103). *Kern River series*.—Unconsolidated sands and clays of fresh-water origin, and, in its more basinward phase, of interstratified marine Etchegoin sediments. At numerous places along eastern fringe of the valley these beds are lacking, but farther west they increase in thickness to several thousand feet within a short distance. These Kern River beds represent the entire series of deposits from early Pliocene to Recent time.

Kettle meta-andesite.

Pennsylvanian: Northern California (Taylorsville region).

J. S. Diller, 1908 (U. S. Geol. Survey Bull. 353). An extended series of lava flows and products of volcanic explosions. The principal rock is decidedly porphyritic, with many small phenocrysts of feldspar, some of hornblende, and, rarely, round grains of quartz, all embedded in a reddish-brown or gray partially crystalline groundmass containing small grains of plagioclase and quartz. Also includes considerable pale greenish-gray, generally nonporphyritic rock. Both types are intimately associated with fragmental rocks, mainly tuffaceous but locally passing into fine conglomerate and sandstone. Appears to have been erupted about the time the Robinson formation was deposited, but to be older than the Reeve meta-andesite.

Named for development around Kettle Rock, northeast of Taylorsville.

Kettleman lake bed.

Probably Pliocene: Southern California (Tulare Lake region).

J. G. Cooper, 1894 (California Acad. Sci. Proc., 2d ser., vol. 4, p. 167). A fossiliferous fresh-water deposit about 10 miles west of Tulare Lake, on the edge of what was probably a Pliocene lake about 20 miles long and 5 miles wide, or half as large as Tulare Lake is now, and south of west from it, in the western corner of Tulare County. Lies 600 feet above sea level. [Type locality not stated, but the beds are probably the fresh-water deposit mentioned as occurring on the west border of the Kettleman Plains.]

Kirker tuff.

Oligocene: Western California (San Francisco Bay region).

B. L. Clark, 1918 (California Univ. Pub., Dept. Geology Bull., vol. 11, pp. 54–111). In the Sobrante anticline, in the Concord quadrangle, the formation consists of about 100 feet of fairly indurated white tuff beds, which contain a few minor layers of tuffaceous sandstone, the formation as a whole being very fine and homogeneous in texture, and disconformably overlain by the Concord formation and underlain by the San Ramon formation. At the type locality (on Kirker Creek, north of Mount Diablo) the formation consists (in descending order) of tuffaceous sandstone, 50 feet; rhyolitic white tuff beds with lentils of bluish tuffaceous sandstone, 350 feet; and sandstone, tuffaceous toward top, 50 feet, resting disconformably on the Markley formation and unconformably overlain by the San Pablo formation. In the latter region [Kirker Creek] the beds were included in the San Pablo by Turner (1898) and Weaver (1909).

Kirker's Pass beds.

Miocene: Western California (Mount Diablo region).

J. P. Smith, 1910 (Jour. Geology, vol. 18, table opp. p. 226). [*Kirker's Pass beds with Santa Margarita fauna* appears in column headed Mount Diablo region. Assigned to middle Miocene and correlated with upper part of San Pablo.]

"Klamath schists."

"Klamath schist series."

Pre-Cambrian (?): Northern California (Klamath Mountains).

Terms used by O H. Hershey (Am. Geologist, vol. 27, pp. 225–245, 1901) to include the Abrams mica schist (sedimentary) and the Salmon hornblende schist (intrusive).

Knoxville formation.

Lower Cretaceous (Shasta series): California and Oregon.

C. A. White, 1885 (U. S. Geol. Survey Bull. 15, pp. 19–32). The strata of the Shasta group occupy only a few isolated areas in California and are in every case either unconformable with the rocks both above and below them or so disturbed that their stratigraphical relations are obscure. Judged by their fossils, two divisions of the strata are plainly indicated, and I shall designate the divisions as the Horsetown beds and the Knoxville beds, respectively. The Horsetown beds have been found mainly in Shasta County and the Knoxville beds mainly in Lake, Colusa, Contra Costa, and Santa Clara Counties. The Knoxville beds are characterized by *Aucella,* which is, so far as known, absent from the Horsetown. The Horsetown fossils appear to represent the Gault and the Knoxville fossils to represent the Lower Neocomian. There is probably a considerable hiatus between the Knoxville and Horsetown beds.

J. S. Diller and T. W. Stanton, 1894 (Geol. Soc. America Bull., vol. 5, pp. 435–464). [Give detailed sections of the Horsetown and Knoxville formations and list their faunas.] The upper or Horsetown formation consists of about 6,000 feet of shales, sandstones, and conglomerates. The lower or Knoxville formation consists chiefly of shales, although many sandstones and calcareous layers occur; 20,000 feet maximum thickness. The Horsetown formation is overlain by the Chico formation.

Some geologists refer the lower part of the Knoxville formation to the Jurassic.

Named for exposures at Knoxville, Napa County, Calif.

"Koipatoan series."

Triassic (Middle?): Northern Nevada.

C. [R.] Keyes, 1923 (Pan-Am. Geologist, vol. 40, pp. 52, 59, 79). "Title adopted from King's Humboldt Range section of Mid Triassic sandstones." Sandstones, 2,000 feet thick, underlying Staran series and younger than Inyoan series. Of Mid Triassic age and covers all Mid Triassic of Nevada. "The early title of Koipatoan [Koipato series] for the entire Mid Triassic section of this region is probably too comprehensive, and if the section in this folded belt is actually so thick as formerly considered several units of serial rank are doubtless represented."

Same as Koipato formation, which was named for development in West Humboldt Range, Humboldt County, Nev., the Indian name for which is Koipato.

Kreyenhagen shale.

Oligocene? (may be Eocene): Southern California (Diablo Range).

F. M. Anderson, 1905 (California Acad. Sci. Proc., 3d ser., vol. 2, pp. 163–168). *Kreyenhagen shales.*—Brown bituminous or carbonaceous shale, more or less sandy in lower part, 600 feet exposed on hills a few miles north of Coalinga, but thickens to south and southeast, and at Kreyenhagen wells, for which it is named, it is about 900 feet thick. Thins to 250 or 300 feet at the head of the Jacalitos and on Zapata Chino. Underlie Domijean sands and overlie Avenal sandstones. Of Eocene age.

For many years the Kreyenhagen shale has been defined as the shale unconformably underlying the Vaqueros sandstone and overlying, probably unconformably, the Tejon formation in the Coalinga and neighboring districts.

F. E. von Estorff, 1930 (Am. Assoc. Petroleum Geologists Bull., vol. 14, No. 10, pp. 1321–1336). Type locality of *Kreyenhagen shale* is on Canoas Creek, about 20 miles south of Coalinga, Fresno County. Its maximum thickness in vicinity of Canoas Creek and Big Tar Canyon is 1,000 feet. It consists of shale with a very few lenticular beds of sandstone and a few lenses or nodules of limestone. The sandstone is common only at base of the formation, where the *Kreyenhagen* seems to grade into a transitional friable white sandstone interbedded with sandy clay shale which is tentatively included in the Kreyenhagen. It here overlies, with seeming conformity, but possibly with unconformity, the Domengine sandstone, of upper middle Eocene age, and unconformably underlies Temblor sandstone, of lower middle Miocene age.

La Jolla formation.

Eocene: Southern California (San Diego County).

B. L. Clark, November 4, 1926 (California Univ. Pub., Dept. Geol. Sci. Bull., vol. 16, No. 5, pp. 103, 111, 117). At present there is in press a monograph on the stratigraphy and fauna of the Eocene beds of San Diego County, by Marcus A. Hanna. In that monograph he refers the major portion of this section to a new formation, which he calls the *La Jolla* and which he correlates tentatively with the Domengine formation described in this paper. Many species are common to the La Jolla and Domengine formations. Overlying the La Jolla are the Poway conglomerates, which previous workers have referred to the Pliocene but which Hanna has shown conclusively are of Eocene age, and he has tentatively correlated them with Tejon.

M. A. Hanna, 1926 (California Univ. Pub., Dept. Geol. Sci. Bull., vol. 16, No. 7, pp. 187–246). In previous publications the Delmar sand, Torrey sand, and Rose Cañon shale have been mapped together and referred to the Tejon Eocene. In the present paper they are recognized as a distinct formation and so designated under the name La Jolla formation. The whole of the La Jolla formation probably represents deposition along an oscillating coast. For the most part the species found in the La Jolla formation are not present in either the Tejon or Meganos. The La Jolla formation is therefore considered as stratigraphically between the Meganos [as restricted by B. L. Clark] and Tejon formations, or approximately equivalent to the Domengine formation.

Landavista terrace material.

Quaternary: Southern California (San Diego County).

M. A. Hanna, 1926 (California Univ. Pub., Dept. Geol. Sci. Bull., vol. 16, No. 7, pp. 187–246). Sand and gravel scattered over the Landavista terrace, which is a cut terrace in the La Jolla quadrangle. Color prevailingly red and brown. Boulders largely from Poway conglomerate. Thickness 25 to 100 feet. No fossils found, so that its marine origin has not been determined with certainty.

"Lang division."

Tertiary: Southern California (Los Angeles County).

O. H. Hershey, 1902 (Am. Geologist, vol. 29, pp. 349–372). A great bed of gravel and sand of buff color; red and brown lava cobbles plentiful. Thickness 3,000 feet. Has appearance of delta of a large river flowing westward on site approximately of Soledad Canyon. May be marine in western part of basin. Conformably underlies Soledad division and unconformably overlies Mellenia series. Named for exposures at Lang, Los Angeles County.

W. S. W. Kew, 1924 (U. S. Geol. Survey Bull. 753, p. 81). The "Lang division" of Hershey is thought by writer to be equivalent, in greater part at least, to the upper part of the Mint Canyon formation (upper Miocene) of this report.

Las Posas formation.

Pleistocene: Southern California (Ventura County).

E. D. Pressler, 1929 (California Univ. Pub., Dept. Geol. Sci. Bull., vol. 18, No. 13, pp. 325–345). *Las Posas formation.*—In South Mountain area consists of 1,500± feet of loose sands and conglomerate alternating with beds of silty sand

and gravel. In Las Posas Hills it consists of 75 feet of light-colored conglomerates, and yellow to tan, fine to medium grained sands. Overlaps Pico in some places, and in other places appears to rest conformably on Santa Barbara beds (Upper Pico, Pliocene). Divided into Long Canyon member (above) and Kalorama member (below). Is marine Pleistocene, equivalent to Upper San Pedro, Lower San Pedro, and "San Pedro Pliocene" of Deadman's Island. Is equivalent to Saugus, which typically is terrestrial. "It seems unsatisfactory to use the same name for both marine and terrestrial strata, which are so situated that their integrating phases can not be traced, and for this reason the term Las Posas formation has been applied to the beds containing the Kalorama and Long Canyon faunas that come above the cool-water Santa Barbara in the western part of the basin."

Las Virgenes sandstone.

Eocene (lower): Southern California (Ventura County).

R. N. Nelson, 1925 (California Univ. Pub., Dept. Geol. Sci. Bull., vol. 15, No. 11, pp. 400–401, map). Beds of coarse-grained sandstone, conformably overlying and in part grading laterally into the Simi conglomerate and conformably underlying and in part grading laterally into the marine member of the Martinez group on the west side of the faults south of Simi Valley. Thickness 311 feet 1 mile west of head of Las Virgenes Canyon. Is middle division of Martinez group (lower Eocene). Named for typical development at head of Las Virgenes Canyon, on south side of Simi Hills, Ventura County.

"Latrania sands."

Miocene (lower): Southern California (Imperial County).

G. D. Hanna, 1926 (California Acad. Sci. Proc., 4th ser., vol. 14, No. 18, p. 435). [See quotation under *Imperial formation*.] "Contains a large assemblage of marine Mollusca." [Letter from G. D. Hanna, dated August 19, 1926, states that the name "is derived from *latrans*, the Latin name for a barker, such as a dog or a wolf," the rocks being exposed in Coyote Mountain, and the name Coyote having been previously used.]

An undifferentiated part of Imperial formation. See W. P. Woodring, 1930, under *Imperial formation.*

Leaning Tower quartz monzonite.

Probably Cretaceous: Yosemite National Park.

F. C. Calkins, 1930 (U. S. Geol. Survey Prof. Paper 160, p. 123, map). On fresh fracture of dull-gray color and moderately fine texture. On weathered surfaces deeply decayed and rusty.

Named from fact that it forms a considerable part of slopes of Leaning Tower, Yosemite National Park.

Leona rhyolite.

Pliocene (?): Western California (San Francisco region).

A. C. Lawson, 1914 (U. S. Geol. Survey Geol. Atlas, San Francisco folio, No. 193). Pyritic lava that forms a discontinuous belt along the west front of the Berkeley Hills, from Hamilton Gulch in Berkeley nearly to Decoto, a distance of 21 miles. Reaches its maximum width a little south of Leona Heights, Alameda County. Is in general an acidic or rhyolitic lava, but it includes local masses of darker, more basic rock. Is of about the same age and the same chemical composition as the Northbrae rhyolite, but has certain physical differences. Thickness about 500 feet. Classified as Pliocene, but its age is not proved, and it may belong to some other series of the Tertiary.

Lion sandstone.

Miocene (lower): Southern California (San Bernardino Mountains).

F. E. Vaughan, 1922 (California Univ. Pub., Dept. Geol. Sci. Bull., vol. 13, No. 9, pp. 344, 375–376, 378, map). *Lion sandstone.*—Sandstone containing a small marine fauna consisting of forms found by Kew in Carrizo Creek region, which are regarded by T. W. Vaughan as not older than lower Pliocene. This fauna belongs to that of the Gulf of California and not to that of southern California coast. Is older than Hathaway formation and younger than Potato sandstone.

W. P. Woodring, 1931 (Carnegie Inst. Washington Pub. 418, pp. 1–25). Lion sandstone of F. E. Vaughan is late lower Miocene and of same age as the marine Imperial formation as here redefined.

Named for Lion Canyon, Riverside County, near which (on third ridge to west of the canyon) it crops out.

Little Chief porphyry.

Age (?): Southeastern California (Inyo County).

F. MacMurphy, 1930 (Econ. Geology, vol. 25, p. 311). Intrudes Telescope group (lower Paleozoic?). [Derivation of name not stated.]

"Little Grizzly Creek beds."

Pennsylvanian: Northern California (Taylorsville region).

H. W. Turner, 1894 (Am. Geologist, vol. 13, pp. 230–231). *Little Grizzly Creek beds.*—At the southwest base of Mount Ingalls [Plumas County, in Downieville quadrangle], by the road to the Cascade gravel mine and to the east of Little Grizzly Creek, there occurs a highly metamorphic tuff, in a fine-grained portion of which fossils were collected, which were identified by Charles Schuchert as Upper Carboniferous and closely related to the Robinson beds. These beds are stratigraphically nearly in a line with the Robinson beds.

H. W. Turner, 1894 (U. S. Geol. Survey Fourteenth Ann. Rept., pt. 2, p. 448). Little Grizzly Creek beds, which consist of highly metamorphic tuff containing many fossils, will probably be correlated with the Robinson formation. [In the Downieville folio, No. 37, these beds were mapped by Turner as Robinson formation. The latter name has priority over "Little Grizzly Creek beds."]

Lloyd zone.

An oil zone, 2,620 feet thick, in Pico formation of Ventura County. Top lies 1,300 feet below base of Gosnell shale zone.

Lone Mountain limestone.

Silurian and Upper Ordovician: Northern Nevada.

Arnold Hague, 1883 (U. S. Geol. Survey Third Ann. Rept., pp. 253, 262, 267). Light-gray siliceous rock, with all traces of bedding obliterated, and with black gritty beds at base. Thickness of formation 1,800 feet. Unconformably overlies Eureka quartzite and underlies Nevada limestone (Devonian).

The formation contains Silurian fossils of Niagaran age in upper part, and Upper Ordovician fossils of Richmond age in lower part.

Type locality, Lone Mountain, northeast of Eureka, Nev. Has also been mapped by S. H. Ball (U. S. Geol. Survey Bull. 308, 1907) in Inyo County, Calif.

Long Canyon member (of Las Posas formation).

Pleistocene: Southern California (Ventura County).

E. D. Pressler, 1929 (California Univ. Pub., Dept. Geol. Sci. Bull., vol. 18, No. 13, pp. 325–345). *Long Canyon member* (also *Long Canyon horizon*).—Cross-bedded sands, some thin layers of calcareous sand, and a group of tan to yellow, fine-grained sands. Thickness 200 feet. Upper part of Las Posas formation. Contains a warmer-water (marine Pleistocene) fauna than underlying Kalorama member. Occurs in Long Canyon, on south slope of South Mountain, Ventura County. Correlates with Upper San Pedro.

Lopez fanglomerate.

Quaternary: Southern California (San Gabriel Mountains).

M. L. Hill, 1930 (California Univ. Pub., Dept. Geol. Sci. Bull., vol. 19, No. 6, pp. 141, 144). *Lopez formation.*—The older and topographically higher Quaternary fanglomerate, which blankets part of ridge tops on either side of Lopez Canyon. Composed of subangular and poorly sorted fragments of gneiss and granitic rocks up to 2 feet in diameter. Is of browner color than the younger Kagel formation. Overlies Saugus formation with angular unconformity.

Los Angelan epoch.

Pleistocene: Southern California.

O. H. Hershey, 1902 (California Univ. Pub., Dept. Geology Bull., vol. 3, pp. 1–29). *Los Angelan epoch (erosion).*—Represented by valley of Los Angeles River in city of Los Angeles. The three middle terraces of San Pedro Hill belong to this epoch, which preceded San Pedran epoch and followed Red Bluff epoch. (See under *Sierran.*)

Los Cerritos beds. See under *Deadman Island beds.*

" McCloud formation."

Pennsylvanian and Mississippian: Northern California (Redding region).

J. P. Smith, 1894 (Jour. Geology, vol. 2, pp. 592–593). The McCloud formation (H. W. Fairbanks MS.) is especially well developed in the region of McCloud River in Shasta County, and from this it receives its name. Divided into Baird shales (Lower Carboniferous), 500 feet thick, overlain by McCloud limestone (Upper Carboniferous), 2,000 feet thick. Is overlain by McCloud shales, the basal formation of the Pitt formation, and underlain by the Sacramento formation (Kennett limestone and shales).

Unnecessary name with conflicting usages.

McCloud limestone.

Pennsylvanian: Northern California (Redding region).

H. W. Fairbanks, July, 1894 (Am. Geologist, vol. 14, pp. 29–30). "The limestone peaks along the east side of the McCloud extend in a north and south direction, but the strike of the strata is about N. 30° W. The repetition of the limestone bodies in the north and south direction, as well as that of the fossiliferous beds along the river, is undoubtedly due to sharp folding or faulting. If this were not so the thickness of the limestone would be immense. The McCloud limestones are considered by Mr. [J. P.] Smith as belonging to the Upper Carboniferous."

J. P. Smith, October, 1894 (Jour. Geology, vol. 2, pp. 592, 599–601). Immediately above the Baird shales, and probably conformably with them, lies the McCloud limestone, consisting of about 2,000 feet of massive limestones and marbles of the McCloud River, rich in corals and brachiopods. Underlie the McCloud shales. Form upper division of McCloud formation.

Now treated as a distinct formation, of Pennsylvanian age. Overlies Baird shale and underlies Nosoni formation.

" McCloud shales."

Pennsylvanian: Northern California (Redding region).

H. W. Fairbanks, July, 1894 (Am. Geologist, vol. 14, p. 30). "*McCloud shales.*—The uppermost horizon of fossiliferous strata on the McCloud occurs about 20 miles above the Fisheries on the east side of the river. Here is found a calcareous argillite rich in several species of *Productus*, besides other forms, which, according to Mr. Smith, belong in the upper portion of the Carboniferous. These argillitic limestones and the associated shales are embraced under the designation McCloud shales."

J. P. Smith, October, 1894 (Jour. Geology, vol. 2, pp. 592, 601–602). *McCloud shales.*—Siliceous and calcareous shales and conglomerates, with Upper Carboniferous fauna at the base. Occurs on east bank of McCloud River, about 20 miles north of the United States fisheries. Thickness, 1,000 feet. Basal formation of Pitt formation. Underlies Pitt shales and overlies McCloud limestone.

Same as Nosoni formation.

McKittrick formation.

Pliocene and lower Pleistocene(?): Southern California (McKittrick-Sunset district).

R. Arnold, 1909 (U. S. Geol. Survey Bull. 396, p. 22). At most localities along the flanks of the Diablo and Temblor Ranges south of the Coalinga district it is impossible to separate the post-Santa Margarita(?) Tertiary formations, and to these beds—the equivalent of the Jacalitos, Etchegoin, and possibly Tulare formations of the Coalinga district—the name McKittrick formation has been given in the McKittrick district (R. Arnold and H. R. Johnson, U. S. Geol. Survey Bull. 406). This name was chosen because of the importance of the beds in that district, the basal members yielding the petroleum found in the productive McKittrick field.

R. Arnold and R. Anderson, 1910 (U. S. Geol. Survey Bull. 398, p. 79). To the south of the Coalinga district the McKittrick formation is distributed over both sides of the Temblor Range along most of its length and forms the whole of the Buena Vista and Elk Hills. On the east side of the Temblor Range the formation consists of coarse to fine conglomerates and coarse sands near its base, then a zone of bluish sandy clay, then medium to coarse sands and sandy shales, and at the top a succession of alternating coarse gravel and clay beds. Thickness ranges from 1,300 to possibly 2,500 feet. Unconformably overlies Monterey and Santa Margarita(?) formations and is unconformably overlain by Quaternary deposits. Is equivalent to Jacalitos, Etchegoin, and Tulare formations of Coalinga district.

R. Arnold and H. R. Johnson, 1910 (U. S. Geol. Survey Bull. 406, pp. 74–90). [Same definition as above.] Named for exposures half a mile south of McKittrick, Kern County.

McLure shale.

Miocene or Pliocene: Southern California (Fresno and Kings Counties).

G. Henny, 1930 (Am. Assoc. Petroleum Geologists Bull., vol. 14, No. 4, p. 403). *McLure shale* is a name given by writer to the brown shale of southern Coalinga region, Fresno and Kings Counties, previously termed Santa Margarita (?) shale on the geologic maps of United States Geological Survey. It is found, however, that this shale lies with an angular unconformity on Santa Margarita sandstone (Miocene), and that the Etchegoin (Pliocene) lies unconformably on the shale. Whether it is upper Miocene or lowest Pliocene in age has not been determined. Average thickness 800± feet. Base consists of 30± feet of light-gray coarse sandstone with concretions. Borders McLure Valley on nearly all sides. Type locality is a canyon crossing Tent Hills south of Avenal Creek, near west line of sec. 6, T. 24 S., R. 17 E. In Zapata Canyon it overlies Temblor sandstone. In Devils Den it rests unconformably on Monterey shale.

Manix lake beds.

Pleistocene: Southern California (San Bernardino County).

J. P. Buwalda, 1914 (California Univ. Pub., Dept. Geology Bull., vol. 7, p. 444). Lake beds of arenaceous clays and fine argillaceous sands, both of light grayish-green color; quartz, feldspar, and mica are the abundant coarser constituents. The most notable characteristic is the evenness, persistence, and parallelism of the individual strata. Thickness about 75 feet, but the beds thin out gradually toward the west. Believed to be slightly younger than the Pleistocene fanglomerates. Are deposits of an extinct lake named Manix Lake. Well exposed along Mohave River 2 miles southeast of Manix, about 120 miles northeast of Los Angeles.

Maricopa shale.

Miocene (upper and middle): Southern California (Sunset-Midway district).

W. A. English, 1916 (U. S. Geol. Survey Bull. 621, pp. 191–215). The Maricopa shale, which overlies the white sandstone of the Vaqueros formation south of Cuyama Valley and which forms the upper part of the Monterey group, has been mapped separately only as far eastward as Salisbury Canyon [about 25 miles west of the Maricopa type locality]. It consists of about 1,700 feet of brown shale, in which reef-like outcrops of white sandstone are locally prominent. The shale is made up mostly of clastic fragments, locally clayey, and not noticeably diatomaceous. It is unconformably overlain by Santa Margarita formation. The name Maricopa shale is used in the report on the Sunset-Midway region [afterwards published as U. S. Geol. Survey Prof. Paper 116, 1920] for a great thickness of diatomaceous shale which in the preliminary report was mapped as Monterey shale. [The above definition of Maricopa shale (the first in print) applies the name to only the lower part of the typical Maricopa shale, as defined below by Pack, and the name Maricopa is no longer applicable in Cuyama Valley.]

R. W. Pack, 1920 (U. S. Geol. Survey Prof. Paper 116). Mainly thin-bedded siliceous, diatomaceous shale containing numerous thin calcareous layers and in the lower part a relatively small amount of arkosic sandstone, but in the upper part numerous lenses of arkosic sandstone and boulder beds. Typically developed in the gulch that drains northward through secs. 13 and 24, T. 11 N., R. 24 W., where exposed thickness is about 4,800 feet. Rests conformably on Vaqueros formation and is unconformably overlain by beds which are here tentatively called

Etchegoin formation but which probably include at base a representative of the Jacalitos formation. The upper part of the diatomaceous shales included in the Maricopa is equivalent to the Santa Margarita formation as mapped in the western part of the San Emigdio Mountains, which contains a typical Santa Margarita fauna and overlaps onto the Vaqueros and Tejon formations.

Named for exposures west of Maricopa and Maricopa Flat, Kern County.

Marin sandstone.

Jurassic (?): Western California (San Francisco region).

R. Arnold, March, 1902 (Science, new ser., vol. 15, table on p. 416). Marin sandstone, 1,000 feet thick, underlies San Miguel cherts and overlies Sausalito cherts. A subdivision of the Franciscan.

A. C. Lawson, February, 1903 (Geol. Soc. America Bull., vol. 13, table on pp. 544–545). [Same as above.]

A. C. Lawson, 1914 (U. S. Geol. Survey Atlas, San Francisco folio, No. 193). Massive dark-gray sandstone, obscurely stratified. Thickness 1,000 feet. Underlies Ingleside chert and overlies Sausalito chert. Included in Franciscan group. Named for occurrence on Marin Peninsula, Marin County.

"Marino" formation. Incorrect spelling of Moreno formation.

Mariposa slate.

Upper Jurassic: Northern California (Mariposa, Calaveras, and neighboring counties).

G. F. Becker, 1885 (U. S. Geol. Survey Bull. 19, pp. 18–23). *Mariposa beds.*—An immense thickness of highly metamorphosed auriferous slates occurring along the foothills from Mariposa to Nevada, and containing *Aucella, Belemnites,* and other fossils. Thin-bedded strata prevail, and silicification and serpentinization are predominant characteristics. The beds are upturned into a nearly vertical position, and are unconformably overlain by the Chico beds. Regarded as identical with the Knoxville beds.

Beds of sandstone and conglomerate are also included in the Mariposa slate, and contemporaneous greenstone is associated and in part interbedded with the formation. In 1910 (Jour. Geology, vol. 18, charts opp. pp. 217 and 221) J. P. Smith restricted the name Mariposa to the lower part of the Mariposa slate of previous reports, or to the slates of the Gold Belt carrying *Aucella erringtoni* and *Cardioceras alternans,* and applied the new name Colfax formation to the upper part of the Mariposa, or to the "tuffs and shales of the Gold Belt with *Perisphinctes colfaxi.*" The U. S. Geological Survey uses the original broad definition of Mariposa and classifies it as older than Knoxville.

Named for occurrence on the Mariposa estate, in Mariposa County.

Markley formation.

Oligocene: Western California (San Francisco Bay region).

B. L. Clark, 1918 (California Univ. Pub., Dept. Geology Bull., vol. 11, pp. 54–111). Heterogeneous assemblage of beds, mostly of shallow-water origin but possibly in part continental. Thickness 3,300 feet. Lithology very different from that of San Ramon formation, but very probably it is contemporaneous, at least in part, with the San Ramon. The upper 1,300 feet consists of alternating layers of clay shale, sandy shale, and sandstone and contains a meager fauna. The lower 2,000 feet is predominantly sandstone and contains no fossils. In former paper writer included the latter beds in the Tejon, but he now believes them to be lower Oligocene. Disconformably underlies Kirker formation. The Kirker and Markley formations compose the San Lorenzo series in this area. Named for exposures in vicinity of Markley Canyon, Mount Diablo region.

Mark West andesite.

Pliocene: Northern California (Sonoma County).

V. C. Osmont, 1904 (California Univ. Pub., Dept. Geology Bull., vol. 4, pp. 58–87). Thickness varies up to 1,500 feet. Conformably underlies Sonoma tuff. Is certainly post-San Pablo and probably post-Orindan.

Apparently named for Mark West Springs, Sonoma County.

Martinez formation.

Eocene (lower): Western California.

W. M. Gabb, 1869 (California Geol. Survey, Paleontology, vol. 2, p. xiii, as reported by J. D. Whitney from an unpublished paper by Gabb, and footnote by Gabb on p. 129). The term Martinez group is proposed provisionally for the upper portion of "Division A" of the California reports, to include a series of beds of small geographical extent found at Martinez [Contra Costa County] and on the northern flank of Monte Diablo. "It may eventually prove to be worthy of ranking only as a subdivision of the Chico group." Underlies Tejon group and overlies Chico group.

T. W. Stanton, 1896 (U. S. Geol. Survey Seventeenth Ann. Rept., pt. 1, p. 1028). "The Martinez group of the California Survey is not a simple formation that can be considered a mere subdivision of the Chico but consists of two distinct portions, one of which is Cretaceous and inseparable from the Chico, while the other is Eocene and is here classed as Lower Tejon."

J. C. Merriam, 1897 (Jour. Geology, vol. 5, pp. 767–775). *Martinez group.*—The name Martinez is here applied to that portion of Gabb's Martinez group which remains after the removal of the Chico Cretaceous element. Is the Lower Tejon of Stanton and consists of sandstones, shales, and glauconitic sands. At Martinez it appears to be conformably overlain by the Tejon and conformably underlain by the Chico, although an unconformity probably exists at its base. It differs from the adjoining formations in the slightly different aspect of its sandstones and the presence in them of considerable quantities of glauconite. The sandstones of the Martinez are grayish, those of the Chico yellowish or bluish, and those of the Tejon white to dull red. The fauna also differs from the Chico and Tejon faunas and is a unit, although it grades to some extent into the Tejon fauna.

The present generally accepted definition of Martinez formation is for the beds unconformably underlying the Meganos formation, unconformably overlying the Chico formation, and reaching a maximum thickness of 3,500 feet or more. The rocks consist of conglomerate, sandstone, and shale characterized by fossils of lower Eocene age. See definition of Meganos formation.

Martinez marine member.

Eocene: Southern California (Ventura County, south of Simi Valley).

R. N. Nelson, 1925 (California Univ. Pub., Dept. Geol. Sci. Bull., vol. 15, No. 11). On the southwest side of the faults the Martinez group has been separated into the three following lithologic units: Martinez marine member, Las Virgenes sandstone, and Simi conglomerate. These members grade into one another both laterally and vertically, but with sufficient abruptness that their boundaries may be accurately mapped. The fossiliferous *Martinez marine member* of the Martinez group consists of 800 to 2,400 feet of beds that "may be subdivided into a sandstone above and a shale below, but their boundaries are too indefinite to be indicated on the map. With the exception of about 200 feet of light-gray shale at the top the marine member of the Martinez consists of medium to fine grained sandstones with occasional beds of coarse-grained sandstone in the lower portion."

Marvel limestone.

Lower Paleozoic (?): Southeastern California (Inyo County).

F. MacMurphy, 1930 (Econ. Geology, vol. 25, pp. 309–310, and map). *Marvel dolomitic limestone.*—Essentially a light bluish-gray cherty rock, showing frequent irregular mottling due to brecciation. All traces of organic structure destroyed. Age unknown. Is complexly folded. From its general characteristics a Lower Paleozoic age is assumed. Underlies Surprise formation, usually with gradation from a true limestone to a true schist for a distance of 5 to 30 feet. Exposed along Marvel Canyon. ["Interbedded schist in Marvel dolomitic limestone" is mapped separately on the geologic map.]

Marysville formation.

Eocene (middle): Northern California (Sutter County).

Howel Williams, 1929 (California Univ. Pub., Dept. Geol. Sci. Bull., vol. 18, pp. 112, 121–124). *Marysville formation.*—Loose buff sands, usually traversed by parallel strings of ferruginous calcareous concretions and by thin lenticular masses of compact green-gray sandstone and, more rarely, limestone. In many places this sandy facies is associated with a thick development of green-gray glauconitic shales that weather to a deep reddish brown soil. In some places, on west side of the Buttes, there is a *Melania*-bearing grit at base. Lithology and thickness are very variable over small areas. The ferruginous concretions range in size from a hen's egg to 4 or 5 feet long. Thickness 300 to 600 feet. Disconformably overlies Chico beds, and underlies, with minor disconformity, the White Ione sands. Fauna referred by B. L. Clark to Meganos (middle Eocene). The formation is present at Marysville and on Marysville Buttes.

Matilija sandstone member.

Eocene: Southern California (Ventura County).

P. F. Kerr and H. G. Schenck, 1928 (Geol. Soc. America Bull., vol. 39, p. 1090). *Matilija sandstone member*.—Basal member of Tejon formation. Comprises beds 2,500± feet thick, in which sandstone predominates over shale. The resistant massive arkose at base forms convenient guide for separating from underlying Chico formation, upon which it rests without apparent angular discordance. Is disconformably overlain by Cozy Dell shale member. Well exposed at type locality (in canyon at Matilija Springs), also on top of Topatopa Bluff and on San Cayetano Mountain. Near the springs is a bed of lignitic facies distinguished by abundant mollusks embedded in a green and purplish sandy shale, and the same bed is found farther east at same position in geologic column.

Meganos formation.

Eocene (middle): Western California.

B. L. Clark, 1918 (Geol. Soc. America Bull., vol. 29, pp. 94, 281–296). "The name Meganos group is given to the new group situated between typical Martinez and typical Tejon. It is believed that deposits of the Meganos group have a wide distribution throughout the Coast Ranges of California. In certain localities they have been referred to the Martinez group and at other places to the Tejon." Unconformably underlies typical Tejon and contains a faunal representative differing considerably from that of typical Tejon and also differing from the typical Martinez fauna of the lower Eocene. Unconformably overlies typical Martinez group. Includes the *Turritella andersoni* beds.

B. L. Clark and R. B. Stewart, 1925 (Geol. Soc. America Bull., vol. 36, p. 227), and B. L. Clark, 1926 (California Univ. Pub., Dept. Geol. Sci. Bull., vol. 16, No. 5). [Restrict Meganos to the lower part of Meganos as above defined, and apply the name Domengine to the beds between typical Tejon and Meganos restricted. See second entry under *Domengine formation*.]

The United States Geological Survey includes the Domengine formation of Clark and Stewart in the Meganos formation.

Named for exposures on Meganos ranch or land grant, southeast of Martinez, Contra Costa County. In 1927 (California Univ. Pub., Dept. Geol. Sci. Bull., vol. 17, p. 71) B. L. Clark and A. O. Woodford stated that the type section of Meganos restricted is a strip beginning about 1½ miles east and a little north of Clayton and ending in vicinity of Byron Hot Springs.

"Mellenia series."

Miocene: Southern California.

O. H. Hershey, April, 1902 (California Univ. Pub., Dept. Geology Bull., vol. 3, pl. 1, map). [On legend of map of a part of southern California the *Mellenia series* appears between San Pablo series below and upper Pliocene above.]

O. H. Hershey, 1902 (Am. Geologist, vol. 29, pp. 349–372). Fresh-water sediments, 1,700 feet thick, composed of conglomerates, shales, and sandstones, unconformably underlying the Lang division and believed to be younger than the San Pablo formation.

W. S. W. Kew, 1924 (U. S. Geol. Survey Bull. 753, p. 52). As the term "Mellenia," so far as could be ascertained, is not a place name, and its origin is doubtful, this series of strata is here renamed, to correspond to the rule of nomenclature of the United States Geological Survey, Mint Canyon formation, the beds being particularly well developed in the Mint Canyon region.

Merced formation.

Pliocene: Western California (San Francisco Bay region).

A. C. Lawson, 1893 (California Univ. Pub., Dept. Geology Bull., vol. 1, pp. 142–151). *Merced series.*—For convenience the Pliocene rocks here referred to will be designated the Merced series, from Lake Merced, which lies in a structural or synclinal depression of the Pliocene terrane, to the south of the city. The base of the series is observable at Mussel Rock. The basal bed is a stratum of partially carbonized forest material. Is a local or delta accumulation. Very fossiliferous. The delta gravels on the San Benito [on p. 153 casually called San Benito gravels] are the direct equivalent of the Merced series.

The Merced formation (marine) in the San Francisco region rests unconformably on the Pinole tuff. In the Santa Cruz region it rests on the Purisima formation. It is considered equivalent to the nonmarine Orinda formation and older than the Berkeley group.

Merritt sand.

Pleistocene: Western California (San Francisco region).

A. C. Lawson, 1914 (U. S. Geol. Survey Geol. Atlas, San Francisco folio, No. 193). Marine sand, 30 feet thick, unconformably overlying San Antonio formation and unconformably underlying Temescal formation. Forms the sand underlying the cities of Oakland and Alameda. Named for its occurrence on Lake Merritt, in the city of Oakland. Thickness 44 feet.

Meyer oil zone.

Name applied to the lower oil zone (consisting of 850 or 860 feet of brown shale and sandy brown shale) in the Santa Fe Springs field, Los Angeles County. Contains oil at three distinct horizons. Is capped by the Bell oil zone.

Middle Park formation.

Lower Paleozoic (?): Southeastern California (Inyo County).

See under *Telescope group.* Derivation of name not stated.

Millerton formation.

Lower and middle Pleistocene: Western California (north of San Francisco Bay region).

R. E. Dickerson, 1922 (California Acad. Sci. Proc., 4th ser., vol. 11, No. 19, with maps). Fossiliferous marine deposits, unconformably underlying Tomales formation and overlying Merced group and its correlative the Sonoma group. The best stratigraphic section seen (in headland 1½ miles northwest of Millerton station) consisted (in descending order) of (1) 23 feet of carbonaceous tan-colored sandstone and dark-gray shale; (2) prominent conglomerate 2 feet thick; (3) 85 feet of carbonaceous tan-colored sandstone and dark-gray shale with marine fossils in middle part; and (4) 50 to 65 feet of conglomerate at base.

Named for exposures in headland near Millerton station, Marin County.

Millett clay.

Southeastern California (Inyo County) and southwestern Nevada.

C. [R.] Keyes, 1923 (Pan-Am. Geologist, vol. 40, pp. 52, 61, 79). *Millett clays.*—Named for old Millett borax camp, in Furnace Canyon [east of Death Valley, Inyo County, Calif.], which was situated directly upon the principal borate-bearing beds, which appear to be Miocene, and separated from higher clays of similar character by marked unconformity. Thickness, 1,000 feet. Unconformably below Negra clays and above Redhill sandstones. Top formation of Furnacian series in Nevada.

Milton formation.

Jurassic (?): Northern California (Downieville region).

H. W. Turner, 1894 (Am. Geologist, vol. 13, pp. 232–234). *Milton series.*—Comparatively little altered sediments containing a large amount of fragmental diabasic material with some quartzite, fine-grained reddish clastic rocks, a variegated breccia, and a few limestone lenses. Considered older than Mariposa slate and younger than Sailor Canyon formation.

Named for exposures in the neighborhood of Milton, an old stage station on Middle Fork of Yuba River, in Downieville quadrangle.

Mineral King beds.

Triassic (?): Southern California (Tulare County).

H. W. Turner, 1894 (Am. Geologist, vol. 13, p. 231; U. S. Geol. Survey Fourteenth Ann. Rept., pt. 2, p. 451). Clay slate, mica schist, quartzite, and crystalline limestone, exposed at the old mining camp of Mineral King, about 15 miles southwest of Mount Whitney, at the headwaters of Kaweah River, Tulare County. Assigned to Triassic (?) on basis of poorly preserved fossils.

Mint Canyon formation.

Miocene (upper): Southern California (Los Angeles County).

W. S. W. Kew, 1923 (Am. Assoc. Petroleum Geologists Bull., vol. 7, pp. 411–420). Land-laid deposits locally developed in vicinity of Mint Canyon, a branch of the upper part of Santa Clara River north of San Gabriel Mountains. Contains good vertebrate faunas at several horizons. Rests unconformably on beds that are probably equivalent to the Sespe formation. Is in places overlain by strata containing an upper Miocene fauna and tentatively correlated with the Modelo formation, and in other places it lies unconformably beneath the Pico formation. [In U. S. Geol. Survey Bull. 753, 1924, Kew gives the thickness of the Mint Canyon formation as 4,000 ± feet and states that the name is substituted for "Mellenia" because that name is not geographic.]

Modelo formation.

Miocene (upper): Southern California (Ventura and Los Angeles Counties).

G. H. Eldridge, 1907 (U. S. Geol. Survey Bull. 309). Consists of 1,700 to 6,000 feet of strata, divided into a lower sandstone, massive and heavy bedded, 200 to 2,000 feet thick; overlain by 400 to 1,600 feet of earthy shale, gray to brown, with limestone concretions that weather yellow; succeeded by the upper sandstone member, about 900 feet thick and similar to the lower sandstone member except that it is nonconcretionary and is thinner bedded. The top member of the Modelo consists of a body of brown, gray, or yellowish shale of uncertain thickness (owing to the erosion unconformity above it), but variously estimated at between 200 and 1,500 feet. The upper shale member is indistinguishable from the shale between the two sandstones; both vary from granular siliceous to earthy and fissile, and both carry calcareous layers and here and there lenticular limestone concretions. Rests on Vaqueros sandstone [younger than true Vaqueros, according to Kew] and is unconformably overlain by Fernando formation. The formation is well developed in Hopper Canyon and at the head of Modelo Canyon, Ventura County.

W. S. W. Kew, 1924 (U. S. Geol. Survey Bull. 753). The beds called Vaqueros sandstone by Eldridge are younger than true Vaqueros sandstone, and Modelo formation is here redefined to include the Modelo formation and the 2,000 to 3,000 feet of so-called Vaqueros of Eldridge, all of which are of upper Miocene age. As redefined the Modelo formation aggregates 9,000 feet in thickness. It is primarily clay, diatomaceous shale, and fine-grained laminated sandstone and cherty beds, and contains huge lenses of coarse brown and tan sandstone about 4,000 feet in maximum thickness. It rests unconformably on the Topanga formation, and is unconformably overlain by the Pico formation, the basal division of the Fernando group.

Later work by Kew and other geologists proved that typical Modelo contains beds equivalent to Topanga formation (middle Miocene), but the United States Geological Survey follows Kew's 1924 definition, which restricted the name Modelo to upper Miocene beds, believing that that usage will be more useful, and that the Topanga may eventually be separated from the type Modelo.

Modin formation.

Lower Jurassic: Northern California (Redding quadrangle).

J. S. Diller, 1906 (U. S. Geol. Survey Geol. Atlas, Redding folio, No. 138). An extensive succession of tuffaceous beds, overlain by a greater mass of compact, fine gray shaly sandstones and shales, with a few small lenses of limestone. At base an extensive bed of volcanic conglomerate, having a maximum thickness of about 400 feet in Bear Mountain. Estimated thickness of formation 3,000 feet. Rests unconformably on Brock shale. "The relation of the Modin formation to the overlying Potem formation appears to be one of conformity, though the Modin epoch closed at a time of vigorous volcanic activity, especially in the vicinity of Bagley Mountain." [See *Bagley andesite*.] Named for exposures on Modin Creek, near the mouth of which, in the northeastern part of the Redding quadrangle, the formation has yielded most of its fossils.

Mohave (approved spelling). See "*Mojave*."

Mohawk lake beds.

Miocene (upper): Northern California (Plumas County).

H. W. Turner, 1891 (Washington Philos. Soc. Bull. 11, pp. 385–410). Name applied to lake beds of fine stratified material deposited in Mohawk Valley and vicinity, in Plumas County, during Pliocene and Pleistocene time. Rest on Tertiary igneous rocks (andesites and rhyolites) and are overlain by recent alluvium.

According to J. P. Smith (California State Min. Bur. Bull. 72, p. 37, 1916) these beds are of upper Miocene age.

"Mojave formation."

Tertiary (probably Eocene): Southern California (Mohave region).

J. Hervey Smith, 1900 (Jour. Geology, vol. 8, pp. 455–456). A formation in southeastern California described [but not named] by H. W. Fairbanks (Am. Geologist, vol. 17, p. 63 [also 67–68], 1896) as consisting of "a series of beds of clays, sandstone, volcanic tuffs, and interbedded lava flows, probably 1,000 feet or more in thickness," occurring "on the northern slope of the El Paso Range, between Mojave and Owen's Lake," and probably extending over a considerable area between the El Paso Range and the Sierra Nevada. Finely exposed in Red Rock Canyon and about Black Mountain; tilted northward at an angle of 15°–20°. Fossil plants identified by F. H. Knowlton as without doubt Tertiary and as probably Eocene.

Mono shale.

Eocene: Southern California (southern part of Santa Ynez quadrangle, Santa Barbara County).

R. N. Nelson, 1925 (California Univ. Pub., Dept. Geol. Sci. Bull., vol. 15, No. 10, pp. 350, 352, pl. 46, map). At type locality consists of a series of sandy gray shales, in beds up to 4 inches thick, interbedded with light-gray, medium fine-grained micaceous sandstones varying in thickness from 1 to 4 inches. In lower part some of the softer shales are locally contorted. Oval concretions occur locally. Toward top are impure limestone ledges 1 to 2 feet thick. At base is a rather hard, massive coarse-grained sandstone about 50 feet thick. Total thickness of formation 700 feet. Rests conformably on Indian conglomerate and is conformably overlain by Sierra Blanca limestone. No fossils but believed to be of marine origin. Extends from Mono Creek to Santa Cruz Creek; also occurs on southeast side of Big Pine Mountain. Named for exposure in canyon of Mono Creek, at mouth of Roble Creek, Santa Barbara County.

"Montara granite."

Late Jurassic (?): Western California (San Francisco Peninsula and southward).

A. C. Lawson, 1895 (U. S. Geol. Survey Fifteenth Ann. Rept., p. 408; Am. Geologist, vol. 15, pp. 343–346). Montara granite, of undetermined age. Is intrusive into the crystalline limestone [Gabilan limestone] and constitutes the mass of Montara Mountain, San Francisco Peninsula.

A. C. Lawson, 1914 (U. S. Geol. Survey Geol. Atlas, San Francisco folio, No. 193). [Mapped and described as quartz diorite of pre-Franciscan age, the name "Montara granite" being discarded.]

Monte de Oro formation.

Upper (?) Jurassic: Northern California (Oroville, Butte County).

H. W. Turner, 1896 (U. S. Geol. Survey Seventeenth Ann. Rept., pt. 1, p. 548). Plant-bearing clay slate with some conglomerate. The slates are very similar to those of the Mariposa formation, from known areas of which they are, however, widely separated. Occur near Oroville, just south of Monte de Oro, Butte County.

Local name for slate whose relations to Mariposa slate still remain undetermined.

Monterey group.

Miocene (middle and lower): Western California.

W. P. Blake, 1856 (Acad. Nat. Sci. (Philadelphia) Proc., vol. 7, pp. 328–331). *Monterey formation*, consisting of "regular strata of light-colored, prevailingly white argillaceous and arenaceous material, the particles being very fine and firmly impacted, so that in some places the strata break with smooth, curved surfaces and have a semivitreous luster." Top 50 feet very rich in diatoms, and the underlying beds may be equally rich. Thickness undetermined. Typical section is about 2 miles southeast from center of town of Monterey, and it forms a portion of a hill 500 to 600 feet high, which fronts the bay and rises on the east side of the stage road to San Francisco. This hill is separated from the bay by a broad sandy plain and a belt of sand hills along the beach. The detailed section approximates 81 feet, exclusive of the basal member, which "extends down for a long distance." The formation is unconformably overlain by a rudely stratified or assorted mass of boulders and gravel like the accumulation along a beach, and it "appears to be conformably underlain by Tertiary strata that underlie a part of the town of Monterey and extend to and beyond the Mission of San Carlos." Is quarried near town of Monterey.

G. D. Louderback, 1913 (California Univ. Pub., Dept. Geol. Sci. Bull., vol. 7, pp. 191–241), proposed *Monterey series* to include all the Miocene deposits as well as the underlying Sespe formation, chiefly if not wholly of Oligocene age.

A. C. Lawson, 1914 (U. S. Geol. Survey Geol. Atlas, San Francisco folio, No. 193). The *Monterey group* is divided into (descending order) Briones sandstones, 2,300 feet, containing Hercules shale member near middle; Rodeo shale, 670 feet; Hambre sandstone, 1.200 feet; Tice shale, 460 feet; Oursan sandstone, 600 feet; Claremont shale, 800 feet; and Sobrante sandstone, 400 feet. [The subsequent studies of B. L. Clark resulted in excluding the Briones sandstone from the Monterey group.]

The United States Geological Survey includes in the Monterey group the Salinas shale, Temblor formation, and the underlying Vaqueros sandstone, and it now excludes Briones sandstone.

Montgomery limestone.

Silurian (Niagaran): Northern California (Taylorsville region).

J. S. Diller, 1892 (Geol. Soc. America Bull., vol. 3, pp. 370–394). Limestone of Niagara age, 10 to 60 feet thick. Older than Taylor[s]ville slates and younger than Grizzly quartzite.

J. S. Diller, 1908 (U. S. Geol. Survey Bull. 353). Light to dark bluish gray limestone with occasional knots or benches of black chert. The form of the limestone is lenticular, and the largest lentil, which is on the crest of the northern end of the Grizzly Mountains and is fossiliferous, has a thickness of 60 feet with a length of about 200 feet. Five of these limestone lentils have been found. One is on the south bank of Montgomery Creek, where it forms prominent cliffs at an altitude of about 4,000 feet. Rests conformably on Grizzly formation. Believed to be unconformable with overlying Taylorsville formation.

Named for occurrence on Montgomery Creek, 2⅓ miles south of Taylorsville, Plumas County.

Moraga formation.

Pliocene: Western California (San Francisco region).

A. C. Lawson, 1914 (U. S. Geol. Survey Geol. Atlas, San Francisco folio, No. 193). Chiefly flows of andesite and basalt, with which are associated some basic tuffs and beds of well-cemented rhyolite tuff. Between these volcanic rocks lie lenticular beds of conglomerate, clay, and limestone. One of the limestone beds contains fresh-water fossils, is 30 feet thick, and has lavas above and below it. One of the conglomerate lenses in places reaches a thickness of about 200 feet. The first of the flows after an unusually long interval [between flows of the Moraga formation] was the andesite of Grizzly and Ruin Peaks. Maximum thickness of Moraga formation about 1,200 feet. Is basal formation of Berkeley group. Underlies Siesta formation and unconformably overlies Merced formation. Named for occurrence in Moraga Valley, Contra Costa County.

Morales member.

Miocene (upper): Southern California (Cuyama Valley).

W. A. English, 1916 (U. S. Geol. Survey Bull. 621, pp. 191–215). Upper member of Santa Margarita formation. Consists of about 2,000 feet of clay, white sand, and gravel, with, at base, 300 to 400 feet of light-gray, poorly bedded soft clay shale containing a few thin beds of white limestone which on weathering break up into small irregular fragments. Rests unconformably on Whiterock Bluff shale member of Santa Margarita, which in places it overlaps. Is unconformably overlain by Cuyama formation. Named for development in vicinity of Morales Canyon.

Moreno formation.

Upper Cretaceous: Southern California (Diablo Range).

R. Anderson and R. W. Pack, 1915 (U. S. Geol. Survey Bull. 603). Upper formation of Chico group. Rests conformably on the Panoche formation, the lower formation of the Chico group, and is unconformably overlain by the Martinez (?) formation. Is lithologically divisible into two parts, a huge lens of concretionary sandstone and interbedded shale (the Cantua sandstone member), which forms its lower and major part in a small area, and a body of foraminiferal and diatomaceous chocolate-brown and maroon clay shale with minor amounts of sandstone and some calcareous layers and concretions, which constitutes the upper part of the formation but which also includes lower beds believed to be equivalent to the Cantua sandstone member where that is lacking. The maximum thickness of the Cantua sandstone is at least 4,500 feet. The thickness of the clayey member averages 450 feet, with a maximum of about 1,000 feet. Named for exposures in Moreno Gulch, on the east flank of the Panoche Hills, Fresno County.

Mormon sandstone.

Middle Jurassic: Northern California (Taylorsville region).

J. S. Diller, 1892 (Geol. Soc. America Bull., vol. 3, pp. 370–394). Fine-grained compact gray sandstone with several small beds of conglomerate. Thickness 500 feet. Older than Bicknell sandstone and younger than Thompson limestone.

J. S. Diller, 1908 (U. S. Geol. Survey Bull. 353). Prevailingly fine-grained gray compact sandstone, passing on the one hand into greenish or reddish conglomerate and on the other hand into more shaly beds. Thickness 550 feet. Rests conformably on Thompson limestone and is overlain, probably conformably, by the Bicknell sandstone. Extends across Mount Jura from the lower slopes of Grizzly Mountains to North Arm.

Named for exposures at Mormon station, on old stage route near Taylorsville, Plumas County.

"Morrison sandstone."

Middle Jurassic: Northern California (Trinity and Shasta Counties).

O. H. Hershey, 1904 (Am. Geologist, vol. 33, pp. 356–360). [*Morrison sandstone* as used on pages above cited is, according to J. S. Diller (unpublished note), a misprint for Mormon sandstone.]

Mountain Girl conglomerate-quartzite.

Lower Paleozoic (?): Southeastern California (Inyo County).

See under *Telescope group.* Derivation of name not stated.

Mount Clark granite.

Probably Cretaceous: Yosemite National Park.

F. C. Calkins, 1930 (U. S. Geol. Survey Prof. Paper 160, p. 128, map). Very siliceous light-colored granite or alaskite, composed almost wholly of feldspar and quartz. Moderately coarse grained and even textured. Is practically devoid of ferromagnesian minerals, such as biotite and hornblende.

Named from fact that it composes Mount Clark, Yosemite National Park.

Mount Lowe granodiorite.

Age (?): Southern California (San Gabriel Mountains, Los Angeles County).

W. J. Miller, 1926 (Geol. Soc. America Bull., vol. 37, p. 149, abstract). White to light-gray massive to moderately foliated granodiorite, which may be called *Mount Lowe granodiorite,* because of its typical occurrence on Mount Lowe and vicinity. Younger than Mount Wilson quartz diorite.

Mount Wilson quartz diorite.

Age (?): Southern California (San Gabriel Mountains, Los Angeles County).

W. J. Miller, 1926 (Geol. Soc. America Bull., vol. 37, p. 149, abstract). The most typical and extensively developed of the diorites of the San Gabriel Mountains may be called the *Mount Wilson quartz diorite,* because of fine exposures on and near Mount Wilson. A hornblende-rich diorite, occurring in smaller masses, may be older than the Mount Wilson diorite or it may be only a facies of it. A pinkish-gray, more or less foliated granite, which occupies a considerable area, is younger than the diorite. The diorite is older than Mount Lowe granodiorite.

Mud Hill series.

Miocene to Pleistocene (?): Southern California (Riverside County).

E. E. Free, 1914 (Carnegie Inst. Washington Pub. 193, pp. 22–23). Consists of an upper member of very variable sandstones and clays, mostly thinly bedded and showing many probable unconformities; underlain by a thick member of coarse arkose sandstone, usually of reddish color and quite uniform texture; at base a basal conglomerate, resting normally upon an eroded surface of schists and granites such as make up the core of the range. Thickness 3,000 feet. No fossils at type locality at Mecca, but in Carrizo Creek Valley Blake found Miocene fossils in lower beds. Very probably includes beds of all ages from Carrizo Creek Miocene into early Pleistocene. Named for occurrence in Mecca Mud Hills, Mecca, Riverside County.

Neocene.

A term that has had considerable usage in geologic literature to include the Pliocene and Miocene series.

Nerola formation.

Miocene: Central western California (Mount Diablo region).

B. L. Clark and A. O. Woodford, 1927 (California Univ. Pub., Dept. Geol. Sci. Bull., vol. 17, p. 69). "Unconformably on the San Lorenzo deposits is the San Pablo group, divided into two formations, the Cierbo and the *Nerola.* Unconformably on the San Pablo is a series of tuffs and sandstones; the tuffs have generally been referred to the Pinole tuff, the sandstones to the Orinda formation."

Nordheimer formation.

Carboniferous (?): Northwestern California (Klamath Mountains).

O. H. Hershey, 1906 (Am. Jour. Sci., 4th ser., vol. 21, pp. 58–66). Black slaty shale with maximum estimated thickness of 3,000 feet. At base a slight development of coarse sandstone, apparently made up of débris from the underlying quartz-bearing rhyolite. This sandstone is nowhere more than 50 feet thick but can be traced for several miles. No evidence of nonconformity between the sandstone and the rhyolite. No other sandstones and no conglomerate or limestone, but contains a few thin layers of chert. Is badly shattered by intrusive rocks. No fossils. May be late Devonian but is more likely Carboniferous. Some characters suggest Baird formation. It might also be a western representative of the Triassic Pit shales, but is not likely to be any younger. The valley of Nordheimer Creek is cut in the formation.

Northbrae rhyolite.

Pliocene: Western California (San Francisco region).

A. C. Lawson, 1914 (U. S. Geol. Survey Geol. Atlas, San Francisco folio, No. 193). Numerous isolated patches of a white rhyolite lava, apparently the remnants of a flow, the greater part of which has been removed by erosion. Thickness probably nowhere exceeds 100 feet. Occurs on western slope of Berkeley Hills north of Berkeley. Rests on worn surface of Franciscan and Cretaceous formations. Overlain by Campus and Orinda formations. Named for occurrence in Northbrae district, near Berkeley.

Nosoni formation.

Pennsylvanian: Northern California (Redding quadrangle).

J. S. Diller, 1906 (U. S. Geol. Survey Geol. Atlas, Redding folio, No. 138). Largely andesite or basalt tuffs and tuffaceous conglomerate and a few flows of lava, locally interstratified with shales and sandstones, in part calcareous and often rich in fossils. Thickness 500 to 1,200 feet. Top formation of the Pennsylvanian. Conformably overlies McCloud limestone and underlies Dekkas andesite. Includes the "McCloud shales" of Smith and Fairbanks, as well as the pyroclastic rocks with which these shales are so intimately associated. Named for exposures on Nosoni Creek.

Oakland conglomerate member.

Upper Cretaceous: Western California (San Francisco region).

R. Arnold, 1902 (Science, new ser., vol. 15, table on p. 416). Oakland, 500 feet (conglomerate). [Shown as underlying Chico and as younger than Knoxville.]

A. C. Lawson, 1903 (Geol. Soc. America Bull., vol. 13, table on pp. 544–545). [Same as above.]

A. C. Lawson, 1914 (U. S. Geol. Survey Geol. Atlas, San Francisco folio, No. 193). *Oakland conglomerate member of Chico formation.*—Conglomerate, 100 to 1,000 feet thick, forming the basal member of the Chico formation in the Berkeley Hills. At many places the conglomerate shows distinct stratification but exhibits none of the subordinate plication observed in the underlying shale of the Knoxville formation, upon which it rests conformably. Named for type exposure at the city of Oakland.

Oakridge sandstone.

Jurassic (?): Western California (Alameda County).

C. F. Tolman, jr., 1915 (Nature and science on Pacific coast, p. 45, San Francisco, Elder & Co.). Oakridge sandstone, upper member of Franciscan series at Corral Hollow [near Livermore, Alameda County]; slightly metamorphosed. Younger than Corral Hollow shales.

"Ocoya Creek beds."

Miocene (lower): Southern California (Kern County).

H. W. Turner, 1894 (Am. Geologist, vol. 13, p. 239). Ocoya Creek beds, of Miocene age, occur on Ocoya or Posé Creek and farther south.

In Pacific Railroad Reports (vol. 5, pp. 164–173, 1856) W. P. Blake described the Miocene beds along Ocoya Creek, but did not name them. These beds were for a time included in the Vaqueros sandstone, but according to J. P. Smith (Jour. Geology, vol. 18, No. 3, 1910) they carry the *Turritella ocoyana* fauna and are therefore younger than the Vaqueros sandstone as now restricted to the beds characterized by the *Turritella inezana* fauna. The name Temblor formation is now generally applied to the beds carrying the *Turritella ocoyana* fauna in this region.

Orinda formation.

Pliocene: Western California (San Francisco region).

A. C. Lawson and C. Palache, 1902 (California Univ. Pub., Dept. Geology Bull., vol. 2, p. 371, map). *Orindan formation.*—Fresh-water conglomerates, sandstones, shales, clays, limestones, and tuffs, with pebble conglomerate at base. Thickness 800 to more than 2,400 feet. Basal formation of Berkeleyan series. Rests on Monterey series and is overlain by rhyolite tuff that forms the basal division of the Upper Berkeleyan.

A. C. Lawson, 1914 (U. S. Geol. Survey Geol. Atlas, San Francisco folio, No. 193). *Orinda formation.*—Fresh-water conglomerates, sandstone, clay shales, limestones, some thin seams of lignite, and at a few horizons thin layers of brown decomposed volcanic tuff. Farther east, in Mount Diablo quadrangle, it includes, in lower part, a few beds of pumiceous tuff similar to Pinole tuff. Thickness 2,000 to 2,500 feet in San Pablo Ridge, but 6,000 feet to the southeast, near southern border of Concord quadrangle. Lies conformably on Pinole tuff, or, where that is absent, rests on San Pablo or older formations. Excluded from Berkeley group. Is overlain by Moraga formation, which is now treated as the basal division of the Berkeley group. Named for exposures at Orinda, Contra Costa County.

"Orindan" formation. See *Orinda formation.*

Oro Grande series.

Lower Cambrian: Southern California (San Bernardino County).

O. H. Hershey, 1902 (Am. Geologist, vol. 29, pp. 273–290). Nearly pure limestone underlain by pure quartzite. The alteration of the Oro Grande series has destroyed all fossils, and its age can only be conjectured. Except for higher degree of metamorphism it is identical in character with the Lower Cambrian series described by Walcott from Inyo County, and I believe the propriety of classing it as Lower Cambrian will hardly be questioned.

Osos basalt.

Jurassic(?): Western California (San Luis Obispo region).

H. W. Fairbanks, 1904 (U. S. Geol. Survey Geol. Atlas, San Luis folio, No. 101). Dark fine-grained, generally amygdaloidal basalt, which occurs in several areas and from its relation to San Luis formation [Franciscan] does not appear to be intrusive but to have cooled as surface flows. Other basalts occur in the area. Named for outcrops in Los Osos Valley, San Luis Obispo County.

Oursan sandstone.

Miocene (middle): Western California (San Francisco region).

A. C. Lawson, 1914 (U. S. Geol. Survey Geol. Atlas, San Francisco folio, No. 193). Rather fine-grained sandstone, 600 feet thick. A formation of the Monterey group. Underlies Tice shale and overlies Claremont shale. Named for exposures on Oursan Ridge, Concord quadrangle, Contra Costa County.

Owenyo limestone.

Permian: Eastern California (Inyo Range).

E. Kirk, 1918 (U. S. Geol. Survey Prof. Paper 110). Mainly massive grayish crystalline to compact limestones. Basal 2 feet is blue-gray compact limestone carrying irregular lenses and stringers of sandstone whose grains were apparently derived from the underlying Reward conglomerate. Here and there, particularly in the upper third, are layers carrying rounded chert pebbles. Thickness 125 feet. The limestones carry a Permian (*Spiriferina pulchra*) fauna throughout and according to G. H. Girty are probably to be correlated in part with the Park City, Phosphoria, and Embar formations of Utah, Idaho, and Wyoming. Only two exposures of the Owenyo limestone are known, both of which lie between the Reward mine and Union Wash. One shows the base and the other the top of the formation. It is unconformably overlain by Lower Triassic shales and unconformably underlain by Reward conglomerate. Named for exposures about 3½ miles north of Owenyo station on Southern Pacific, between Union Wash (the first large canyon to the north) and the Reward mine.

"Ozarkian."

Pliocene and Quaternary: Time term.

O. H. Hershey, 1896 (Science, new ser., vol. 3, pp. 620–622). A marked period of elevation and subaerial erosion instituted by the great post-Tertiary epeirogenic uplift of North America and terminated by the Kansan epoch of widely extended glaciation. Preceded by the Lafayette epoch of deposition. Assigned to the Pleistocene.

See *Sierran.*

Paicines formation.

Pliocene: Southern California (San Benito County).

P. F. Kerr and H. G. Schenck, 1925 (Geol. Soc. America Bull., vol. 36, pp. 470, 476, map). "Continental Pliocene herein given the local formational name 'Paicines' pending more exact correlation." Yellow, loosely consolidated sandstone interbedded with shale; soft gray sandstone colored by fragments of Franciscan metamorphics; occasional peat seams. Fresh-water fossils. "The age of the Paicines is in all probability Pliocene." [Is classified as Pliocene.] It lies unconformably on Etchegoin formation and is overlain, probably unconformably, by San Benito gravels. [Apparently named for extensive development west of Paicines, Benito County.]

Pala conglomerate.

Pleistocene: Southern California (San Diego County).

A. J. Ellis, 1919 (U. S. Geol. Survey Water-Supply Paper 446). Coarse valley-fill conglomerate of a type not common in this area. It is a conglomeratic mass of boulders and residuum, having a thickness of about 200 feet above and extending to an undetermined depth below the present level of the river. Is older than the valley fill which underlies the present valley floors and may be as old or even older than the San Pedro formation. Occurs in the valley of the San Luis Rey, in the vicinity of Pala, San Diego County.

Palm Spring formation.

Miocene (middle or upper): Southeastern California (Imperial County).

W. P. Woodring, 1931 (Carnegie Inst. Washington Pub. 418, p. 10). *Palm Spring formation.*—Unconsolidated or poorly consolidated nonmarine sands and light chocolate-brown and faint brick-red silts 1,000± feet thick. Of middle or upper Miocene age. Conformably overlie the marine Imperial formation in Carrizo Mountain and vicinity, Imperial County. Named for a spring on lower part of Vallecito Creek, a southeastward-flowing tributary entering Carrizo Creek about 1 mile above the old stage station.

Palos Verdes sand.

Pleistocene: Southern California (Los Angeles County).

A. J. Tieje, 1926 (Am. Assoc. Petroleum Geologists Bull., vol. 10, No. 5, pp. 505–512). Massive gray-green, very coarse to gravelly quartzose and loosely cemented marine sands, of several varieties, containing pebbles up to one-half inch in diameter. Thickness 50 feet. "Sand dollars (*Echinarachnius excentricus* Esch.?) amazingly abundant, and the pelecypods and gastropods are typically Palos Verdes, with some 70 species thus far identified." Rest on 104 feet of unfossiliferous sands of beach type and are overlain by 150 feet of unfossiliferous sands assumed to be of fresh-water origin. Assigned to the Pleistocene. Younger than San Pedro sands.

Composes a part of the San Pedro formation of previous reports, but in report cited above the San Pedro is restricted to a part only of the formation as heretofore defined.

Panoche formation.

Upper Cretaceous: Southern California (Diablo Range).

R. Anderson and R. W. Pack, 1915 (U. S. Geol. Survey Bull. 603). Lower formation of Chico group. Rests unconformably on Franciscan formation and is conformably overlain by Moreno formation, the upper formation of the Chico group. The Panoche consists of alternating beds of dark thin-bedded clay shale and massive gray concretionary sandstone aggregating 9,500 to over 20,000 feet in thickness. The formation also includes some arenaceous shale, platy sandstone, and beds of coarse conglomerate, which locally attain great thicknesses. The lowest beds here included in the Panoche formation are nonfossiliferous and may represent the Knoxville formation, which, however, is believed to be absent. Named for development in the Panoche Hills, Fresno County.

Pasadena formation.

Miocene: Southern California (San Gabriel Mountains)

R. Arnold and A. M. Strong, 1905 (Geol. Soc. America Bull., vol. 16, p. 188). A conformable series of conglomerates, sandstones, and shales of either lower or middle Miocene age. Flanks the San Rafael Hills on the south and underlies the southern portion of the city of Pasadena. The conglomerates of this formation rest on and are composed of the San Gabriel plutonic and metamorphic rocks.

"Paskenta horizon."

Lower Cretaceous: Northern California (Tehama County).

F. M. Anderson, 1902 (California Acad. Sci. Proc., 3d ser., vol. 2, pp. 43–47). *Paskenta horizon* is here applied to upper 4,000 feet of the 20,000 feet of strata composing the Knoxville formation, which is especially well represented in the vicinity of Paskenta, Tehama County, and which lies conformably on the rest of the Knoxville.

Paso Robles formation.

Pliocene and lower Pleistocene (?): Western California (San Luis Obispo County and neighboring areas).

H. W. Fairbanks, 1898 (Jour. Geology, vol. 6, pp. 565–566). Fresh-water conglomerates and sandy and marly clays, usually slightly consolidated. Overlap unconformably upon the upturned and sharply folded San Pablo formation. Fill the Salinas Valley as far up as Atascadero. Are characteristically exposed about town of Paso Robles [San Luis Obispo County], from where they extend westward toward Santa Lucia Mountains and for many miles north and east of that place, filling the valley of the Estrella and its tributaries, and may reach into the Great Valley. Are of later Neocene age.

Pato red member.

Miocene (lower): Southern California (Cuyama Valley).

W. A. English, 1916 (U. S. Geol. Survey Bull. 621, pp. 191–215). Gray and red clay shale and sandstone, 1,300 feet thick, forming the basal member of the Vaqueros formation. The upper 500 feet of beds are of a brilliant crimson color and are composed of material eroded from the adjacent land at the time the red beds were being deposited. Conformably below these bright-red beds is about 800 feet of gray and red clay, which forms the lower part of the member. The Pato member is overlain, in places unconformably, by massive white sandstone of the Vaqueros. It rests with marked unconformity on pre-Monterey shale. Named for exposures in Pato Canyon, Cuyama Valley.

According to W. S. W. Kew (California Univ. Pub., Dept. Geology Bull., vol. 12, pp. 1–21, 1919) the Pato red member is older than true Vaqueros and corresponds to the Sespe formation, of Oligocene and lower Miocene (?) age.

Peale formation.

Mississippian: Northern California (Taylorsville region).

J. S. Diller, 1908 (U. S. Geol. Survey Bull. 353). Of variable character. Reddish to brown slaty shale, sometimes gray or greenish, passing into tuffaceous sandstone and fine conglomerate, is most common. The fine conglomerate contains much volcanic material, with occasional red lapilli and small lenses of calcareous matter. Thin beds of gray quartzite also occur, and masses of black, gray, or red chert form prominent ledges. The tuffaceous beds are well exposed and fossiliferous on the horse trail from Wards Creek to Peale diggings, also beyond Hosselkus and to within about a mile of Lucky S road. The chert is best exposed near the forks of the road just east of Hosselkus, where there is a prominent ledge of red banded chert full of quartz veins, but no considerable amount of hematite with it as on Houghs Peak. Red siliceous slate and chert occur near the summit along the trail from Wards Creek to Peale diggings, as well as in the divide at the head of Hinchman Ravine. [Fossils listed.] The formation is almost completely surrounded by igneous rocks, meta-andesites, and is in part made up of pyroclastic material of the same sort. It evidently represents an epoch of volcanic activity, although the immediately enveloping rock may be in large part intrusive. Thickness 1,400 feet. Is overlain by Reeve meta-andesite. Is older than Robinson formation and younger than Shoofly formation.

Pedroian.

A time term used by J. E. Eaton (Am. Assoc. Petroleum Geologists Bull., vol. 12, p. 138, 1928) to cover the San Pedro formation as restricted by him (to the basal part of the original San Pedro) and his overlying Hall Canyon formation, or to all of the lower Pleistocene.

Pelona schist series.

Pre-Cambrian (?): Southern California (Los Angeles County).

O. H. Hershey, April, 1902 (California Univ. Pub., Dept. Geology Bull., vol. 3, pl. 1, map). [*Pelona schists* on legend of map lie between gneiss below and Archean gneiss above.]

O. H. Hershey, 1902 (Am. Geologist, vol. 29, pp. 273–290). *Pelona schist series.*—3,000 feet of dark-colored and more schistose mica schist underlain by 2,000 feet of light-yellowish coarse, angular mica schist. Assigned to pre-Cambrian (?). Named for Sierra Pelona, Los Angeles County.

O. H. Hershey, 1912 (Am. Jour. Sci., 4th ser., vol. 34, pp. 271–273). Another area of the Pelona series constitutes the greater part of the Rand Mountains near Randsburg, Kern County. This series is the youngest important Archean series. "I propose to extend the name over the Abrams and Salmon formations of the Klamath region."

"Pescadero series."

Upper Cretaceous, Eocene, Miocene: Western California (Santa Cruz Mountains region).

G. H. Ashley, 1895 (Jour. Geology, vol. 3, pp. 435–439). A great series of sandstones, shales, and conglomerates having considerable prominence in the Santa Cruz Mountains. They consist in part of the San Francisco sandstone of previous writers. The section near Pescadero gives a questionable thickness of over 10,000 feet. The rocks have been greatly disturbed and faulted. "Their age has been shown to be in part Miocene and is thought to extend down through the Eocene and possibly into the Cretaceous." Unconformably underlies Monterey series and rests, probably unconformably, on pre-Cretaceous metamorphic sandstone.

Named for exposures at Pescadero Point and near Pescadero, San Mateo County.

Petaluma formation.

Miocene (upper): Northern California (north of San Francisco Bay region).

R. E. Dickerson, 1922 (California Acad. Sci. Proc., 4th ser., vol. 11, No. 19, with maps). Chiefly lacustrine deposits of clays, clay shale, and sandstone. Is characterized by great abundance of clays, but only in certain stream canyons is there opportunity to observe them. It is a fresh-water and brackish-water phase of marine San Pablo formation and is confined to northeast corner of Petaluma quadrangle and southeast corner of Santa Rosa quadrangle. Is unconformably overlain by Merced group or its correlative the Sonoma group. Is probably underlain by Monterey group at many localities.

Named, apparently, for exposures in vicinity of Petaluma, Sonoma County.

Pico formation.

Pliocene: Southern California (Los Angeles and Ventura Counties).

B. L. Clark, 1921 (Jour. Geology, vol. 29, pp. 608–609, chart opp. p. 586). Over a fairly large area in the Los Angeles region there is a marked difference in dip and strike between the lower and middle Fernando, now referred to the Pico formation by the United States Geological Survey, and what has previously been referred to as the upper Fernando. (Footnote: A paper by Dr. W. S. W. Kew, of the United States Geological Survey, is now in press in which the Fernando is considered a group composed of the Pico and Saugus formations separated by an unconformity.) The beds of this upper horizon contain a very large percentage of recent species. The Geological Survey proposes to use the name Saugus formation for the upper Fernando section, which is herein referred to as the Saugus group.

W. S. W. Kew, 1923 (Am. Assoc. Petroleum Geologists Bull., vol. 7, pp. 411–420). The author's name Pico formation, for the lower formation of the Fernando group, first appeared in print in 1921, in a brief paper by B. L. Clark on the Los Angeles region. The formation is well exposed in Pico Canyon, Los Angeles County, from which it is named. It is also well exposed in Santa

Clara Valley and in San Fernando Valley, where it rests unconformably upon the Modelo formation and lies unconformably below the Saugus formation. It is entirely of marine origin and contains a fauna belonging to the base of the Pliocene.

W. S. W. Kew, 1924 (U. S. Geol. Survey Bull. 753). The Pico formation, the lower formation of the Fernando group, consists of fine-grained gray sandstone, interbedded with coarse sandstone and conglomerate, and is about 4,000 feet thick. Along the south side of Fernando Valley and westward to Las Virgenes Canyon it consists of laminated gray sandy clay and fine-grained sandstone with zones or lenses of white diatomaceous soft shale; the upper strata largely medium-grained soft sandstone with some conglomerate.

J. E. Eaton, 1926 (Oil and Gas Jour., Nov. 11, 1926, p. 72; Oil Age, November, 1926, p. 16). Santa Paula formation, 10,000 feet thick, previously unrecognized, underlies Pico formation and unconformably overlies Modelo formation. [See under *Santa Paula formation*.]

Pie Knob andesite.

Pleistocene: Western California (San Francisco region).

A. C. Lawson and C. Palache, 1902 (California Univ. Pub., Dept. Geology Bull., vol. 2, pp. 403–404, map). Andesite, 180 feet thick on Pie Knob, occurring in the lower part of the Campan series, about 250 feet above its base. Forms a large part of Pie Knob, north of the university campus, Berkeley.

Pilarcitos sandstone.

Jurassic(?): Western California (San Francisco region).

R. Arnold, 1902 (Science, new ser., vol. 15, table on p. 416). Pilarcitos sandstone, 790 feet thick. A formation of the Franciscan. [Shown in table as underlying volcanics that are older than Calera limestone.]

A. C. Lawson, 1903 (Geol. Soc. America Bull., vol. 13, pp. 544–545). [Same as above.]

A. C. Lawson, 1914 (U. S. Geol. Survey Geol. Atlas, San Francisco folio, No. 193). [Maps the Franciscan rocks along Pilarcitos Creek and Pilarcitos Lake, both in San Mateo County, as Cahil sandstone, of which the Calera limestone is a member.]

Pinecate formation.

Oligocene: Southern California (San Benito County).

P. F. Kerr and H. G. Schenck, 1925 (Geol. Soc. America Bull., vol. 36, pp. 470, 472, map). Chiefly massive yellowish pebbly sandstone with interbedded conglomerate. Cross-bedding common. Thickness about 1,000 feet. Fossils rare but when found indicate marine origin. Lies on San Juan Bautista formation with probable disconformity. Underlies Vaqueros formation, probably unconformably. Is upper formation of San Lorenzo series. Typically exposed at Pinecate Peak, 4 miles northwest of San Juan, and also near the San Juan Cement Works.

Pinoche formation. Misprint for Panoche formation.

Pinole tuff.

Pliocene: Western California (San Francisco region).

R. Arnold, March, 1902 (Science, new ser., vol. 15, table on p. 416). Pinole, 1,000 feet (pumiceous, fossiliferous tuffs). [Shown as underlying Orindan formation and overlying San Pablo formation.]

A. C. Lawson, 1903 (Geol. Soc. America Bull., vol. 13, table on pp. 544–545). Pinole tuffs, 1,000 feet (fossiliferous, pumiceous). [Shown as underlying Orindan formation and overlying San Pablo formation.]

A. C. Lawson, 1914 (U. S. Geol. Survey Geol. Atlas, San Francisco folio, No. 193). The Pinole tuff in most of its deposits is distinctly stratified. It consists almost wholly of whitish or light-yellowish pumice, partly in fragments ranging from 1 to 50 millimeters and partly in fine dust. It occurs only in small exposures in the Concord and San Francisco quadrangles but is more extensively exposed in the Coast Ranges farther north. Stratigraphically it lies chiefly between the San Pablo formation below and the Orinda formation above, but it is in part interbedded with the basal sediments of the Orinda, with which it is more closely associated than with the marine San Pablo. On the shores of San Pablo Bay it contains fresh-water fossils and bones of terrestrial mammals. Thickness 0 to 1,000 feet. Rests, with probable unconformity, on San Pablo formation. Named for exposures near Pinole, on San Pablo Bay.

Pipes fanglomerate.

Upper Pliocene or lower Quaternary (mapped as Pliocene): Southern California (San Bernardino Mountains).

F. E. Vaughan, 1922 (California Univ. Pub., Dept. Geol. Sci. Bull., vol. 13, No. 9, pp. 344, 379–380, map). A flat-lying sedimentary deposit. Lower 15 feet, soft gray sandstone containing many rounded pebbles. This grades upward into reddish conglomerate, for most part of rounded granite, aplite, and quartz pebbles up to 6 inches in diameter, but containing considerable angular material. Larger part of mass on hill half a mile southeast of The Pipes is rather well cemented and more resistant to weathering than the underlying granite, so that it forms a distinct bench near top of the ridge. Total thickness on this hill is 50 feet. Total thickness at table-topped hill directly east of The Pipes is 60 feet on south side, but less than 20 feet on north side. Is overlain by basalt. Is younger than Hathaway formation.

Named for The Pipes, a watering place in San Bernardino County, near which it occurs.

Pismo formation.

Miocene (upper): Southern California (San Luis Obispo region).

H. W. Fairbanks, 1904 (U. S. Geol. Survey Geol. Atlas, San Luis folio, No. 101). Siliceous shale, diatomaceous earth, and thick beds of soft sandstone, with a member of sandstone and conglomerate at the base. Thickness about 3,000 feet. Occurs in southern part of area mapped and is considered to be contemporaneous with Santa Margarita formation of the northern part of the area, though the two formations are not known to have been connected. Unconformably overlain by Paso Robles formation and unconformably underlain by Monterey shale.

Named for exposures at Pismo, San Luis Obispo County.

Pit shale.

Middle and Upper Triassic: Northern California (Shasta County).

H. W. Fairbanks, July, 1894 (Am. Geologist, vol. 14, p. 28). *Pitt shales.*—Siliceous slates, of which nearly 2,000 feet are exposed at Silverthorne's ferry [on Pit River (approved spelling)], containing fossils regarded by J. P. Smith as Middle and possibly Lower Triassic. "It is intended to apply the term Pitt shales to these rocks, which, together with some Upper Carboniferous strata (McCloud shales), 20 miles above the fisheries, shall be embraced under the designation Pitt formation."

J. P. Smith, October, 1894 (Jour. Geology, vol. 2, pp. 592, 601–604). The Pitt formation (H. W. Fairbanks MS.) overlies conformably the McCloud limestone and consists of about 3,000 feet of siliceous and calcareous shales, conglomerates, and tuffs. The rocks in most places are highly metamorphosed, very poor in fossils, and folded to such a degree that the stratigraphy is obscure. The formation is largely developed in the region near the junction of Pitt and McCloud Rivers. It contains both Carboniferous and Triassic rocks, in an apparently conformable series. Divided into Pitt shales, 2,000 feet thick, of Middle and Upper Triassic age, and McCloud shales, 1,000 feet thick, of Upper Carboniferous age. Underlies Swearinger slates. The Pitt shales consist of siliceous shales and conglomerates containing Triassic fossils about 1,500 feet below their top, underlain by several hundred feet of shales and conglomerates without fossils.

J. S. Diller, 1906 (U. S. Geol. Survey Geol. Atlas, Redding folio, No. 138). *Pit shale.*—Largely dark and gray shales, thin-bedded sandstones, and many layers of tuffs. Thickness probably more than 2,000 feet. Conformably underlies Hosselkus limestone and rests upon the volcanic rocks called Bully Hill rhyolite and Dekkas andesite, the latter being in part interbedded with lower beds of the Pit shale. Fossils indicate Upper and Middle Triassic age.

"Pit formation."

"Pitt formation."

Pennsylvanian to Upper Triassic: Northern California (Shasta County).

See definition under *Pit shale*. The United States Geological Survey does not use the broad definition of the name Pit, which included the Pit shale and Nosoni formation ("McCloud shales") of present terminology.

Pitt series.

G. H. Ashley, 1923 (Eng. and Min. Jour.-Press, vol. 115, pp. 1106–1108), proposed *Pitt series* as a geographic name for the Middle Triassic series.

"Pleito formation."

Oligocene: Southern California (Kern County).

C. M. Wagner and K. H. Schilling, 1923 (California Univ. Pub., Dept. Geol. Sci. Bull., vol. 14, pp. 235–252). Upper formation of San Lorenzo group in San Emigdio region. Disconformably overlies San Emigdio formation, the lower formation of the San Lorenzo group, and is unconformably overlain by Monterey group. At Caraera Pass, east of Pleito Creek, it consists of 350 feet of brownish and pearl-gray fine sandstones, the lower portion medium grained and white; underlain by 600 feet of massive dark-brown and buff sandstones with fossiliferous layers and light bluish-gray massive conglomerates toward base; the basal 50 feet consists of dark brick-red coarse sandstones and conglomerates, grading into gray toward west. Exposed on Pleito Creek, Kern County. The Pleito and San Emigdio are littoral deposits but faunally distinct, the faunas being more closely related to each other than either one is to the faunas of overlying and underlying formations.

Is a faunal zone in San Lorenzo formation.

Plumas series.

Jurassic (Upper, Middle, and Lower): Northern California.

J. P. Smith, 1910 (Jour. Geology, vol. 18, table opp. p. 217). *Plumas series*, includes Hinchman sandstone of Plumas County, Mormon sandstone, and Hardgrave sandstone, the *Arietites* beds of Inyo County, Calif., and Nevada being considered equivalent to the lower part of the Hardgrave sandstone.

Pogonip limestone.

Lower Ordovician: Northern Nevada.

Clarence King, 1876 (U. S. Expl. 40th Par. Atlas, map 4) and 1878 (U. S. Expl. 40th Par Rept., vol. 1, pp. 187–195, 248). *Pogonip limestone.*—Dark-colored limestone, 4,000 feet thick, conformably underlying Devonian Ogden quartzite and conformably overlying Cambrian quartzites. The lower limestone beds are highly siliceous, of steely black color, with blue shales, and vary in physical characteristics, passing downward into rather argillaceous shales. Higher in formation it develops a dark-blue color and is much banded by zones of arenaceous limestone and occasional seams of pure chert several inches thick. Type locality Pogonip Ridge at White Pine (Hamilton), Nev.

In 1883 (U. S. Geol. Survey Third Ann. Rept., pp. 253–263, map) Arnold Hague, in his report on the Eureka district, defined the Pogonip limestone as comprising 2,700 feet of highly fossiliferous limestones, the upper part consisting of purer fine-grained limestone of bluish-gray color and distinctly bedded, and the lower part consisting of interstratified limestones, argillites, and, at base, arenaceous beds; the formation being overlain by the Eureka quartzite and underlain by the Hamburg shale (later named Dunderberg shale). This is the commonly accepted definition of Pogonip limestone. As thus defined the main mass of the formation has been classified as of Beekmantown age, but at top it carries a Chazy fauna. In 1923 (Smithsonian Misc. Coll., vol. 67, No. 8, pp. 466–467, 475), however, C. D. Walcott proposed restricting the name Pogonip to the upper part of the Pogonip limestone of previous usage, and applied the name Goodwin formation to the lower 1,500 feet, which he stated contains a "Lower Ozarkian" fauna. The formation has been mapped by S. H. Ball (U. S. Geol. Survey Bull. 308, 1907) in Inyo County, Calif. The U. S. Geological Survey uses Pogonip limestone in the broad sense.

Pohono granodiorite.

Probably Cretaceous: Yosemite National Park.

F. C. Calkins, 1930 (U. S. Geol. Survey Prof. Paper 160, p. 123). Grayish-white mixture of quartz and feldspar in which are embedded elongated grains of hornblende and biotite about 1 millimeter in diameter.

Named from occurrence near Pohono Trail, Yosemite National Park.

Poncho Rico formation.

Pliocene and Miocene (?): Southern California (Salinas Valley).

R. D. Reed, 1925 (Jour. Geology, vol. 33, pp. 591, 592, 605–607). *Poncho Rico formation.*—Marine strata variously classed as latest Miocene or earliest Pliocene. Overlies Santa Margarita formation; where latter is absent rests on Monterey shale. Underlies nonmarine Paso Robles formation. "A striking feature of the lower portion of the sandy strata resting on the Monterey shale (Santa Margarita, in the strict sense) is the large amount of cleanly washed white granitic sand that it contains. One sample proved to contain almost nothing but quartz grains, an extremely unusual condition for a Tertiary sandstone. * * * In higher parts of the series diatomite occurs on a great scale; also clastic shale, yellowish sandstone, and conglomerate beds in which Monterey shale pebbles play an increasingly prominent rôle toward the top of the series. These are the strata here grouped together as the Poncho Rico formation."

These beds were identified as Jacalitos and Etchegoin formations by W. A. English in United States Geological Survey Bulletin 691, page 231, 1919.

Probably named for exposures along or near Poncho Rico Creek, Monterey County.

Potato sandstone.

Miocene, probably: Southern California (San Bernardino Mountains).

F. E. Vaughan, 1922 (California Univ. Pub., Dept. Geol. Sci. Bull., vol. 13. No. 9, pp. 344, 374–375, map). Very hard sandstone, entirely different from any other rock in district. For most part is a well-bedded coarse angular arkose with angular boulders of schist and granite. A yellowish variety predominates, but there are also finer greenish and some red varieties. A few thin beds of shale are found between the sandstone strata. Bedding varies in thickness from a few inches to more than 30 feet. Age not definitely determined. The intense shearing and induration indicate that it is older than Hathaway formation and Santa Ana sandstone. Is believed to be younger than Saragossa quartzite, but relations are obscure. Tentatively considered Miocene. Resembles Puente sandstone, of Miocene age.

Named for Potato Canyon, San Bernardino County. Forms the portion of the ridge between Potato Canyon and Mill Creek east of Wilson Creek.

Potem formation.

Middle and Lower Jurassic: Northern California (Redding quadrangle).

J. S. Diller, 1906 (U. S. Geol. Survey Geol. Atlas, Redding folio, No. 138). Sandstones, shales, and tuffs. Thin-bedded sandstones and gray, sometimes slaty shales predominate in its lower part and make up the greater portion of the formation. They are more or less calcareous and contain a few small lentils of limestone. Tuffaceous conglomerates occur sparingly in lower half of formation, but in upper part are most abundant—in fact, nearly all the sediments of this part are of igneous material, some of which may have been furnished by contemporaneous volcanic activity, but most of it was derived by the ordinary processes of erosion from a wide expanse of volcanic rocks. "Must be at least several thousand feet thick" [2,000± in columnar section]. Regarded as equivalent to Hardgrave sandstone and most likely the Mormon sandstone also. Underlies Chico formation and overlies in places Bagley andesite and in other places rests, probably conformably, on Modin formation. [See also under *Bagley andesite.*] Named for development on Potem Creek, Shasta County.

Poway conglomerate.

Tertiary (Eocene): Southern California (San Diego County).

A. J. Ellis, 1919 (U. S. Geol. Survey Water-Supply Paper 446). Chiefly conglomerates, but lenses of cross-bedded sand and thin layers of marly clay are exposed in some of the canyon walls. Forms Poway Mesa and occurs in a narrow belt extending from that mesa eastward to Witch Creek. Also well exposed near town of Poway and forms south wall of Poway Valley. Maximum thickness west of Foster is about 1,000 feet. No fossils found and relations to marine San Diego formation not determined, but probably is somewhat older than the upper part of the San Diego. Rests on pre-Tertiary crystalline rocks.

M. A. Hanna, 1926 (California Univ. Pub., Dept. Geol. Sci. Bull., vol. 16, No. 7), says fauna is Eocene and tentatively correlates formation with the Tejon formation.

Prospect Mountain quartzite.

Lower Cambrian: Northern Nevada.

Arnold Hague, 1883 (U. S. Geol. Survey Third Ann. Rept., pp. 253, 254). Bedded brownish-white quartzites weathering dark brown; ferruginous near base; intercalated with thin layers of arenaceous shales; beds whiter near summit. Thickness 1,500 feet. Oldest sedimentary rock exposed in Eureka district. Directly overlain by Prospect Mountain limestone [name now replaced by Eldorado limestone]. Named for occurrence in Prospect Peak, Eureka district, Nev.

This formation has been mapped by S. H. Ball (U. S. Geol. Survey Bull. 308, 1907) in Inyo County, Calif.

Puente formation.

Miocene (upper and middle): Southern California (Puente Hills and Los Angeles district).

G. H. Eldridge and R. Arnold, 1907 (U. S. Geol. Survey Bull. 309). *Puente formation.*—Miocene deposits unconformably underlying the Fernando formation in the Puente Hills [southern part of Los Angeles County] and Los Angeles district. Consists, in descending order, of

Upper Puente shale. 300–2,000 feet. (Earthy chalklike shale with a few beds of fine yellow ferruginous sandstone and quartzo calcareous concretions.) Resembles Monterey shale.

Puente sandstone. 300–2,000 feet. (Moderately coarse gray and yellow heavy-bedded sandstone separated by minor bands of organic siliceous shale.)

Lower Puente shale. 2,000 feet. (Chiefly earthy shale, but with minor members of a siliceous nature, the whole gray or brown from presence of iron and bitumen. Thin, fine-grained sandstones interbedded from top to base, and lentils of gray limestone. This is lowest rock exposed in Puente Hills.)

Is unconformably overlain by Fernando formation, and overlies, unconformably, pre-Cretaceous granite and schist.

According to W. S. W. Kew (U. S. Geol. Survey Bull. 753, pl. 3, 1924) the Puente formation of the Puente Hills corresponds to the Modelo formation of Bulletin 753, and the Puente formation of the Los Angeles district corresponds to the Modelo and underlying Topanga formation of Bulletin 753.

"Puente sandstone." See under *Puente formation.*

"Puente shale." See under *Puente formation.*

"Pulaski sand."

A sand bed, about 40 feet thick, in the Vaqueros sandstone in the Coalinga district, lying about 40 feet below the "Sauer Dough."

Purisima formation.

Pliocene: Western California (Santa Cruz Mountains).

H. L. Haehl and R. Arnold, 1904 (Am. Philos. Soc. Proc., vol. 43, pp. 16–53). Fine-grained sandstones and shale 700 feet thick resting on basal conglomerate 20 feet thick. At top grades into beds having a fauna somewhat similar to that of the Merced formation. "Its upper limit may be defined as the base of the Merced." Rests unconformably on Monterey shale.

Named for exposures near Purisima and along Purisima Creek, San Mateo County.

Radcliff formation.

Lower Paleozoic (?): Southeastern California (Inyo County).

See under *Telescope group.* Derivation of name not stated.

"Rainbow beds." See under "*Coalinga beds.*"

Rainbow series.

Post-Franciscan: Northern California (Humboldt County).

W. Stalder, 1915 (California State Min. Bur. Bull. 69, pp. 447–449). Post-Franciscan and pre-upper Miocene rocks of Rainbow Ridge, divided into Walker Ridge sandstones above, 50 to 750 feet thick, and Walker Ridge shales below, 500 to 1,500 feet thick. Underlies Bear River series (upper Miocene) and overlies post-Franciscan rocks called basal sandstone series.

"Raised Beach formation."

Pleistocene: Southern California (San Pedro and vicinity).

R. Arnold, 1903 (California Acad. Sci. Mem., vol. 3), applied this non-geographic term to beds younger than San Pedro series.

Rand schist.

Archean: Southern California (Randsburg quadrangle, Kern and San Bernardino Counties).

C. D. Hulin, 1925 (California State Min. Bur. Bull. 95, pp. 23–29, map). Predominately a mica-albite schist, showing highly developed schistosity; usually dark silvery gray, but weathers yellowish brown. Amphibole schists are next in order of abundance and are only slightly subordinate in amount to the mica-albite schist. Actinolite schist, actinolite-talc schist, talc schist, and hornblende schist also occur in minor amounts. The mica-albite schist and the amphibole schists are interbedded with quartzite and limestone in beds from 1 to 10 feet thick. Greenstone schist, of igneous origin, is present in small, irregular, and isolated masses. The rest of the formation is of sedimentary origin. It is believed to unconformably overlie Johannesburg gneiss and to unconformably underlie the rocks of Paleozoic age. Assigned to Archean. Thickness exposed is probably between 1,500 and 2,000 feet. Composes the bulk of the Rand Mountains, Kern County.

Rattlesnake granite.

Probably pre-Cretaceous: Southern California (San Diego County).

F. S. Hudson, 1922 (California Univ. Pub. Dept. Geol. Sci. Bull., vol. 13, No. 6, pp. 181, 207–208, map). A true granite, varying from an alaskite to a biotite-hornblende granite. Intrudes rocks of probable Triassic age.

Named for Rattlesnake Valley, Cuyamaca region, San Diego County.

Ravenna plutonic series.

Mesozoic (?): Southern California (Los Angeles County).

O. H. Hershey, 1902 (California Univ. Pub., Dept. Geology Bull., vol. 3, pl. 1, map). [Maps but does not describe *Ravenna plutonics.* As mapped lies between Cretaceous shales above and the granite below.] (Am. Geologist, vol. 29, p. 284). "*Ravenna plutonic series.*—I predict it will be found to be Mesozoic in age and just a little older than the granitic series."

Probably named for occurrence at Ravenna station, Los Angeles County, around which it is mapped.

Red Bluff epoch.

Pleistocene: California.

O. H. Hershey, 1902 (California Univ. Pub., Dept. Geology Bull., vol. 3, pp. 1–29). *Red Bluff epoch* (*deposition*).—Divided into *Red Bluff proper* above, and below a sheet of alluvium of same material as Red Bluff proper. Believe that Arnold's Lower San Pedro series corresponds in part at least with the Red Bluff formation. "It seems proper to extend the term Red Bluff to the marine Pleistocene in Los Angeles and to the alluvial material of the 400-foot terrace of Soledad Cañon." [See under *Sierran.*]

Red Bluff formation.

Pleistocene: Northern California (Redding region).

J. S. Diller, 1894 (U. S. Geol. Survey Fourteenth Ann. Rept., pt. 2, pp. 413–416, map, pl. 44). Gravels, clay, and sand of Pleistocene age, overlying Tuscan tuff.

J. S. Diller, 1906 (U. S. Geol. Survey Geol. Atlas, Redding folio, No. 138). Chiefly gravel and sands, with a small proportion of clay, and a few large boulders. Unconformably overlies Tuscan tuff. Thickness more than 200 feet.

Named for exposures at Red Bluff, Tehama County.

Redlands limestone.

Lower Paleozoic (?): Southeastern California (Inyo County).

See under *Telescope group.* Derivation of name not stated.

Red Mountain andesite.

Miocene (upper): Southern California (Randsburg quadrangle, Kern and San Bernardino Counties).

C. D. Hulin, 1925 (California State Min. Bur. Bull. 95, pp. 55–58, map). Chiefly lava flows, but with prominent amounts of agglomerates and tuffs. The general composition of the series is that of a basic andesite. Overlies Rosamond series, usually with angular unconformity, and unconformably underlies Black Mountain basalt. Forms a thick capping of the Rosamond series in Red Mountain [San Bernardino County], where it reaches an approximate thickness of 1,400 feet of flows and pyroclastics. Believed to be early Pliocene.

Redrock Canyon sandstone member.

Miocene (upper): Southern California (Cuyama Valley, southwestern part of Kern County).

W. A. English, 1916 (U. S. Geol. Survey Bull. 621, pp. 191–215). Basal member of Santa Margarita formation in a small area in Redrock Canyon (Cuyama Valley), to which it is limited. Thickness 500 feet. Consists of bright-red sandstone, clay, and conglomerate, the materials of which were derived from an adjacent land mass of pre-Monterey rocks. Rests unconformably on pre-Monterey rocks, the Monterey group being absent, probably through erosion. Is conformably overlain by Whiterock Bluff shale member of the Santa Margarita.

"Red Rock Canyon beds."

Pliocene (lower): Southern California (eastern part of Kern County).

J. C. Merriam, 1919 (California Univ. Pub., Dept. Geology Bull., vol. 11, No. 5). There may be some justification for name *Red Rock Canyon beds, formation, or group*, for stratigraphic sequence containing the Ricardo fauna, but G. K. Gilbert (Geog. and Geol. Expl. W. 100th Mer., pp. 142–143, 1875) and H. W. Fairbanks (Am. Geologist, vol. 17, pp. 68–69, 1896) did not use the name for nomenclature purposes. Following the discovery that the fauna from the beds in Red Rock Canyon [at Ricardo, eastern part of Kern County] is sharply distinct from that in the Barstow section, the writer has described numerous mammalian forms from the Red Rock Canyon section as representing the *Ricardo fauna, Ricardo beds*, or *Ricardo Pliocene*, and he therefore prefers the name Ricardo formation or Ricardo group for the deposits containing them.

Reed dolomite.

Pre-Cambrian: Eastern California (Inyo Range).

E. Kirk, 1918 (U. S. Geol. Survey Prof. Paper 110). Heavy-bedded dolomite, much jointed and breaking up into large angular blocks that form rough talus slopes. Varies from aphanitic to coarsely crystalline. White or slightly bluish on fresh fracture. Weathers slightly creamy to buff. Thickness about 2,000 feet. Unconformably underlies Deep Spring formation. Is underlain by thin-bedded arenaceous slates which grade down into more heavily bedded sandstones. Named for exposures for several miles along eastern side of Reed Flat; best section is in canyon at head of Wyman Creek, in sec. 7, T. 6 S., R. 35 E.

"Reef bed."

Miocene: Southern California.

See under "*Coalinga beds.*"

Reeve meta-andesite.

Pennsylvanian: Northern California (Taylorsville region).

J. S. Diller, 1908 (U. S. Geol. Survey Bull. 353). Volcanic, tuffaceous, porphyritic meta-andesite, about 200 feet thick. Occurs as a definite flow and tuff. Is intimately associated with Robinson formation, into which it grades. Appears to be younger than the Kettle meta-andesite.

Named for an unidentified locality near Genesee, east of Taylorsville.

Relief quartzite.

Mississippian: Northern California (Colfax quadrangle).

W. Lindgren, 1900 (U. S. Geol. Survey Geol. Atlas, Colfax folio, No. 66). Very hard grayish or yellowish siliceous rock of fine grain and clastic origin, which might be characterized as a very fine grained quartzite alternating with streaks of siliceous clay slates. The quartzite is completely filled by small irregular bunches and veinlets of white quartz. No fossils. Corresponds to part of Calaveras formation. Overlies Blue Canyon formation and underlies Cape Horn slate. Named for exposures at Relief. Best exposures in canyons of South Fork of Yuba River below Relief, Bear River, and Steep Hollow north of Dutch Flat.

According to later work by H. G. Ferguson (Am. Inst. Min. and Met. Eng. Tech. Pub. 211, p. 4, 1929), two formations (Tightner below and Kanaka above), composed of interbedded sedimentary and igneous rocks, are now discriminated between Blue Canyon formation and Relief quartzite.

Reward conglomerate.

Pennsylvanian: Eastern California (Inyo Range).

E. Kirk, 1918 (U. S. Geol. Survey Prof. Paper 110). Conglomerate composed of coarse material of both angular and rounded fragments of red, brown, and white grits, together with jasper, brown hornstone, and green cherty pebbles firmly held together by a siliceous cement. A brownish-weathering sandstone with dark-brown patches and layers forms the uppermost 100 feet of the Reward north of Union Wash. Thickness of formation 100 to more than 350 feet. Unconformably underlies Owenyo limestone (Permian) and conformably overlies Pennsylvanian limestone and shale. Named for bold exposures just south of Reward mine.

Ricardo formation.

Pliocene (lower): Southern California (Kern and San Bernardino Counties).

J. C. Merriam, 1914 (California Univ. Pub., Dept. Geology Bull., vol. 8, pp. 276, 278). "The *Ricardo Pliocene* is the next faunal stage known after the Mohave in the Great Basin." A series of beds, occurring at Ricardo [Kern County], on the western border of the Great Basin, representing a faunal and stratigraphic stage which is distinctly pre-Pleistocene, is certainly much later than the Mohave Upper Miocene, and presumably represents early Pliocene. Doubtful that much, if any, of the Pliocene of King really represents the *Ricardo stage*.

J. C. Merriam, 1915 (Pop. Sci. Monthly, vol. 86, pp. 252–254). The Ricardo beds contain Pliocene mammals.

J. C. Merriam, 1917 (California Univ. Pub., Dept. Geology Bull., vol. 10, pp. 430–443). *Ricardo formation*.—Thickness 3,000 to 5,000 feet. Contains Pliocene fauna. The beds in which the fauna occurs consist in large part of tuffs with desert conglomerates or fanglomerates and other deposits formed on land or in evanescent water bodies. Fauna seems to be a unit not divisible into sharply separated stages and indicates an earlier stage than Thousand Creek and Rattlesnake, which is supported by greater degree of induration and deformation of the Ricardo. Is younger than Barstow formation.

J. C. Merriam, 1919. (See under *"Red Rock Canyon beds."*)

Robinson formation.

Pennsylvanian: Northern California (Taylorsville region).

J. S. Diller, 1892 (Geol. Soc. America Bull., vol. 3, pp. 370–394). ***Robinson beds.***—Slates, conglomerates, tuff, and sandstone, of which the last two are most important. Thickness 1,150 feet. Uppermost Carboniferous formation in Taylorsville region. Fossiliferous. Younger than Shoofly beds and older than Hosselkus limestone and Swearinger slate.

J. S. Diller, 1908 (U. S. Geol. Survey Bull. 353). ***Robinson formation.***—A succession of variable sediments ranging from shale to conglomerate and composed chiefly of igneous material with occasional lentils of limestone. Most characteristic portion is gray sandstone that weathers reddish brown. Contains more or less disseminated carbonate of lime forming small lentils up to 15 feet in thickness. Below the calcareous horizon the reddish-brown thin-bedded tuffaceous sandstone and shale extend to bottom of formation. Above the calcareous horizon the pyroclastic material becomes somewhat coarser and passes into a tuffaceous conglomerate containing fossiliferous limestone nodules and beds of reddish-brown sandstone, with here and there crinoid stems like that of the principal horizon below. [Fossils listed.] Is separated from the older Peale formation by the Reeve meta-andesite. Is unconformably overlain by Hosselkus limestone.

Named for exposures on the Robinson ranch (where it makes up the mound east of the house), near Taylorsville.

Rodeo shale.

Miocene (middle): Western California (San Francisco region).

A. C. Lawson, 1914 (U. S. Geol. Survey Geol. Atlas, San Francisco folio, No. 193). Bituminous shale, mostly chalky and more or less stained with oxide of iron but is locally cherty. A subdivision of the Monterey group. Underlies Briones sandstone and overlies Hambre sandstone. Thickness 670 feet. Named for exposures along Rodeo Creek, in the northwestern part of Concord quadrangle, Contra Costa County.

"Rosamond series."

Tertiary: Southeastern California (southeastern Kern County and northern Los Angeles County).

O. H. Hershey, April, 1902 (California Univ. Pub., Dept. Geology Bull., vol. 3, pl. 1, map). [On legend of map appears between Cretaceous shales below and Escondido series above, and is mapped to the north of Rosamond, Kern County.]

O. H. Hershey, 1902 (Am. Geologist, vol. 29, pp. 349–372). A rhyolite series, 1,650 feet thick, consisting of interbedded sandstone and rhyolite tuff with one massive bed of dark-red lava. Unconformably underlies Barstow series. Type section near Rosamond station.

J. C. Merriam, 1919 (California Univ. Pub., Dept. Geology Bull., vol. 11, No. 5, pp. 440–448). While the name Rosamond series may be tentatively used for the middle and late Tertiary sediments of Mohave area it has not been demonstrated that the several formations represented are as closely related in their depositional history as they appeared in the first investigations. If the Barstow formation is a member of the Rosamond series of Hershey it is a late member. It will be recognized as a division of the Rosamond series. It is doubtful if the Rosamond series comprises sediments of the stage represented at Ricardo.

Rose Cañon shale.

Eocene: Southern California (San Diego County).

M. A. Hanna, 1926 (California Univ. Pub., Dept. Geol. Sci. Bull., vol. 16, No. 7, pp. 187–246). Mudstones, gray shales, fine sands, conglomerates, and a few thin beds of limestone. The sandstones are usually fine grained and vary from light to dark brown. Lower part is cross-bedded. Thickness about 300 feet. Is upper division of La Jolla formation. Disconformably underlies Poway conglomerate and grades into underlying Torrey sand. In northwestern part of quadrangle rests with marked angular unconformity on Black Mountain volcanics. Named for exposures at big bend in Rose Cañon, La Jolla quadrangle. Contains brackish-water fauna.

" Sacramento " formation.

Middle Devonian: Northern California (Redding region).

J. P. Smith, 1894 (Jour. Geology, vol. 2, pp. 591, 592). [In heading and table this name is used to cover the *Kennett limestones and shales*, and is credited, in footnote, to H. W. Fairbanks MS. A later publication by J. P. Smith (California State Min. Bur. Bull. 72, 1916) states that the Middle Devonian limestones of Kennett and Lower Soda Springs occur in the Sacramento Canyon.]

Same as Kennett formation.

Sailor Canyon formation.

Upper Triassic (J. P. Smith, 1910) : Northern California (Colfax region).

H. W. Turner, 1894 (Am. Geologist, vol. 13, p. 232). *Sailor Canyon beds.*—At Sailor Canyon, which drains into the American River about 6 miles southeast of Cisco, are a series of beds from which Mr. Lindgren and Dr. Cooper Curtice have collected fossils regarded by Hyatt as of Liassic [Lower Jurassic] age. Considered older than Milton and younger than Cedar formation.

W. Lindgren, 1900 (U. S. Geol. Survey Geol. Atlas, Colfax folio, No. 66). *Sailor Canyon formation.*—Calcareous clay slates with some limestone and a contact-metamorphic facies consisting chiefly of mica schist and hornfels. Younger than Calaveras formation and older than Mariposa slate.

The Sailor Canyon formation has an estimated thickness of 6,000 feet.

St. Helena rhyolite.

Pliocene: Northern California (Sonoma County).

V. C. Osmont, 1904 (California Univ. Pub., Dept. Geology Bull., vol. 4, pp. 59–87). Of varying thickness up to 2,000 feet. Rests conformably on Sonoma tuff.

Apparently named for occurrence on Mount St. Helena, Sonoma County.

" St. Paul sand."

A sand, about 30 feet thick, occurring toward the top of the Santa Margarita formation in the Coalinga district, in the vicinity of the California Oilfields property, sec. 27, No. 20, and extending down into northern part of sec. 34. It lies about 830 feet above the base of the Big Blue serpentinous member and from 150 to 600 feet beneath the surface.

Salinas shale.

Miocene (middle) : Southern California (Salinas Valley region).

W. A. English, 1918 (U. S. Geol. Survey Bull. 691, pp. 219–250). Probably the best known of the California Tertiary formations is the marine diatomaceous shale which extends from Monterey southward. This shale was known as " bituminous shale " by the early California geologists but is now commonly called the " Monterey shale." The name Monterey has been adopted as a group name by the United States Geological Survey to include the so-called " Monterey shale " and the underlying Vaqueros sandstone. The name " Monterey shale " is therefore no longer applicable as a formation name. The name Maricopa shale was used in the writer's report on the Cuyama Valley (U. S. Geol. Survey Bull. 621, 1916) on the mistaken assumption that the shale previously called " Monterey shale " was essentially contemporaneous with the shale exposed in the vicinity of Maricopa, but the latter has since been found to include representatives not only of the shale previously called " Monterey " in the area under consideration but also of the overlying Santa Margarita formation. The name Maricopa shale is therefore not appropriate as a substitute for " Monterey shale." The name Salinas shale is here proposed for the diatomaceous shale which is well developed on the west side of the Salinas Valley within the area mapped and which is believed to extend as a single formation northward along the west side of the valley to the town of Monterey.

Is treated by United States Geological Survey as the upper formation of the Monterey group, of which the Vaqueros sandstone is the lower formation.

Salmon hornblende schist.

Pre-Cambrian (?) : Northern California (Trinity and Shasta Counties).

O. H. Hershey, 1901 (Am. Geologist, vol. 27, pp. 225–245). *Salmon hornblende schist.*—Of remarkable uniformity throughout its thickness of probably not less than 2,500 feet. The largest area of this schist is traversed by the south fork of Salmon River between its head and the vicinity of the village of Cecilville.

According to J. S. Diller and H. G. Ferguson (unpublished manuscript on Weaverville quadrangle) is probably intrusive into Abrams mica schist.

San Antonio formation.

Pleistocene: Western California (San Francisco region).

A. C. Lawson, 1914 (U. S. Geol. Survey Geol. Atlas, San Francisco folio, No. 193). *San Antonio formation.*—A great series of alluvial fans at the foot of the steep face of the Berkeley Hills between East Oakland and Berkeley, built up by streams that emerge from the hills. Is divisible into an older gravel, which consists of rock fragments derived from the front of the hills and does not contain any chert, and a later or upper part, here called the chert-gravel member, because it contains abundant fragments of chert. The formation has been thoroughly dissected and terraced. [Fossils listed.] Unconformably underlies Merritt sand and unconformably overlies Alameda formation. Named for development in San Antonio Township, Alameda County.

San Benito gravels.

Pleistocene: Western California (San Benito County).

A. C. Lawson, 1893 (California Univ. Pub., Dept. Geology Bull., vol. 1, pp. 151–153). [Correlates the Merced "series" (Pliocene) with the delta gravels on the San Benito. On p. 153 he casually uses the term *San Benito gravels,* but apparently not as a geologic name.]

P. F. Kerr and H. G. Schenck, 1925 (Geol. Soc. America Bull., vol. 36, pp. 468–469, 470, 477, map). Yellow loosely consolidated sandstones, blue shale, blue, red, and gray bedded gravel, indurated sandstone in places, strata often brilliantly colored. Thickness 1,000 ± feet. "The gravel was called Pliocene by Whitney and accepted by Lawson, but they carry characteristic Pleistocene vertebrate fossils. * * * These Pleistocene gravels were named 'San Benito gravels' by Lawson (1893), who thought they were Pliocene in age." Unconformably overlie Pliocene Paicines formation. [The formation is mapped along San Benito River.]

San Bruno sandstone.

Jurassic(?) : Western California (San Francisco region).

R. Crandall, 1907 (Am. Philos. Soc. Proc., vol. 46, pp. 3–58). *San Bruno sandstone.*—Chiefly hard blue-gray sandstone interbedded with shales and some coarse conglomerates; several hundred feet of sandstone at top. Thickness great. Is a subdivision of the Franciscan series. Overlain by the lower jasper bed of the Franciscan and rests on crystalline limestones of the Franciscan. Named for fact that it forms San Bruno Mountains.

A. C. Lawson (U. S. Geol. Survey Geol. Atlas, San Francisco folio, No. 193, 1914) mapped the above-described rocks as Cahil sandstone, toward the middle of which occurs the Calera limestone member. As Crandall's San Bruno sandstone rests on the limestone it is equivalent to the upper part of the Cahil sandstone of Lawson.

San Diego formation.

Pliocene (middle?) : Southern California (San Diego region).

W. H. Dall, 1897 (U. S. Geol. Survey Eighteenth Ann. Rept., pt. 2, p. 337). *San Diego beds.*—Pliocene sandy marls exhibited in well explored by Hemphill in city park; below Pleistocene at Pacific Beach, San Diego, on shores of False Bay near by; and on Coronado Peninsula opposite San Diego. The same horizon crops out in various places northward, especially at Dead Mans Island and Harbor Hill, San Pedro, and on coast of Todos Santos Bay, Lower California.

A. J. Ellis, 1919 (U. S. Geol. Survey Water-Supply Paper 446). *San Diego formation.*—An extension of Dall's use of the name. Consists of lenticular deposits of conglomerate, sandy marls, sand, and clay, with rare lenses of limestone. The sandy marls which are exposed around Mission Bay and in Mission Valley and underlying the conglomerates east of San Diego have been referred to in the literature as the San Diego beds. Fossil collections obtained from them have been classified as Pliocene. Orcutt has assembled data in regard to fossil collections obtained from these deposits in a well boring in the city of San Diego. The beds described by Orcutt are near base of later Tertiary section. They are best developed in immediate environs of city of San Diego, but they have been recognized by their lithologic character as far south as Otay and in the northern part of the area in the vicinity of Oceanside. They seem to be integral parts of a simple formation and chronologically inseparable from the other lenticular strata with which they are interbedded. On this ground it is proposed to include all the later Tertiary marine deposits in this area under the name San Diego formation. It is essentially a shallow-water deposit. Rests on Eocene beds and is overlain by San Pedro formation. Thickness 500 feet.

San Dimas formation.

Quaternary(?): California (southwestern part of San Bernardino County).

R. Eckis, 1928 (Jour. Geology, vol. 36, pp. 228, 235–236). *San Dimas formation* on map, *San Dimas alluvium* in heading.—Dissected alluvium with decomposed gravels of red, brown, or yellow color commonly occurring as high fan-head remnants and as isolated or nearly isolated midfan mesas. Called "earlier alluvium" by W. C. Mendenhall in United States Geological Survey Water-Supply Paper 219, pages 10–12, 1908. Type locality is at San Dimas, 5 miles west of Claremont. Overlain by Recent alluvium, from which it is sometimes difficult to distinguish it. Is generally undeformed.

San Emedio series.

Pre-Cambrian(?): Southern California (Kern County).

O. H. Hershey, April, 1902 (California Univ. Pub., Dept. Geology Bull., vol. 3, pl. 1, map). [*San Emedio schists* on legend of map lie between Cambrian above and Archean gneiss below.]

O. H. Hershey, 1902 (Am. Geologist, vol. 29, pp. 273–290). A series of thoroughly crystalline schists and limestone. Tentatively assigned to pre-Cambrian(?). Relations to Pelona schist series unknown and can not be conjectured.

Probably named for San Emedio Range.

"San Emigdio formation."

Oligocene: Southern California (Kern County).

G. C. Gester, 1917 (California Acad. Sci. Proc., 4th ser., vol. 7, plate opp. p. 220). [Gives a section of Midway and Tejon districts, in which the name *San Emigdio* is applied to shales and sands underlying the lower Miocene and apparently referred to the Oligocene.]

C. M. Wagner and K. H. Schilling, 1923 (California Univ. Pub., Dept. Geology Bull., vol. 14, pp. 235–252). *San Emigdio formation.*—Basal formation of San Lorenzo group [expanded definition]. Disconformably underlies Pleito formation, the upper formation of the San Lorenzo group, and unconformably overlies Tejon formation. East of San Emigdio Canyon it consists of 700 feet of alternating yellowish and grayish sandstones and sandy shales containing very fossiliferous dark-red bands and lenses; underlain by 150 feet of bluish-black shale carrying fossils in calcareous concretions; with, at base, 150 feet of light-gray and tan unfossiliferous sandstone, in places conglomeratic and gritty. Mapped along east side of San Emigdio Creek, southwestern part of Kern County. Carries *Molopophorus linconensis* zone. Correlated with Butano sandstone, which is older than typical San Lorenzo formation.

Is a faunal zone in San Lorenzo formation.

"San Francisco group."

Late Tertiary and Franciscan (Jurassic?): Western California (San Francisco region).

J. S. Newberry, 1857 (Pacific R. R. Repts., vol. 6, pt. 2, pp. 10–12). Upon the serpentine lies a deposit of sandstones and shales, several hundred feet in thickness. They are somewhat interstratified, their strata conformable and apparently belonging to the same geological epoch, being members of a group widely spread over the Pacific coast, and to which, under the name of *San Francisco group*, I shall frequently have occasion to refer. The sandstone where long exposed is light gray, soft, and easily worked. It forms the slopes of the axis lying between the Bay of San Francisco and the ocean and the rocky basis upon which the city of San Francisco rests. The shales are greenish or yellowish brown. No fossils found in either the sandstone or shale in vicinity of San Francisco, but on San Pablo Bay this group is highly fossiliferous. Assigned to Miocene.

Apparently includes Franciscan and late Tertiary rocks.

"San Francisco sandstone."

Jurassic(?) and late Tertiary: Western California (San Francisco Bay region).

W. P. Blake, 1856 (Pacific R. R. Repts., vol. 5, pp. 145–156). Fine-grained compact sandstones associated with thin shales. Thickness 1,000 to 3,000 feet. Tertiary in part at least, but Upper Cretaceous may also be represented. Forms greater part of hills and mountains around the [San Francisco] bay and, so far as explored, a considerable part of the mass of the Coast Mountains. "Is believed to be the most extensive and highly developed sedimentary formation of the California coast, and may appropriately be known as the San Francisco or California sandstone." [Includes sandstones of Franciscan group and rocks belonging to the Merced formation.]

A. C. Lawson, 1895 (Am. Geologist, vol. 15, p. 347; U. S. Geol. Survey Fifteenth Ann. Rept., p. 417). San Francisco sandstone, the dominant sedimentary formation of the Franciscan series, consists of moderately fine-grained sandstone with subordinate beds of shale and conglomerate. Is interbedded with foraminiferal limestones, radiolarian cherts, and volcanic rocks, including basaltic lavas, diabases, pyroclastic accumulations, etc.

A. C. Lawson, 1914 (U. S. Geol. Survey Geol. Atlas, San Francisco folio, No. 193). [Divides the Franciscan rocks into five named formations, three of which are sandstone.]

The term "San Francisco sandstone" is no longer used by geologists.

San Joaquin clays.

Pliocene: Southern California (San Joaquin Valley).

F. M. Anderson, 1905 (California Acad. Sci. Proc., 3d ser., vol. 2, pp. 178–192). Name applied to upper one-third of Etchegoin formation. [See description under *Etchegoin formation*.]

San Juan Bautista formation.

Oligocene: Southern California (San Benito County).

P. F. Kerr and H. G. Schenck, 1925 (Geol. Soc. America Bull., vol. 36, pp. 470, 471, 472, 493, map). Blue indurated calcareous sandstone; also fine-grained argillaceous buff-colored sandstone, carbonaceous grit, and clay shale. Thickness about 1,500 feet. Base not exposed. Contains numerous fossils, which establish its Oligocene age and marine origin. Lower formation of San Lorenzo series. Named for exposures in vicinity of San Juan Bautista.

San Lorenzo formation.

Oligocene: Southern California (Santa Cruz Mountains region).

R. Arnold, 1906 (U. S. Geol. Survey Prof. Paper 47, p. 16). *San Lorenzo formation.*—Essentially a series of grayish "muddy" shales and fine sandstones, typically exposed along the bed of San Lorenzo River about 2 miles above Boulder Creek, Santa Cruz County. Extends westward from type locality into the Big Basin, on the north side of which it rests conformably against the older yellowish sandstones (possibly Oligocene in age) of Butano Ridge [later named Butano sandstone]. Conformably [unconformably] underlies Vaqueros sandstone. [Fossils listed.] Thickness about 2,300 feet in vicinity of type locality.

In 1918 (California Univ. Pub., Dept. Geology Bull., vol. 11, pp. 54–111) B. L. Clark used the term *San Lorenzo series* to include "all of the known marine beds in California, Oregon, Washington, and British Columbia that have generally been referred to the Oligocene." In the

Sobrante anticline, in the Concord quadrangle, he divided his San Lorenzo series into (descending order) Concord formation (=lower part of Lawson's Sobrante sandstone), Kirker tuff, and San Ramon formation, and stated that it represents the *Agasoma gravidum* zone. In this expanded San Lorenzo Clark now includes the lower part of the Sobrante sandstone of Lawson; the San Lorenzo formation and underlying Butano sandstone of the Santa Cruz Mountains and their equivalent; and the Kreyenhagen shale.

The United States Geological Survey recognizes San Lorenzo formation as originally defined, and as distinct from Butano sandstone.

"San Luis" formation.

Jurassic(?): Southern California (San Luis Obispo region).

H. W. Fairbanks, 1904 (U. S. Geol. Survey Geol. Atlas, San Luis folio, No. 101). Usually earthy sandstone, but in places there is a great thickness of dark shale very similar to the Toro formation. Contains many lentils of radiolarian jasper and some contact-metamorphic schist. Local representative of the Franciscan. Represents all of the Franciscan present in the area. Unconformably underlies Toro formation (Knoxville) and unconformably overlies serpentine and other basic igneous rocks. Named for development in San Luis Valley, San Luis Obispo County.

Replaced by Franciscan formation.

San Mateo formation.

Pliocene(?): Southern California (San Diego and Orange Counties).

A. O. Woodford, 1925 (California Univ. Pub., Dept. Geol. Sci. Bull., vol. 15, No. 7, pp. 169, 217–219). "*Post-Capistrano formation.*—The younger [than Capistrano formation] rocks are of slight significance in the present study. They are very patchy in distribution and lie unconformably on the older rocks. There is the tilted *San Mateo formation*, doubtful correlative of the San Diego Pliocene, consisting of arkosic sands and gravels with a little admixture of blue schists, and containing an occasional marine fossil; and topping all the very slightly deformed or untilted *Terrace gravels and alluvium.*" Thickness several hundred feet. Classified as Pliocene (?). [Mapped.]

Named for occurrence along San Mateo Creek, in northwest corner of San Diego County.

"San Miguel cherts."

Jurassic (?): Western California (San Francisco region).

R. Arnold, 1902 (Science, new ser., vol. 15, p. 416). *San Miguel cherts*, radiolarian, 530 feet thick. Underlie Bonita sandstone and overlie Marin sandstone. A formation in the Franciscan.

A. C. Lawson, 1903 (Geol. Soc. America Bull., vol. 13, pp. 544–545). [Same as above.]

A. C. Lawson, 1914 (U. S. Geol. Survey Geol. Atlas, San Francisco folio, No. 193). [The rocks of San Miguel Hills, San Francisco County, which appears to be the type locality, are mapped as Ingleside chert, Marin sandstone, and Sausalito chert. The name San Miguel is preoccupied.]

San Onofre breccia.

Miocene (lower): Southern California (San Diego County).

A. J. Ellis, 1919 (U. S. Geol. Survey Water-Supply Paper 446). Very coarse breccias or agglomerates, made up almost entirely of angular boulders and slabs of garnetiferous glaucophane schists and other schistose rock fragments. Forms the San Onofre Hills, in San Diego County. Older than Poway conglomerate and San Diego formation. [M. A. Hanna, 1926 (California Univ. Pub., Dept. Geol. Sci. Bull., vol. 16, No. 7) says Poway fauna is Eocene.] Assigned to lower Miocene.

A. O. Woodford, 1925 (California Univ. Pub., Dept. Geol. Sci. Bull., vol. 15, No. 7). [Describes the above formation as the *San Onofre facies of the Temblor formation* or *Turritella ocoyana* zone, gives the thickness as 2,610 feet, and states that the Temblor beds underlying the San Onofre facies consist of 300 feet or more of gray or white sandstone and shale. "Doubtful correlatives" of the San Onofre are described under the headings San Pedro schist breccia and sandstone, Catalina schist breccia, and Bouquet Cañon breccia.]

San Pablo formation.

Miocene (upper): Western California (San Francisco region).

J. C. Merriam, 1898 (California Univ. Pub., Dept. Geology Bull., vol. 2, pp. 109–118). *San Pablo formation.*—Marine sandstones, tuffs, and ashes, 1,500 feet thick, characterized by presence of *Astrodopsis* and *Scutella* (*Clypeaster*) *gabbi.* A considerable thickness of tuffs and ashes, most prominent in the upper portion of the formation, and the peculiar weathering of the sandstones are constant and striking characters of the greatest value in identifying the formation where fossil remains are rare or absent. Overlies Contra Costa County Miocene, without distinct unconformity, although a break is indicated at several localities.

A. C. Lawson, 1914 (U. S. Geol. Survey Geol. Atlas, San Francisco folio, No. 193). [Describes the San Pablo formation as resting unconformably on the Briones sandstone, and as unconformably overlain by Pliocene rocks (Pinole tuff in some areas and the younger Orinda formation in other areas). According to B. L. Clark (Jour. Geology, vol. 29, pp. 586–614, 1921) the San Pablo formation (renamed by him Cierbo group) occurs only in the general region of San Francisco Bay, lies disconformably below the Santa Margarita formation, and rests disconformably on the Briones sandstone.]

Named for occurrence on San Pablo Bay, Contra Costa County, near town of Rodeo.

San Pablo group.

San Pablo series.

Miocene (upper): Western California (coast region).

B. L. Clark and R. Arnold, 1918 (Geol. Soc. America Bull., vol. 29, p. 298). [Apply the name *San Pablo group* to all the upper Miocene deposits of western California, including the Briones sandstone at the base and the Santa Margarita formation at the top.]

B. L. Clark, 1921 (Jour. Geology, vol. 29, pp. 586–614). [Uses *San Pablo series* to cover all the upper Miocene formations of western California, including Santa Margarita formation, Mint Canyon formation, and Maricopa shale. In the Mount Diablo region he divides it, in descending order, into Santa Margarita formation (300 to 3,000 feet thick), resting disconformably on Cierbo group (600 to 1,300 feet thick and the formation heretofore called San Pablo formation), which in turn is disconformable on the Briones sandstone (2,300 feet thick and formerly included in the Monterey group). As thus applied the San Pablo series is described as resting on the Rodeo shale of the Mount Diablo region, the Salinas shale of the Salinas Valley, and on the rocks designated Temblor by B. L. Clark; and it is described as unconformably overlain, in different areas, by the Pinole tuff, the Jacalitos formation, and the Fernando group. See under *Cierbo group.*]

San Pedran epoch.

Pleistocene: Southern California.

O. H. Hershey, 1902 (California Univ. Pub., Dept. Geology Bull., vol. 3, pp. 1–29). *San Pedran epoch* (*deposition*).—"Arnold's Upper San Pedro series seems to include the deposits of the three lower [of the 10] terraces of San Pedro Hill, and perhaps it might be convenient to extend the name, in the form of *San Pedran*, to the epoch as well." May be approximately equivalent to Iowan. [He applied *Los Angelan epoch* to the erosion epoch preceding the upper San Pedro and correlated Arnold's lower San Pedro with what he called the *Red Bluff epoch* (*deposition*). See under *Sierran.*]

San Pedro formation.

Pleistocene: Southern California (San Diego, Los Angeles, and Ventura Counties).

W. H. Dall, 1897 (U. S. Geol. Survey Eighteenth Ann. Rept., pt. 2, 1898—first published in 1897 as 55th Cong., 2d sess., H. Doc. 5—p. 335). *San Pedro beds.*—

Extensive beds of unconsolidated Pleistocene sand replete with molluscan shells in very perfect condition, best exhibited at Harbor Hill, at head of San Pedro Harbor, Los Angeles County. Assigned to Pleistocene. Same horizon is recognizable above the Pliocene of Pacific Beach, San Diego; at various points on Coronado Beach peninsula opposite San Diego, especially at a cove called Spanish Bight; and also at Santa Barbara and elsewhere. Unconformably overlies Merced group.

W. S. W. Kew, 1923 (Am. Assoc. Petroleum Geologists Bull., vol. 7, p. 420). *San Pedro formation (Pleistocene)*.—This series of beds, which is typically developed in the vicinity of San Pedro, has been described in detail by Ralph Arnold (California Acad. Sci. Mem., vol. 3, 1903), who has divided it into two members, separated by an unconformity. The San Pedro occurs at many places in the Los Angeles Basin, resting unconformably upon the Saugus formation or upon beds of San Diego age.

A. J. Tieje, 1926 (Am. Assoc. Petroleum Geologists Bull., vol. 10, pp. 502–512), applied *Palos Verdes sands* to the upper member and restricted San Pedro to the lower member.

The United States Geological Survey follows the original broad definition.

San Pedro schist breccia and sandstone.

Miocene or Pliocene: Southern California (San Pedro and San Pedro Hill).

A. O. Woodford, 1925 (California Univ. Pub., Dept. Geol. Sci. Bull., vol. 15, No. 7, pp. 210–211). "*San Pedro schist breccia and sandstone*.—Point Fermin at San Pedro is composed of blue schist sandstone, with a little breccia of various sorts, interfingering with more or less purely diatomaceous shale. One may trace in the sea cliffs the gradual change from a section that is chiefly blue sandstone to one exclusively made up of thin beds of white shale. At the very tip of Point Fermin there are 100 feet of tar-saturated blue schist sandstone intercalated in the shale series. In this sandstone are included several 1 to 3 foot beds of breccia and, near top and bottom, thin beds of shale. * * * The San Pedro-Point Fermin Oil & Gas Co. well at Point Fermin passed through the following materials (oral communication from officers of the company, supplemented by inspection of samples):

0–600 feet below sea level. Chiefly fine sandstone and shale.
600–1,200 feet. Blue sandstone, schist breccia, some shale.
1,200–1,800 feet. Soft shale, with blue schist flakes.
1,800–2,500 feet. Bedrock, chiefly blue-green quartzose schist.

In San Pedro Hill, 5 miles northwest of Point Fermin, the schists in place are separated from the overlying shale by a few feet of fine schist breccia, which along the eastern edge of the schists becomes much thicker, and probably grades out into shale, as at the point. The overlying shale contains blue sandstone beds and pockets, as well as numerous pumice fragments. The fossil evidence is inadequate for certain correlation of the San Pedro occurrences. * * * The fossils listed suggest a Lower Miocene age for at least a portion of the section. However, W. S. W. Kew, of the United States Geological Survey, who has studied the San Pedro region in detail, considers the beds below the Point Fermin breccia to be Upper Miocene and those above Pliocene, on the basis of the resemblance of the shales to those of the Upper Miocene and Pliocene, respectively, of the Santa Monica Mountains. Below the breccia, chert predominates, and Kew has never been able to find diatoms; above, soft diatomaceous shale predominates." [Described under center heading "Doubtful correlatives of the San Onofre facies."]

"San Pedro shales."

Eocene (?): Western California (San Francisco region).

R. Crandall, 1907 (Am. Philos. Soc. Proc., vol. 46, pp. 3–58). Thin-bedded black coarse-grained hard shales, 4,000 feet thick, exposed in cliffs north and south of San Pedro Point. Included in Franciscan series. Rest on basal coarse conglomerate of the Franciscan and are overlain by crystalline limestone of the Calera Valley [Calera limestone member], which is also included in the Franciscan.

The name is preoccupied in southern California. The rocks of the San Pedro Point southwest of San Francisco and in San Mateo County, and of adjacent areas, are mapped by A. C. Lawson (U. S. Geol. Survey Geol. Atlas, San Francisco folio, No. 193, 1914) as Martinez (?) formation.

San Ramon formation.

Oligocene (?): Western California (San Francisco Bay region).

B. L. Clark, 1918 (California Univ. Pub., Dept. Geology Bull., vol. 11, pp. 54–111). On the Sobrante anticline, in the Concord quadrangle, the formation consists for the most part of medium-fine gray sandstones, which at base are massive, rather coarse, and somewhat calcareous, but toward top are not so massive, thin beds of micaceous gray medium-fine sandstone alternating with thinner layers of sandy shale and clay shale, well exposed on side of road just south of divide between Bear and Pinole Creeks, on the north side of the anticline. The formation is the basal formation of the San Lorenzo series in this region, where it is overlain by the Kirker tuff and rests unconformably on Tejon formation. The San Lorenzo series of San Ramon syncline, Mount Diablo region, is considerably different from that of Sobrante anticline. Only one distinct formation was recognized in the Ramon syncline, and "this is called the San Ramon formation, the name already applied to the basal member of the San Lorenzo of the Sobrante anticline. It seems very probable that the San Ramon formation of this section represents a longer period of deposition than the San Ramon formation of the Sobrante anticline, but whether the time of the deposition of the Kirker tuffs and Concord formation [the two upper formations of his San Lorenzo series in the Sobrante anticline] are represented in this record may be open to doubt." It rests unconformably on the Tejon formation.

W. P. Woodring, 1931 (Carnegie Inst. Washington Pub. 418, pp. 1–25). Fauna of San Ramon formation "looks suspiciously like Miocene."

Santa Ana.

Triassic: Southern California.

F. J. H. Merrill, 1914 (Geology and mineral resources of San Diego and Imperial Counties, p. 9, California State Min. Bur.). [*Santa Ana* is used in table as a "local" name for Triassic. Statement on page 10 indicates that it is intended to be applied to the same metamorphic rocks in Orange County (in which are the Santa Ana Mountains) as those to which the name Julian group is applied in adjoining San Diego County.]

Santa Ana limestone.

Triassic: Southern California (Orange County).

J. P. Smith, 1898 (Jour. Geology, vol. 6, pp. 779–780). Hard black siliceous limestone on west slope of Santa Ana Range, Orange County.

Santa Ana sandstone.

Probably upper Pliocene or lower Quaternary (mapped as Pliocene): Southern California (San Bernardino Mountains).

F. E. Vaughan, 1922 (California Univ. Pub., Dept. Geol. Sci. Bull., vol. 13, No. 9, pp. 344, 378–379, map). Sandstone and shale formation, for most part of medium-gray color, although brown and reddish streaks are present. Also includes strata of coarse granitic detritus up to 5 and 6 feet thick, between which are finely laminated shales and occasional calcareous seams. Can not be correlated with much certainty with any other formation in district. May possibly have been formed at same time as Hathaway formation, of south side of range. Is unconformably overlain by Cabezon fanglomerate. The present position of the evenly bedded sandstone and shale in bottom of a deep canyon can only be explained by faulting.

Named for Santa Ana River, San Bernardino County, along which it is exposed.

Santa Barbara beds (also marls).

Pliocene (upper): Southern California (Santa Barbara County).

J. P. Smith, 1912 (California Acad. Sci. Proc., 4th ser., vol. 3, pp. 161–182). "The upper Pliocene is recorded under the name Santa Barbara, because it is by no means certain that the name Merced, which has been used for the upper Pliocene, is applicable in southern California."

J. P. Smith, 1915 (Nature and science on Pacific Coast, p. 51, San Francisco, Elder & Co.). [The name *Santa Barbara beds* is used in chart for uppermost Pliocene beds in the Coast Ranges, which are shown as younger than San Diego and Merced.]

C. M. Carson, 1925 (Pan-Am. Geologist, vol. 43, pp. 265–270). *Santa Barbara marls.*—Composed of evenly bedded soft brownish-yellow sandy bryozoan marls giving place above to fine soft sands. Thickness 1,000 feet. Probably rests unconformably on Miocene shales. Younger than Ventura sands and San Diego clays. The Santa Barbara formation represents the coldest part of the Pliocene epoch, immediately preceding the very cold early Pleistocene. It occurs at Santa Barbara and San Pedro.

Santa Clara formation.

Pliocene and Pleistocene: Western California (Santa Clara County).

J. G. Cooper, 1894 (California Acad. Sci. Proc., 2d ser., vol. 4, p. 171). "*The Santa Clara lake beds.*—Fossil fresh-water shells have been found at several points on both sides of this valley and at different heights above it, but sufficient specimens have not yet been collected to determine the ages, elevations, disturbances, etc., of the various beds. The oldest known is that at San José Mission, where a ridge apparently of Pliocene date remains as a remnant of a thick bed of gravel and alluvium once filling the greater part of the valley to a depth of probably 300 feet above tides. The same deposit is seen at intervals from East Oakland along the foothills southward on the east side of the valley, and less abundantly on the west side to near Redwood City, but does not everywhere contain fossils. It is considerably disturbed in some places, usually by elevation of the mountains since its deposit." Fossils from San José Mission listed.

J. C. Branner, J. F. Newsom, and R. Arnold, 1909 (U. S. Geol. Survey Geol. Atlas, Santa Cruz folio, No. 163). *Santa Clara formation.*—Coarse gravel, sand, and sandy clay, locally lignitic, containing a fresh-water fauna. Thickness at least 500 feet. Greater part is contemporaneous with Paso Robles formation. Rests, probably conformably, on Purisima formation. Overlain by Quaternary deposits. Recent alluvium resting unconformably on it in at least one place. Considered contemporaneous with Merced formation.

Appears to have been named for its considerable development in Santa Clara County.

Santa Claran epoch.

Pleistocene: California.

O. H. Hershey, 1902 (California Univ. Pub., Dept. Geology Bull., vol. 3, pp. 1–29). *Santa Claran epoch (erosion).*—The epoch of erosion that initiated the Sierran period of Le Conte precedes Red Bluff epoch of deposition. "There is no portion of the State in which this epoch is so clearly defined as on the Upper Pliocene area of the Santa Clara River Valley of the south. Therefore I suggest for it the name Santa Claran as being eminently appropriate." (See under *Sierran.*)

Santa Lucia granite.

Santa Lucia quartz diorite.

Pre-Cretaceous: Southern California.

A. C. Lawson, 1893 (California Univ. Pub., Dept. Geology Bull., vol. 1, pp. 1–89). *Santa Lucia granite,* pre-Cretaceous, forms the main ridge of the Santa Lucia Range.

P. D. Trask, 1926 (California Univ. Pub., Dept. Geol. Sci. Bull., vol. 16, No. 6). *Santa Lucia quartz diorite.*—The term Santa Lucia was first applied by Lawson (1893) to the porphyritic granite in the vicinity of Carmel Bay, but the porphyritic variety that he describes is only of local extent in Point Sur quadrangle. As it apparently grades into the main quartz diorite mass of the region and hence is probably a differentiate of the quartz diorite, the name Santa Lucia is retained for the entire plutonic mass.

Santa Lucia series.

Pre-Franciscan (possibly pre-Cambrian): Southern California (Monterey, San Benito, and San Luis Obispo Counties).

B. Willis, 1900 (Science, new ser., vol. 11, p. 221). *Santa Lucia series*, pre-Franciscan. Separated from Franciscan by erosion interval. [All there is about it.]

J. P. Smith, 1916 (California State Min. Bur. Bull. 72, pp. 9, 25–26). *Santa Lucia formation*.—Schists, gneisses, and crystalline limestone of the Santa Lucia Range in Monterey and San Luis Obispo Counties, and Fremont's Peak of the Gavilan Range in San Benito County, have been named by Bailey Willis [above citation] the Santa Lucia series. The rocks have never been fully described, but a partial description is given by H. W. Fairbanks (California State Min. Bur. Rept. 12, pp. 493–526) without naming the series. No definite fossils known, but round crinoid stems are said to have been found in the Gavilan limestones of Fremont's Peak. They are certainly pre-granitic, and the granite of the Santa Lucia Range is older than the Franciscan. The rocks are thoroughly metamorphosed and look as old as the pre-Cambrian rocks of southern California. Thickness and structural relations unknown, but the Franciscan rocks lie unconformably upon them in the few places where contacts have been observed.

Same as Coast complex of Willis and Sur series of Trask.

Santa Margarita formation.

Miocene (upper): Southern California (Santa Cruz Mountains and southward).

H. W. Fairbanks, 1904 (U. S. Geol. Survey Geol. Atlas, San Luis folio, No. 101). *Santa Margarita formation*.—Alternating beds of conglomerate and soft sandstone, with several strata of diatomaceous earth and pumice. Thickness about 1,500 feet. Occurs in northern part of the area, and considered to be contemporaneous with the Pismo formation of the southern part of the area, though the two formations are not known to have been connected. Unconformably underlies Paso Robles formation and unconformably overlies Monterey shale.

Named for exposures at Santa Margarita, San Luis Obispo County.

"Santa Maria" formation.

Pliocene and Pleistocene: Southern California (Santa Barbara County).

C. M. Carson, 1925 (Pan-Am. Geologist, vol. 43, pp. 265–270). In the Santa Maria district the Fernando formation is sometimes called the Santa Maria formation. It consists of a succession of shaly conglomerates, fine white and yellow sandstones, coarse gray sands, and thick beds of incoherent conglomerates having an aggregate thickness of not less than 3,000 feet according to Arnold and Anderson.

Santa Monica slate.

Triassic(?): Southern California (Santa Monica Mountains).

H. W. Hoots, 1931 (U. S. Geol. Survey Prof. Paper 165, pp. 88–89). *Santa Monica slate*.—Dark-gray and bluish-gray to black slate and phyllite, much of which has undergone contact and regional metamorphism and is locally altered to mica schist. Thickness 5,000 to 7,000 feet. Is of pre-Chico age. Assigned to Triassic(?); may be Jurassic or Paleozoic. Is intruded by Jurassic(?) granite and granodiorite. Named for occurrence in Santa Monica Mountains.

Santa Paula formation.

Lower Pliocene and Miocene?: Southern California (Ventura Basin).

J. E. Eaton, 1926 (Oil and Gas Jour., Nov. 11, 1926, p. 72; Oil Age, November, 1926, p. 16). *Santa Paula formation*.—Previously unrecognized. Well-bedded sandstones, blue sandy and brown sticky shales and conglomerates, locally present in Los Angeles Basin. Northwest of Santa Paula 10,000 feet exposed; absent south of Ventura Basin (on upthrown side of Santa Clara River fault) from South Mountain to and including type locality of Pico formation. Best exposed on great monocline northwest of Santa Paula. The exposed Santa Paula sediments in Ventura Basin are Lower Pliocene in age, but base is not there exposed and is elsewhere indicated to be of Santa Margarita (Upper Miocene) age. Basal formation of Fernando group. Underlies Pico formation and unconformably overlies Modelo formation.

J. E. Eaton, 1929 (Am. Assoc. Petroleum Geologists Bull., vol. 13, No. 7, p. 755). *Santa Paula formation.*—Consists of (1) heavy-bedded gray to blue arkosic sandstone, with lesser members of thin and medium-bedded sandstone and brown and blue clay; locally conglomeratic; 7,500 feet; (2) calcareous sandstone and brown and blue sandy clay; locally conglomeratic; 1,750 feet. Of Middle and Lower Pliocene age. Underlies Pico formation and overlies Santa Margarita formation.

Santa Susana shale.

Eocene (middle): Southern California (Ventura County).

B. L. Clark, 1924 (Pan-Pacific Sci. Cong., Australia, 1923, Proc., pp. 874–879). *Santa Susana formation.*—A formation only recently recognized and as yet differentiated only in region of Simi Valley, Ventura County. Richard Nelson, who has completed a monograph on Martinez of Simi Valley, proposes to call it Santa Susana formation. The beds referable to it had previously been mapped as part of the Martinez. Consists very largely of shale and shaly sandstones with heavy conglomerates at base. Thickness 1,000 to 1,500 feet. Fauna entirely different from that of the underlying Martinez and has very little in common with that of the unconformably overlying Meganos group, although it is more closely related to Meganos fauna than to Martinez fauna.

R. N. Nelson, 1925 (California Univ. Pub., Dept. Geol. Sci. Bull., vol. 15, No. 11, p. 401, map). *Santa Susana shale.*—Predominantly light-gray shale with some fine-grained sandstone and a lens of conglomerate at the base toward its eastern end. Sporadic boulders of quartzite up to 6 inches in diameter have been found in both sandstone and shale. [Thickness not stated.] Grades into upper shale of underlying Martinez group and into overlying Domengine formation. Is of middle Eocene age. Occurs east of the main fault south of Simi Valley. Fauna includes several distinctive genera, such as *Corbis* and *Velates*, which are new to the Eocene of California. Other forms are closely related to those in the Meganos but distinct from any known in the Martinez. Named for its occurrence in proximity to town of Santa Susana.

San Timoteo beds.

Pliocene (upper): Southern California (San Jacinto quadrangle, Riverside County).

C. Frick, 1921 (California Univ. Pub., Dept. Geology Bull., vol. 12, pp. 283–288). Great thickness of beds of late Pliocene age, coarser than the Eden beds, the upper division of the lower Pliocene in this region, and containing vertebrate fossils which correlate in general way with the Blanco of Texas. Occur in San Timoteo Canyon area.

Saragossa quartzite.

Probably Silurian or Devonian: Southern California (San Bernardino Mountains).

F. E. Vaughan, 1922 (California Univ. Pub., Dept. Geol. Sci. Bull., vol. 13, No. 9, pp. 344, 352–363, map). At least 3,500 feet of rocks (upper limit unknown) consisting (in descending order) of

1. Very heavy-bedded saccharoidal quartzites containing occasional strata of schist.
2. Series of soft biotite and muscovite schists.
3. Saccharoidal quartzite, cross bedded.
4. Schists, 200 feet thick, rather thin bedded and varying from fine biotite schist to coarse gritty quartz-biotite schist; toward top free from dark constituents.
5. Quartzite pebble conglomerate. Several feet.
6. White and pink quartzite, so recrystallized as to have lost all semblance of original clastic structure, 120 feet.
7. Soft decomposed biotite schist, 50 feet.

Is intruded by granites. Grades downward into Furnace limestone.

Named for Saragossa Spring, San Bernardino County, around which it is well developed.

"Sauer Dough."

A local sand bed, about 10 feet thick, in the Vaqueros sandstone of the Coalinga district. It is the uppermost sand in some wells along the western edge of sec. 22, T. 19 S., R. 15 E., and lies about 40 feet above the "Pulaski sand."

Saugus formation.

Upper Pliocene and lower Pleistocene: Southern California (Los Angeles County).

O. H. Hershey, 1902 (Am. Geologist, vol. 29, pp. 349–372). Great series, 2,000 feet thick, of unlithified sand, gravel, and clay, stratified, waterworn, and water deposited. Is an alluvial deposit, a river delta progressively sinking. Splendidly exposed in railway cuts in Soledad Canyon near Saugus, Los Angeles County. Conformably overlies Soledad division.

W. S. W. Kew, 1923 (Am. Assoc. Petroleum Geologists Bull., vol. 7, pp. 411–420) and 1924 (U. S. Geol. Survey Bull. 753, p. 81). The Saugus formation was first recognized by Hershey as the "Saugus division of the upper Pliocene series." In previous reports the Saugus deposits have been included in the Fernando formation, of which they constitute the upper unconformable part. In this report the Saugus deposits are treated as a distinct formation and the Fernando is made a group. In most places the Saugus formation rests unconformably on the Pico, the lower formation of the Fernando group, and is unconformably overlain by Pleistocene terrace deposits.

The typical Saugus deposits are nonmarine, but to the west contemporaneous marine beds are included in the formation.

Sausalito chert.

Jurassic (?): Western California (San Francisco region).

R. Arnold, 1902 (Science, new ser., vol. 15, table on p. 416). Sausalito cherts, radiolarian, 900 feet thick. [Shown in table as underlying Marin sandstone and overlying Bolinas sandstone.] A subdivision of the Franciscan.

A. C. Lawson, 1903 (Geol. Soc. America Bull., vol. 13, table on pp. 544–545). [Same as above.]

A. C. Lawson, 1914 (U. S. Geol. Survey Geol. Atlas, San Francisco folio, No. 193). Radiolarian chert, prevailingly dull brownish red, especially in thicker and more evenly bedded portions, but includes some rock of yellow, green, and other colors, interbedded with thousands of thin layers of shale. Underlies Marin sandstone and overlies Cahil sandstone. Included in Franciscan group.

Named for exposures west of town of Sausalito, on Marin Peninsula, Marin County.

Sentinel dolomite.

Lower Paleozoic (?): Southeastern California (Inyo County).

See under *Telescope group*. Derivation of name not stated.

Sentinel granodiorite.

Probably Cretaceous: Yosemite National Park.

F. C. Calkins, 1930 (U. S. Geol. Survey Prof. Paper 160, p. 125, map). Is less uniform in composition than most of the other intrusive bodies. In western part of the zone crossed by Yosemite Valley the rock is relatively light-colored and homogeneous, but in the eastern part of the valley it is darker and more streaky and contains many dark inclusions. Constitutes greater part of both walls of Yosemite Valley from the Three Brothers nearly to the Royal Arches and from the Fissures eastward to Glacier Point. Is oldest known formation of Tuolumne intrusive series. Next older than Half Dome quartz monzonite, and generally contains more biotite and hornblende than the Half Dome.

Named from fact that it composes Sentinel Rock, Yosemite National Park.

Sespe formation.

Oligocene and lower Miocene (?): Southern California (Ventura County).

W. L. Watts, 1897 (California State Min. Bur. Bull. 11, pp. 22–38). *Sespe brownstone formation.*—Consists of sandstone, shales, and conglomerate, all more or less brown. Is widely exposed in Sespe district. Underlain, with apparent conformity, by white sandstone, and overlain, also with apparent conformity, by drab sandstone. Is of Tertiary age, and younger than rocks containing Eocene fossils and older than beds containing Miocene fossils.

W. S. W. Kew, 1924 (U. S. Geol. Survey Bull. 753). *Sespe formation.*—Nonmarine red, brown, and yellow conglomerate and sandstone with interbedded shale. Corresponds to the Sespe brownstone formation of Watts. Thickness 3,500 feet at type locality on Sespe Creek, in the northwest part of the Camulos quadrangle. Ranges up to 4,000 feet or more. Conformably underlies the marine Vaqueros formation (with true Vaqueros—*Turritella inezana*—fauna), and unconformably overlies the marine Tejon formation. The top 500 feet of the Tejon consists of light-gray sandstone with some shale and corresponds to the "white sandstone" of Watts. The Vaqueros corresponds to the "drab sandstone" of Watts. The typical Sespe corresponds to the middle member only of the Sespe formation of G. H. Eldridge and R. Arnold, as mapped and described in United States Geological Survey Bull. 309, 1907.

The Sespe formation and the overlying and underlying formations are exposed in the gorge of Sespe Creek near the entrance of Tar Creek and in the region that extends eastward between the waters of Tar and Little Sespe Creeks.

Shasta series.

Lower Cretaceous: California and Oregon.

W. M. Gabb, 1869 (California Geol. Survey, Paleontology, vol. 2, pp. vii, xiv, 129, 133).

A provincial series term applied to the lower part of the marine Cretaceous rocks as developed on the Pacific coast. These rocks are now divided into the Horsetown formation above and the Knoxville formation below and are unconformably overlain by the Chico formation and unconformably underlain by the Franciscan formation.

Named for development of the rocks in Shasta County.

"Shasta-Chico series."

Lower and Upper Cretaceous: California and Oregon.

J. S. Diller, 1893 (Geol. Soc. America Bull., vol. 4, pp. 205–224). "An essentially conformable and continuous series of sediments formed without a distinct interruption. For this series Mr. [T. W.] Stanton and I have agreed to use the name Shasta-Chico series." Includes Chico, Horsetown, and Knoxville formations, or all of the known Cretaceous of California.

Shastan. See *Shasta series*.

Shoofly formation.

Mississippian: Northern California (Taylorsville region).

J. S. Diller, 1892 (Geol. Soc. America Bull., vol. 3, pp. 370–394). *Shoo Fly beds.*—Thickness 8,600 feet. Contain a limestone which crops out on Clear Creek, about 2 miles southeast of Shoo Fly Bridge.

J. S. Diller, 1908 (U. S. Geol. Survey Bull. 353). *Shoo Fly formation.*—Mainly clay slates above and quartzite below. The slates are light to dark gray, generally dull, but sometimes silky and in places slightly micaceous, and contain occasional films of gray or black flinty material as well as thin beds of sandstone and fine conglomerate of quartz pebbles. Here and there are traces of beds composed exclusively of volcanic fragments, some of which are clearly vesicular. Near middle are limestone lentils, some over 50 feet thick. The quartzites that prevail in the upper part are thin bedded, somewhat slaty, and indistinctly schistose, with micaceous partings. Thickness 6,800± feet. Everywhere separated from the underlying Arlington formation by the Taylor meta-andesite. Is older than the Peale formation, but relations not determined.

Named for exposures in road between Shoo Fly Bridge and Spanish Creek, Taylorsville region.

"Siebert" formation.

Miocene (upper): Southern Nevada.

S. H. Ball, 1907 (U. S. Geol. Survey Bull. 308, pp. 27, 32–34, map). *Siebert lake beds.*—Thick masses of sediments occur in the majority of the ranges of the area [southwestern Nevada and Inyo County, eastern California], and on lithologic and stratigraphic grounds are correlated with the Siebert lake beds, of Miocene age, at Tonopah, described by Spurr. These tuffaceous sandstones and conglomerates, largely composed of rhyolitic material, reach an observed maximum (in Amargosa Range) of 1,150 feet. Are unconformably underlain by rhyolite and unconformably overlain by rhyolite. In southern Klondike Hills and the Silver Peak Range the Siebert lake beds are interbedded, without erosional unconformity, with rhyolites and siliceous latites and dacites. [As above defined and mapped Ball's Siebert lake beds include the Fraction rhyolite breccia, which is not a part of the Siebert tuff of Spurr.]

The Siebert formation of F. L. Ransome (U. S. Geol. Survey Bull. 303, 1907, and Prof. Paper 66, 1909) in the Goldfield district, Nev., also included the Fraction rhyolite breccia and is therefore a larger unit than the Siebert tuff as originally defined by Spurr. Siebert in this broad sense has been abandoned by the United States Geological Survey, being the same as the older name, Esmeralda formation.

Sierra Blanca limestone.

Eocene (upper): Southern California (southern part of Santa Ynez quadrangle, Santa Barbara County).

R. N. Nelson, 1925 (California Univ. Pub., Dept. Geol. Sci. Bull., vol. 15, No. 10, pp. 350, 352–354, pl. 46, map). Remarkably pure massive, almost white foraminiferal limestone, its upper 10 or 15 feet grading into medium to fairly coarse grained gray sandstone interbedded with gray shales. Thickness 0 to 200 feet. In Indian Canyon it is 200 feet thick. Decreases in thickness to the east and disappears a little over a mile west of Mono Creek. Rests conformably on Mono shale. On south side of San Rafael Mountains it is overlain by 25 feet of massive maroon-gray to gray shale of Eocene age. It is also unconformably overlain by Miocene strata. Is conspicuously exposed on south side of Sierra Blanca Mountain, 1½ miles southwest of Loma Pelona.

Sierran.

Pliocene and Quaternary: Time term.

J. Le Conte, 1899 (Jour. Geology, vol. 7, pp. 525–544). Name proposed to replace Ozarkian (preoccupied), applied to "a time of general uplift and erosion, longer than both the Glacial and the Champlain put together. * * * In eastern part of continent the Ozarkian grades into the Tertiary. In Sierra Nevada it is sharply marked off from the Tertiary. That it belongs to the Quaternary is certain."

O. H. Hershey, 1902 (Am. Geologist, vol. 29, pp. 88–95). "The term Sierran is not the equivalent and can not properly replace the term Ozarkian. As I understand Le Conte, Sierran is derived from the cañons of the Sierra Nevada region and its definition may be given as the designation of that period during which these cañons were in process of formation. * * * Under Le Conte's definition Sierran apparently covers at least part of the Ozarkian or preglacial portion of the Pleistocene, and nearly the whole of the Glacial period as the latter has been established in the Eastern States and Europe. * * * I have avoided applying the term Ozarkian in California because, the Glacial period being so very imperfectly represented here, I could not distinguish the work of the Ozarkian from that of later time."

O. H. Hershey, 1902 (California Univ. Pub., Dept. Geology Bull., vol 3, pp. 1–29). Divides Le Conte's Sierran period into (descending order):

- Erosion epoch not named.
- San Pedran epoch (deposition). "May be approximately equivalent to Iowan."
- Los Angelan epoch (erosion).
- Red Bluff epoch (deposition).
- Santa Claran epoch (erosion).

J. P. Smith, 1910 (Jour. Geology, vol. 18, No. 3, p. 227), divided Quaternary of California into (descending order) Terrace epoch, Champlain epoch, and Sierran epoch (including Glacial and pre-Glacial).

J. E. Eaton, 1928 (Am. Assoc. Petroleum Geologists Bull., vol. 12, p. 119), divided the Pleistocene of California into (descending order) Champlain, Glacial, Sierran, and Pedroian.

Siesta formation.

Pliocene: Western California (San Francisco region).

A. C. Lawson and C. Palache, 1902 (California Univ. Pub., Dept. Geology Bull., vol. 2, pp. 384–390, map). *Siestan formation.*—Fresh-water conglomerates, sandstones, and shales, with lignites, clays, limestone, chert, and tuff. Included in Upper Berkeleyan. Overlies in places Grizzly Peak andesite and underlies in places a fresh-water limestone member of the Upper Berkeleyan.

A. C. Lawson, 1914 (U. S. Geol. Survey Geol. Atlas, San Francisco folio, No. 193). *Siesta formation.*—Lake beds. [Same lithology as above.] Thickness 200 feet. Underlies Bald Peak basalt and overlies Moraga formation. Middle formation of Berkeley group.

Named for development in Siesta Valley, Berkeley Hills.

"Siestan" formation. See *Siesta formation.*

Silver Peak group.

Lower Cambrian: Southern Nevada and Inyo County, Calif.

H. W. Turner, 1902 (Am. Geologist, vol. 29, pp. 261–272). *Silver Peak formation.*—Lower Cambrian rocks consisting, in the mountains north of Clayton Valley, Esmeralda County, Nev., in ascending order, of (1) massive dolomite, (2) massive green quartzite, (3) knotted schists, (4) *Archeocyathus* limestone and green *Olenellus* slate with dark limestone and some quartzite and thin-bedded slate near the top of the series. Also exposed in Silver Peak Range, Esmeralda County, Nev. Unconformably overlain by Upper Cambrian rocks designated as Emigrant formation. Rests on Algonkian rocks. According to C. D. Walcott's division line between Cambrian and Algonkian, items 1, 2, and 3 of the section north of Clayton Valley would belong to the Algonkian, but they are here included in the Lower Cambrian. Thickness not given.

The Silver Peak deposits are regarded as divisible into two or more formations and hence have been called Silver Peak group and Silver Peak "series." They have been identified, with a thickness of 7,000 feet, by E. Kirk (U. S. Geol. Survey Prof. Paper 110, pp. 28–30, 1918) in the Inyo Range, Calif. C. D. Walcott also identified them in the Inyo Range in 1908.

"Silver Terrace" sandstone.

Jurassic (?): Western California (San Francisco).

R. Crandall, 1907 (Am. Philos. Soc. Proc., vol. 46, pp. 3–58). Sandstones, with some shales, tuffs, and lignites. Thickness 500 feet. Forms the Silver Terrace Hills, in the eastern part of the city of San Francisco. Is older than the Telegraph Hill sandstone. In places is overlain by the upper jasper bed. Is a part of the Franciscan.

A. C. Lawson (U. S. Geol. Survey Geol. Atlas, San Francisco folio, No. 193, 1914) mapped this sandstone as Marin sandstone.

Simi conglomerate.

Eocene (lower): Southern California (Ventura County).

R. N. Nelson, 1925 (California Univ. Pub., Dept. Geol. Sci. Bull., vol. 15, No. 11, pp. 400–401, map). A very persistent conglomerate of well-rounded pebbles and boulders of all sizes up to 1 foot in diameter, in a matrix of coarse-grained arkosic sandstone. Occasionally, especially near top, there are lenticular beds of sandstone varying in thickness from 6 inches to several feet. The pebbles are chiefly quartzite, but granite and rhyolite pebbles are abundant, and the formation also contains pebbles of diorite, sandstone, gneiss, and schist. Thickness few feet to 800 feet on west side of the faults south of Simi Valley, with a maximum of about 1,500 feet east of the main fault. Is the basal formation of Martinez group (lower Eocene). Rests unconformably on Chico formation. Grades vertically and laterally into the overlying Las Virgenes sandstone. Named for occurrence on the flanks of Simi Hills, Ventura County.

Sobrante sandstone.

Miocene (lower): Western California (San Francisco region).

A. C. Lawson, 1914 (U. S. Geol. Survey Geol. Atlas, San Francisco folio, No. 193). Sandstone, somewhat variable in character, but prevailingly fine grained and light colored, though it shows local ferruginous staining. Some beds are gritty and some flaggy. Near base a bed of volcanic ash that ranges in thickness from a few inches to 20 or more feet. Is basal formation of Monterey group. Thickness 400 feet. Underlies Claremont shale and unconformably overlies Tejon formation. Named for exposures on Sobrante Ridge, Contra Costa County.

In 1918 (California Univ. Pub., Dept. Geology Bull., vol. 11, No. 2, pp. 54–111) B. L. Clark proposed to restrict the name Sobrante sandstone to the upper 80 to 100 feet of Lawson's Sobrante sandstone, or to the beds containing the *Arca montereyana* fauna, and to transfer the lower (and unconformable) part to the San Lorenzo (Oligocene) or *Agasoma gravidum* zone.

"Soledad division."

Miocene (upper): Southern California (Los Angeles County).

O. H. Hershey, 1902 (Am. Geologist, vol. 29, pp. 349–372). Gravel and sand, chiefly granitic, with lava pebbles and cobbles less abundant than in the Lang division, and finer and more evenly bedded. Supposed to be marine. Thickness 3,000 feet. Conformably underlies Saugus division and conformably overlies Lang division.

W. S. W. Kew, 1924 (U. S. Geol. Survey Bull. 753, p. 81). The "Soledad division" of Hershey is now thought by the writer to be equivalent, in greater part at least, to the upper part of the Mint Canyon formation (upper Miocene) of this report.

Named for exposures in Soledad Canyon, near Saugus, Los Angeles County.

Soledad group.

Miocene (lower) or Oligocene: Southern California (Los Angeles County).

D. S. Jordan, 1919 (Leland Stanford Junior Univ. Pub., Univ. ser., Fossil fishes of southern California, pp. 3–5). *Soledad group.*—Sandstones and shales; the sandstones of pale yellow color, also soft white sandstones and rather fine white shaly sandstone. Considerably older than the diatomaceous deposits referred to Monterey, which are sometimes segregated under the name Puente. The fish fauna is older than Monterey and of lowest Miocene or possibly of Oligocene age. Well developed about Soledad Pass, in the extreme northern part of Los Angeles County, about 40 miles north of Los Angeles.

Sonoma group.

Pliocene: Northern California (north of San Francisco Bay region).

R. E. Dickerson, 1922 (California Acad. Sci. Proc., 4th ser., vol. 11, No. 19, maps). Basalts, andesites, rhyolites, tuff breccia, fine-grained tuff, and other agglomerates. Generalized section running north from Adobe Fort to Petaluma Reservoir shows following sequence, in descending order: Basalt, tuff, basalt, conglomerate, basalt, *Neohipparion gidleyi* beds, and tuff, resting unconformably on Petaluma formation. Includes the Sonoma tuff, Mark West andesite, and St. Helena rhyolite of Osmont. Is overlain by Millerton formation. In Pinole syncline is known as Pinole tuff. The tuffaceous facies of Sonoma group are represented as interbedded tuff members of marine Merced group.

Named for typical exposures on western flanks of Sonoma Mountains, Sonoma County.

Sonoma tuff.

Pliocene: Northern California (Sonoma County).

V. C. Osmont, 1904 (California Univ. Pub., Dept. Geology Bull., vol. 4, pp. 39–87). *Sonoma tuff.*—Andesitic in character and interbedded with thin flows of basalt, and with sandstones and volcanic conglomerates, to the west, where it is of fluviatile origin. To east interbedded with volcanic agglomerates and breccias and largely of eolian origin. Rests conformably on Mark West andesite. Thickness 1,700 feet.

Probably named for exposures in Sonoma Mountains, Sonoma County.

Sour Dough limestone.

Lower Paleozoic (?): Southeastern California (Inyo County).

See under *Telescope group*. Exposed in Sour Dough Canyon.

" Spanish formation."

Mississippian: Northern California (Lassen Peak region).

J. S. Diller, 1892 (preliminary proof-sheet edition of Lassen Peak folio, No. 15, of U. S. Geol. Survey Geol. Atlas). Chiefly quartzites and slates with occasional lenses of limestone. Has yielded no fossils. Is younger than Caribou formation and older than Arlington formation. Named from fact it surrounds the northern end of Spanish Peak.

In the published Lassen Peak folio (No. 15) these rocks are mapped and described as Calaveras formation.

" Staran series."

Triassic (Upper?): Humboldt County, Nev.

C. [R.] Keyes, 1923 (Pan-Am. Geologist, vol. 40, pp. 52, 59). " The great Star Peak limestone, or *Staran series*, of the Humboldt Mountains, reported to be more than 5,000 feet in thickness." [Thickness assigned by Keyes 3,000 feet.] Unconformably below Jurassic Lovelockian series and above Koipatoan series. Of late Triassic age.

Named for exposures in Star Peak Mountain, Humboldt County, Nev.

" Stewartsville group."

Eocene: Western California.

B. L. Clark, 1918 (Geol. Soc. America Bull., vol. 29, p. 94).

Synonym of Meganos printed through inadvertence.

Stonewall quartz diorite.

Jurassic (" post-Triassic and pre-Cretaceous "): Southern California (Cuyamaca region, San Diego County).

F. S. Hudson, 1922 (California Univ. Pub., Dept. Geol. Sci. Bull., vol. 13, No. 6, pp. 181, 191–193, map). Named after Stonewall Peak, which is composed of this rock, which is intrusive into Julian schist.

" Suisun marble."

Age unknown: Western California (Solano County).

J. D. Whitney, 1865 (California Geol. Survey, vol. 1, p. 104). North of Suisun commences another series of hills, which has received the name of the " Pelevo Hills," at their southeastern end, but which extend northwest and become merged in the chain known as the " Vacca Mountains," which is the name given to the ridges here bounding the Sacramento Valley on the western side. The Pelevo Hills are made up of Cretaceous strata. The well-known " Suisun marble " occurs in these sandstones and is evidently a deposit from calcareous springs. It is a deep brownish-yellow color with a banded structure.

A local deposit of travertine of unknown age.

" Superjacent series."

A descriptive term used in folios and other early reports on the Gold Belt region of northern California, to include the Cretaceous, Tertiary, and Quaternary deposits, in contradistinction to the " Bedrock series," a term applied to the underlying Jurassic, Triassic, and Carboniferous formations.

Sur series.

Pre-Franciscan (possibly pre-Cambrian): Southern California (Southern Coast Ranges).

P. D. Trask, 1926 (California Univ. Pub., Dept. Geology Bull., vol. 16, No. 6). *Sur series*.—The term Santa Lucia series was first applied to the crystalline complex of the Santa Lucia Range by J. P. Smith in 1909 (Science, new ser., vol. 30, p. 347). [Name used but not defined in publication cited.] The name

Santa Lucia, however, had been previously applied by Lawson (1893) to the granite at the north end of Santa Lucia Range. It is very evident that the crystalline schists comprise a sedimentary series deposited prior to the intrusion of the quartz diorite. At present both a series of sediments and the granite which intrudes them bear the same name. A new name should be applied to the schists, since, by priority, the name Santa Lucia should be given to the granite and quartz diorite. The name Sur series is proposed as a comprehensive name for the schist series of the southern Coast Ranges, which is particularly well developed along Sur River. Age unknown. No fossils have yet been found in this series. It is intruded by the Santa Lucia quartz diorite, of pre-Chico age. It consists chiefly of sedimentary rocks now metamorphosed into quartzites, marbles, mica schists, paragneisses, and in part into injection gneiss. It includes the crystalline limestones that have been named Gabilan limestone.

Surprise formation.

Lower Paleozoic(?): Southeastern California (Inyo County).

F. MacMurphy, 1930 (Econ. Geology, vol. 25, pp. 309–311, map). *Surprise formation.*—A series of predominantly fine-textured flaggy or slaty rocks which occupy an irregular strip of country on west side of Panamint Range. Prevailing rock types are conglomerate schist, actinolite schist, ottrelite sch'st, quartz-sericite schist, slate, phyllite, quart-biotite-tourmaline schist, metamorphosed sandstones, and grits, and a few beds of brown limestone, and there exist all gradations and combinations of these rocks. Though bedding is not often seen, it is frequently suggested, and there can be no doubt as to sedimentary origin. Overlies Marvel dolomitic limestone, usually with gradation from a true limestone to a true schist for a distance of from 5 to 30 feet. Underlies Sour Dough dolomitic limestone with nonconformity. Exposed along Surprise Canyon.

Sutter formation.

Eocene(?): Northern California (Marysville Buttes region, Sutter County).

R. E. Dickerson, 1916 (California Univ. Pub., Dept. Geology Bull., vol. 9, pp. 404–406). Chiefly rhyolitic ash, rhyolitic tuff breccia, thin flows of rhyolite, and conglomerate containing rhyolitic and quartz pebbles. Thickness 500 to 600 feet. Rests with marked unconformity on Chico and on Tejon. Is overlain unconformably by lava flows and mud flows that consist of andesitic material. Included in upper part of Ione formation as mapped in Marysville folio of United States Geological Survey, which also included Tejon and Chico rocks. Named for occurrence in Sutter County, in what is now known as the Marysville Buttes (formerly Sutter Buttes).

Howel Williams, 1929 (California Univ. Pub., Dept. Geol. Sci. Bull., vol. 18, pp. 112, 129+). *Sutter formation.*—Predominantly washed rhyolite tuffs below and andesite tuffs above, admixed with sands, clays, and gravels. Thickness 500 to 1,000+ feet. Overlies Butte gravels and is overlain, with erosion unconformity, by intrusive andesite porphyry. Assigned to Miocene and Pliocene(?). "Dickerson's original description of Sutter beds calls for drastic revision. Essentially the Sutter formation is the detrital equivalent of the Tertiary rhyolitic and andesitic deposits of the Sierra Nevada, admixed with sediments that are the equivalents in age of the six auriferous gravels of the intervolcanic period of the Sierra. Although the Sierra was unquestionably the chief source of the Sutter beds, it is likely that part of the sediments was also derived from the Coast Ranges. * * * Its volcanic materials appear to be entirely pyroclastic and free from lava flows, and there is nothing in the formation to suggest a derivation from local vents, as Dickerson has supposed. * * * The most notable and persistent feature of the Sutter formation is the regularity and prominence of its banding." Most complete and typical section is along West Butte Pass, adjacent to road bridge that lies due south of South Butte.

Swearinger slate.

Upper Triassic: Northern California (Taylorsville region).

J. S. Diller, 1892 (Geol. Soc. America Bull., vol. 3, pp. 370–394). Dark calcareous slates with thin blue limestones and some siliceous layers. Thickness 200 feet, Includes *Halobia* bed, *Rhabdoceras* bed, and *Monotis* bed [zone of *Pseudomonotis subcircularis*]. Rests directly and unconformably on the Carboniferous Robinson formation. Believed to underlie Hosselkus limestone.

J. S. Diller, 1908 (U. S. Geol. Survey Bull. 353). Chiefly dark slaty shale, sometimes more or less calcareous and at other times decidedly siliceous, but the thin beds of limestone or chert form only a small proportion of the whole mass. In the side of the slate adjoining the Hosselkus limestone thin lenticular beds of limestone become more abundant. They are generally dark, with irregular cherty or sandy layers, and are fossiliferous. Thickness 200 feet. Is underlain (not overlain, as originally supposed) by Hosselkus limestone, with which it is conformable, but in places it rests on the older Robinson formation. Is overlapped by Trail formation. [Is approximate equivalent of Brock shale.]

Named for fact that it occurs just above Swearinger's house, on north side of Genesee Valley, Plumas County.

Taft granite.

Probably Cretaceous: Yosemite National Park.

F. C. Calkins, 1930 (U. S. Geol. Survey Prof. Paper 160, p. 122, map). Nonporphyritic biotite granite, of even, medium-coarse grain. Consists chiefly of white feldspar and smoky-gray quartz in grains mostly about 5 millimeters in diameter. Is younger than El Capitan granite.

Named from fact that it composes Taft Point, Yosemite National Park.

Tamarack formation.

Term applied by O. H. Hershey (Am. Geologist, vol. 27, p. 226, 1901) to the gabbro in the Klamath Mountain region of northern California.

Tank volcanics.

Quaternary(?): Southern California (Kern County).

A. C. Lawson, 1906 (California Univ. Pub., Dept. Geology Bull., vol. 4, pp. 431–462). Andesitic lava flows and tuffs, best exposed in vicinity of the railway tank 2 miles below Tehachapi station, on Tehachapi Creek. Older than Cable formation and younger than Atlas formation.

"Tassajara lake(?) bed." [U. S. Geographic Board has adopted spelling Tassajero.]

Pliocene (probably): Western California (Alameda County).

J. G. Cooper, 1894 (California Acad. Sci. Proc., 2d ser., vol. 4, p. 170). *Tassajara lake(?) bed.*—Along a small branch of Walnut Creek, in Alameda County, north of Livermore, is a deposit which contains chiefly living species and was formerly called Quaternary, but one extinct species has been described from there, and its high elevation, nearly corresponding with the Contra Costa lake bed, makes it probable that it may better be called Pliocene. [Fossils listed.]

Probably named for exposures on Tassajero Creek, Alameda and Contra Costa Counties.

Taylor meta-andesite.

Mississippian: Northern California (Taylorsville region).

J. S. Diller, 1908 (U. S. Geol. Survey Bull. 353). Green, in places slaty meta-andesite, more than 1,000 feet thick. Occurs as lava flows, tuffs, and volcanic conglomerate. Conformably overlies Arlington formation and conformably underlies Shoofly formation.

Named for exposures around Taylor Rock.

Taylorsville formation.

Devonian: Northern California (Taylorsville region).

J. S. Diller, 1892 (Geol. Soc. America Bull., vol. 3, pp. 370–394). *Taylor[s]ville slates,* 1,800 feet thick. Older than Arlington beds and younger than Montgomery limestone.

J. S. Diller, 1908 (U. S. Geol. Survey Bull. 353). *Taylorsville formation.*—Chiefly slates and thin-bedded sandstones, among which there are numerous small layers of fine black chert or occasional less regular masses of red chert, but at base there is locally a fine greenish-gray conglomerate with indistinct pebbles, and near middle well-defined beds of light-colored quartzite. Thickness 1,800 feet. Rests with probable unconformity on Montgomery limestone. Is older than Arlington formation, from which it is separated by granite. Fossils not distinctive, but formation is believed to be Devonian.

Named for exposures on eastern face of the spur above the limestone about a mile south of Taylorsville, Plumas County.

Taylorville slates. See *Taylorsville formation.*

Tecuja beds. See *Tecuya beds.*

Tecuya beds.

Miocene (lower) : Southern California (San Joaquin Valley).

C. Stock, 1920 (California Univ. Pub., Dept. Geology Bull., vol. 12, No. 4). *Tecuja beds.*—Landlaid beds in which red sandstones and shales are most striking lithologic members, but lavas and tuffs are also present. Rests unconformably on Tejon formation in the immediate vicinity of Tecuja [Tecuya] Canyon, in the lower part of the San Joaquin Valley, and is overlain, without evidence of unconformity, by Monterey marine deposits presumably with a Vaqueros fauna. The beds may be contemporaneous with a part of the Sespe formation or may belong to Monterey series.

B. L. Clark, 1921 (Jour. Geology, vol. 29, pp. 586–614; and First Pan-Pacific Sci. Conference Proc., pt. 3, pp. 801–818). The *Tecuja beds* are continental deposits intercalated in the marine Vaqueros group, and it seems to the writer that they are of lower Miocene age, rather than upper Oligocene.

Tehachapi marble.

Southern California (Kern County).

H. G. Hanks, 1886 (California State Min. Bur. Sixth Ann. Rept., pt. 1, p. 23). A large deposit of yellow brecciated marble half a mile from the town of Tehachapi, Kern County, on the road to Caliente, also 9 miles west of Tehachapi, in Bright's Valley.

Tehachapi formation.

Quaternary (?) : Southern California (Kern County).

A. C. Lawson, 1906 (California Univ. Pub., Dept. Geology Bull., vol. 4, pp. 431–462). A great body of postlacustrine coarse alluvium in fresh undecomposed condition, only slightly cemented. Thickness 250 feet. Younger than Cable formation.

Probably named for occurrence near town of Tehachapi and in Tehachapi Creek Valley.

Tejon formation.

Eocene (upper) : Western California.

W. M. Gabb, 1869 (California Geol. Survey, Paleontology, vol. 2, p. xiii, as reported by J. D. Whitney from an unpublished paper by Gabb, and footnote by Gabb on p. 129). Division B of the Cretaceous of previous California reports is here named the Tejon group, from the locality where it is most strongly developed. This division of the Cretaceous is peculiar to California. Is found most extensively developed in vicinity of Fort Tejon and about Martinez. From latter locality it forms an almost continuous belt in the Coast Ranges to Marsh's, 15 miles east of Monte Diablo, where it sinks under San Joaquin plain. It was also discovered at various points in eastern face of same range as far south as New Idria, and in summer of 1866 by Mr. Gabb, in Mendocino County, near Round Valley, the latter locality being the most northern point at which it is as yet known. Is the only coal-producing formation in California. Contains a large and highly characteristic series of fossils, the larger part peculiar to itself, while a considerable percentage is found extending below into the next [Martinez] group, and several species still further down into the Chico group. [On p. 147 Gabb mentions "beds intermediate between Tejon group and Martinez group west of town of Martinez," but no such beds are mentioned in connection with the definitions of Tejon or Martinez.]

In 1918 (Geol. Soc. America Bull., vol. 29, pp. 94, 281) the name Tejon formation was restricted by B. L. Clark to the upper part of the Tejon of previous usage, or to the beds containing a "typical Tejon fauna," the unconformably underlying beds being named Meganos "group." The United States Geological Survey uses this restricted definition of Tejon formation. The Eocene age of the Tejon formation has long been recognized.

Named for occurrence in vicinity of Fort Tejon, Kern County.

"Telegraph Hill" sandstone.

Jurassic (?): Western California (San Francisco).

R. Crandall, 1907 (Am. Philos. Soc. Proc., vol. 46, pp. 3–58). Sandstones and shales very similar to the older San Bruno sandstone of the Franciscan. Thickness 800 to 1,000 feet. Is topmost formation of Franciscan or Golden Gate series. At the Potrero the formation rests on the jaspers of the Franciscan, which overlie the San Bruno sandstone. Named for exposures at Telegraph Hill, San Francisco.

A. C. Lawson (U. S. Geol. Survey Geol. Atlas, San Francisco folio, No. 193, 1914) mapped this sandstone as Marin sandstone.

Telescope group.

Lower Paleozoic (?): Southeastern California (Inyo County).

F. MacMurphy, 1930 (Econ. Geology, vol. 25, p. 311 and map). *Telescope group.*—Consists of seven mapped units (in descending order)—Redlands dolomitic limestone, Radcliff formation, Sentinel dolomite, Wildrose formation, Mountain Girl conglomerate quartzite, Middle Park formation, and Sour Dough dolomitic limestone. The Mountain Girl conglomerate quartzite overlies Middle Park formation with disconformity (?), and the Sour Dough limestone nonconformably overlies Surprise formation. The names of these formations are derived from geographic terms used in this part of Panamint Range. The rocks have nearly all been metamorphosed to some degree. In absence of diagnostic paleontologic evidence the age of all formations is open to question. Tentative assignment to Lower Paleozoic has been made largely on lithologic grounds. The rocks are undeformed.

Temblor formation.

Miocene (middle): Southern California (Kern County).

F. M. Anderson, 1905 (California Acad. Sci. Proc., 3d ser., vol. 2, pp. 168–187). *Temblor beds.*—The entire series of Miocene sands and shales below the Monterey shales in the Mount Diablo Range. Thickness 1,500 feet. Include (descending order):

"Button beds," 100 feet (sandy beds characterized by great numbers of small discoidal sea urchins, *Astrodapsis*).

Siliceous and clay shales with interstratified sandstone, 600 feet.

Sandstones with numerous fossil species, 800 feet.

Rest unconformably on Domijean sands. In some places there is a distinct overlapping of the Monterey shales beyond the borders of the Temblor beds. [Fossils listed.]

F. M. Anderson, 1908 (California Acad. Sci. Proc., 4th ser., vol. 3, pp. 1–40). *Temblor beds.*—Calcareous beds, clay shale, sands, and gravels, with a pebbly conglomerate at base and containing typical lower Miocene fossils. Thickness 450 to 550 feet. The "Reef bed" of former report [which was included in the "Coalinga beds"] is properly a part of the Temblor beds. Rest unconformably on Oligocene (?) organic shales, which in former report were thought to be Miocene and were called Monterey shales and which overlie the Domijean sands. Stratigraphically and faunally the "Vaqueros sandstone" agrees with the Temblor beds and is without doubt to be correlated with the Temblor of the Mount Diablo Range.

J. P. Smith, 1910 (Jour. Geology, vol. 18, No. 3). *Temblor sandstone.*—The type Temblor is younger than the type Vaqueros and carries a fauna like that of the Ocoya Creek beds. The Temblor fauna carries *Turritella ocoyana* and other fossils, while the older or type Vaqueros is characterized by the *Turritella* *inezana* fauna. The true Vaqueros is absent in the Coalinga region, the type section of the Temblor, and the true Temblor is absent in the Salinas Valley, the type region of the Vaqueros. The true Temblor underlies the diatomaceous Monterey shale.

F. M. Anderson, 1911 (California Acad. Sci. Proc., 4th ser., vol. 3, pp. 17+). *Temblor group.*—[Describes these deposits in the Kern River region and the part of the Diablo Range that is locally known as the Temblor Mountains.] Chiefly marine, but locally contains a fresh-water or brackish-water facies. Thickness ranges up to 1,760 feet. Correlates with Ocoya Creek beds. "If Monterey is present it can not be separated from the Temblor group." The more shaly portion is nearest the base and the beds become coarser toward the top, though clays are distributed throughout the column. Called "Vaqueros" by Arnold and others. Unconformably underlies Kern River group and rests unconformably on granite.

F. M. Anderson and Bruce Martin, 1914 (California Acad. Sci. Proc., 4th ser., vol. 4, pp. 31–51). *Temblor (Vaqueros) beds.*—[Gives details of the beds.] Thickness 500 to 2,500 feet in Temblor Basin and San Juan district. Uncomformably underlie Monterey shale [=Salinas shale] and unconformably overlie granite. "It has yet to be shown that the so-called Vaqueros beds of Salinas Valley are older in time than the Temblor deposits at the base of the Miocene in the Great Valley."

B. L. Clark, 1921 (Jour. Geology, vol. 29, pp. 586–614). The Monterey series contains two fairly distinct but closely related faunas, the upper the Temblor group or *Turritella ocoyana* zone, the lower the Vaqueros group or *Turritella inezana* zone. A very large percentage of the Vaqueros species is common to the Temblor. The marine Temblor includes the middle Miocene land formation locally known as the Big Blue. The Temblor group corresponds to the "Salinas shale" and "Monterey shale" of other reports but is older than the Maricopa shale and the Briones sandstone. In most places it unconformably overlies Vaqueros group and unconformably underlies Santa Margarita formation.

The present generally accepted definition of Temblor formation applies the name to the *Turritella ocoyana* zone, of middle Miocene age and younger than Vaqueros formation (*Turritella inezana* zone), of late lower Miocene age. Belongs to Monterey group.

Named for exposures on Temblor ranch, in the McKittrick district, Kern County.

Temescal formation.

Recent: Western California (San Francisco region).

A. C. Lawson, 1914 (U. S. Geol. Survey Geol. Atlas, San Francisco folio, No. 193). Secondary alluvium derived from the main alluvial embankment of the San Antonio formation in the course of its degradation and consisting of the same kind of material, namely, fragments of Mesozoic and Tertiary rocks. Thickness varies up to 13 feet. Rests unconformably on the marine Merritt sand, of Pleistocene age. Named for development along Temescal Creek, Alameda County.

Tequepis sandstone.

Miocene: Southern California (Santa Barbara County).

R. N. Nelson, 1924 (Geol. Soc. America Bull., vol. 35, pp. 166–167). Is top formation of Monterey series in upper Santa Ynez River region. Is younger than Salinas shale, and unconformably beneath Fernando Pliocene.

R. N. Nelson, 1925 (California Univ. Pub., Dept. Geology Bull., vol. 15, No. 10). Fine-grained light-gray feldspathic and tuffaceous sandstones, in places interbedded with thin layers of brown bituminous shale, and with 100 feet of diatomaceous shale at top. Is characterized by abundance of brown fish scales. Maximum thickness 1,000 feet. The massive cream-gray tuff that overlies the Salinas shale on the north side of Santa Ynez River one-half mile east of Redrock Canyon is considered to be a part of the Tequepis sandstone. The Tequepis is a unit of rather limited extent, overlying the Salinas shale in the western portion of the district along Santa Ynez River. Is top formation of Monterey group, which is unconformably overlain by Fernando Pliocene. Named for development on Tequepis rancho.

Thompson limestone.

Middle Jurassic: Northern California (Taylorsville region).

J. S. Diller, 1892 (Geol. Soc. America Bull., vol. 3, pp. 370–394). 10 to 30 feet of limestone, gray above and red below. "Its position everywhere appears to clearly indicate that it lies between the Mormon and Hardgrave sandstones."

J. S. Diller, 1908 (U. S. Geol. Survey Bull. 353). Gray and red limestone lentils in calcareous shale. Thickness 10 to 30 feet. Appears to conformably overlie Mormon sandstone. Rests on Fant meta-andesite, which in turn is younger than Hardgrave sandstone.

Named for exposures on Thompson's ranch, on west slope of Mount Jura, east of Taylorsville, Plumas County.

Tice shale.

Miocene (middle): Western California (San Francisco region).

A. C. Lawson, 1914 (U. S. Geol. Survey Geol. Atlas, San Francisco folio, No. 193). Bituminous shale, prevailingly chalky, in some places whitish, in others pinkish or yellowish. A formation of Monterey group. Overlies Oursan sandstone and underlies Hambre sandstone. Thickness 460 feet. Named for exposures along Tice Creek, in the Concord quadrangle.

Tightner formation.

Mississippian: Northern California (Colfax region).

H. G. Ferguson, 1929 (Am. Inst. Min. and Met. Eng. Tech. Pub. 211, p. 4). *Tightner formation.*—Almost entirely fine-grained greenish hornblende schist with varying amounts of quartz, probably for the most part secondary. Near the veins the schist is altered to talc schist. A small amount of quartzose mica schist and rare beds of glistening black slate are interbedded. Small lenses of coarsely crystalline white limestone occur here and there. Dominantly of volcanic origin. Thickness of formation probably 7,000 feet. Underlies, probably unconformably, Kanaka formation, and is believed to overlie Blue Canyon formation, but the two are in fault contact. Named for fact that it forms the principal wall rock of the Tightner mine. Extends from North Yuba to South Yuba.

Tolenas marble.

Probably late Tertiary or Quaternary: Western California.

W. L. Watts, 1890 (California State Min. Bur. Tenth Ann. Rept., pp. 668–669). Pure waxlike aragonite, the work of springs; quarried at Tolenas Springs, Solano County.

Tomales formation.

Upper Pleistocene: Western California (Marin and Sonoma Counties).

R. E. Dickerson, 1922 (California Acad. Sci. Proc., 4th ser., vol. 11, No. 19, maps). Largely land or stream-laid deposits, including terrace deposits containing a small but distinctive Pleistocene fauna and also probably material composing alluvial fans. In part of the area the formation consists of lignitic beds overlain by loosely consolidated tan-colored sandstones and conglomerates (or perhaps fanglomerates would be a better designation) of lighter color than the tan-colored sandstones of Millerton formation. A small estuarine fauna found in the upper beds indicates that during part of the time the region was occupied by a shallow bay. Rests unconformably (important break) on Millerton formation.

Named for occurrence on northeast side of Tomales Bay, where most of the headlands are thinly coated with the loosely consolidated sandstones and conglomerates of the formation.

Tomales Bay deposits.

Pleistocene: Western California (Marin County).

V. C. Osmont, 1904 (California Univ. Pub., Dept. Geology Bull., vol. 4, p. 76). *Tomales Bay deposits.*—According to Anderson, consist of coarse arkose detritus with indistinct horizontal stratification. Generally found in the larger depressions of the peninsula. Range in elevation from 500 feet downward. Form a series of low broad hills, extending along the middle of the valley near Olema, and occur at intervals on both shores of Tomales Bay, forming there a system of low benchlike terraces below 200 feet in height. West of the main ridge they are found in occasional patches around the flanks of the hills at the head of Drake's Estero and north of Abbott's Lagoon.

Topanga formation.

Miocene (middle): Southern California (Los Angeles County).

W. S. W. Kew, 1923 (Am. Assoc. Petroleum Geologists Bull., vol. 7, pp. 411–420). Name proposed to include the rocks lying below the Modelo formation and above the Vaqueros formation and containing the *Turritella ocoyana* fauna. The strata are essentially sandstone. Formerly included in the Vaqueros formation (now restricted to *Turritella inezana* fauna). Unconformably overlies true Vaqueros formation and in Topanga Canyon, Los Angeles County, is overlain with marked unconformity by the Modelo formation. [In U. S. Geol. Survey Bull. 753, 1924, Kew gives the thickness of the Topanga formation as 6,000 ± feet.]

"Topatopa formation."

Eocene: Southern California (Ventura County).

G. H. Eldridge, 1907 (U. S. Geol. Survey Bull. 309). The lowest formation outcropping in the mountains north of Santa Clara Valley. Total thickness unknown, but about 5,500 feet are exposed. This consists of very hard, submassive sandstones (light gray to white) and quartzites (greenish gray, clear or mottled with white); shales (of slightly bluish hue) that differ from the quartzites in carrying an additional content of mica and in the fineness of their material. The quartzites and sandstones greatly predominate in the lower 2,000 feet, and the shales predominate in the upper 2,500 feet. Quartzites also occur near the middle of the formation. The conspicuous features of the formation are a tendency to a broad concretionary structure in some of its members; the presence of smaller brown ferruginous sand concretions; the sparse distribution of fossil oysters and other imperfect molluscan remains through a great portion of its thickness, more particularly in the shales; some evidences of woody tissue; and a frequent recurrence of what appear to be fucoids. Underlies Sespe formation and probably rests on granite.

According to W. S. W. Kew (U. S. Geol. Survey Bull. 753, pl. 3) the "Topatopa formation" as above defined corresponds to the Martinez and Meganos formations of Bulletin 753, the deposits corresponding to the Tejon formation having been included in the overlying Sespe formation of Eldridge. The "Topatopa formation" of Arnold as described in United States Geological Survey Bulletin 321, 1907, corresponds to the Tejon, Meganos, and Martinez formations of present terminology, all of which Kew has differentiated and mapped in neighboring areas.

"**Toro**" formation.

Lower Cretaceous: Western California (San Luis Obispo region).

H. W. Fairbanks, 1904 (U. S. Geol. Survey Geol. Atlas, San Luis folio, No. 101). Dark thin-bedded clay shale, with thin irregular layers of conglomerate at bottom and near middle. Thickness about 3,000 feet. Unconformably underlies Chico deposits and unconformably overlies Franciscan deposits. Is the local representative of the Knoxville. Named for exposures along Toro Creek, San Luis Obispo County.

Replaced by Knoxville formation, the name "Toro" being unnecessary.

Torrey sand.

Eocene: Southern California (San Diego County).

M. A. Hanna, 1926 (California Univ. Pub., Dept. Geol. Sci. Bull., vol. 16, No. 7, pp. 187–246). Sand, usually coarse, porous, and unconsolidated; color usually white to light brown; highly cross-bedded. Consists of clean, moderately well rounded grains of quartz with varying amounts of feldspar, some muscovite and biotite, and minor amounts of ferromagnesians. Thickness more than 200 feet. Pinches out to south, where it probably was not deposited. Probably increases in thickness to the north. Is middle division of La Jolla formation in La Jolla quadrangle. Grades into overlying Rose Cañon shale and into underlying Delmar sand. Typically exposed on Torrey Pines grade, where the highway climbs from Soledad Valley to the 400-foot terrace to the south.

Trabuco formation.

Cretaceous: Southern California (Santa Ana Mountains).

E. L. Packard, 1916 (California Univ. Pub., Dept. Geology Bull., vol. 9, pp. 140–141). *Trabuco formation.*—Massive red conglomerates composed of angular and water-worn boulders loosely cemented, with subordinate bands of red sandstone. Thickness 200 feet. No fossils found, but from stratigraphic relations the formation is probably but slightly older than Chico group and presumably represents some phase of the pre-Chico Cretaceous. Grades into overlying Chico group and rests unconformably on basement complex. Extends from North Star Canyon nearly to Trabuco Canyon. Best exposed at Harding Canyon.

Trail formation.

Lower Jurassic: Northern California (Taylorsville region).

J. S. Diller, 1892 (Geol. Soc. America Bull., vol. 3, pp. 370–394). *Trail beds*, Triassic(?); 2,900 feet thick. On structural grounds regarded as Triassic and probably newer than Hosselkus limestone.

J. S. Diller, 1908 (U. S. Geol. Survey Bull. 353). Largely slaty shales with some interbedded sandstone and conglomerates. Shales often purplish or red, but perhaps more frequently gray, with pencil structure locally developed; in places contain numerous cherty nodules of carbonate of lime. Sandstones generally fine, often somewhat slaty, thin bedded, and gray to almost black. Fresh-water fossils. Thickness 2,900 feet. Overlaps, unconformably, Swearinger slate, Hosselkus limestone, and Robinson formation. Is next older than marine Hardgrave sandstone, with which it is assumed to be unconformable.

Named for exposures along Hosselkus Creek on the trail, Plumas County, California.

"Trampan formation."

Miocene (upper): Western California (San Francisco region).

A. C. Lawson and C. Palache, 1902 (California Univ. Pub., Dept. Geology Bull., vol. 2, pp. 447–448). *Trampan formation.*—Marine beds, aggregating about 2,000 feet, succeeding the fresh-water Orindan deposits. Fauna is, in opinion of Prof. J. C. Merriam, closely allied to that of San Pablo formation. Named for exposures along Las Trampas Creek, Contra Costa County.

A. C. Lawson, 1914 (U. S. Geol. Survey Geol. Atlas, San Francisco folio, No. 193). [Maps the marine beds formerly called "Trampan formation" as the San Pablo formation.]

Tres Pinos sandstone.

Eocene: Southern California (San Benito County).

P. F. Kerr and H. G. Schenck, 1925 (Geol. Soc. America Bull., vol. 36, pp. 470, 475). Massive coarse-grained quartzose buff-colored marine sandstone, with conglomerate phases; jointed; more indurated on exposed surfaces; large erosional cavities common. Thickness about 900 feet. No diagnostic fossils. "Of possible Eocene age." Is quite similar lithologically to the Pinecate sandstone and may prove to be the same. But at present is considered to be Tejon(?), because it overlies well-established Meganos deposits with no marked unconformity.

Probably named for exposures at or near Tres Pinos or Tres Pinos Creek.

"Trinity formation."

Term applied by O. H. Hershey (Am. Geologist, vol. 27, p. 226, 1901) to the serpentine in the Klamath Mountain region of northern California.

Truckee formation.

Miocene: Northern Nevada and eastern California (Lake Tahoe region).

Clarence King, 1876 (U. S. Geol. Expl. 40th Par. Atlas, map V) and 1878 (U. S. Geol. Expl. 40th Par. Rept., vol. 1, p. 412). *Truckee group.*—Fresh-water deposits of Miocene age, consisting of coarse sands and gravels, white stratified trachytic tuff, pelagonite tuff, marly grits, some sandstones, and one 60-foot bed of saccharoidal limestone. A large portion of the material is made of trachytic muds, which carry, especially in Oregon, numerous numbers of Miocene fossil mammals. The deposits are partly older and partly contemporaneous with the trachytes that are interbedded with the sediments. Thickness about 4,000 feet. Deposited in lake to which the name Pah-Ute lake is applied. [As mapped in the above-mentioned atlas the formation occurs in disconnected areas across Nevada, indicating the probable deposition of the sediments in several disconnected lakes. It is mapped over considerable areas in the valleys east and west of the south end of the Truckee Range and in Truckee Canyon between Reno and Verdi, Nev.]

Tulare formation.

Pliocene or Pleistocene: Southern California (San Joaquin Valley region).

F. M. Anderson, 1905 (California Acad. Sci. Proc., 3d ser., vol. 2, p. 181). *Tulare formation.*—Fresh-water deposits of gypsiferous sands and clays exposed at intervals along the western border of the Great Valley. In Kettleman Hills, 10 to 15 miles southeast of Coalinga, and near the western shore of Tulare Lake, these beds aggregate fully 1,000 feet in thickness. They lie conformably on the San Joaquin clays (the upper division of the Etchegoin formation), which they in some respects resemble. [Fossils listed.] Doubtfully assigned to Pliocene.

Contemporaneous with part of Paso Robles formation, but deposited in a separate basin.

Tuolumne intrusive series.

Probably Cretaceous: Yosemite National Park.

F. C. Calkins, 1930 (U. S. Geol. Survey Prof. Paper 160, p. 121, map). The great bulk of the granitic rocks in the Yosemite region belong to two series of intrusions, the members of each series exhibiting an especially close relationship to one another. These may be termed the biotite granite series of the Yosemite Valley and the *Tuolumne intrusive series.* * * * The latter includes [ascending order of age] the Sentinel granodiorite, Half Dome quartz monzonite, Cathedral Peak granite, and Johnson granite porphyry—formations which extend in large bodies from the upper half of the Yosemite Valley northward to the Tuolumne River and northeastward into the High Sierra.

Named for exposures along Tuolumne River, Yosemite National Park.

Tuscan tuff.

Pliocene and Miocene (?): Northern California (Lassen Peak, Redding, and Chico regions).

J. S. Diller, 1895 (U. S. Geol. Survey Geol. Atlas, Lassen Peak folio, No. 15). Composed wholly of fragmental material derived from the numerous volcanoes of the Lassen Peak district. Much of it is fine, clearly stratified, and properly called tuff, but a large part is an agglomerate of coarse and fine material intermingled. Most of the fragments are angular, but some beds are made up of pebbles well rounded by water action. Best exposed in canyons of Mill, Deer, and other creeks on their way from the mountains to the Sacramento Valley. At a number of points there are sheets of lava in the tuff. Is youngest Tertiary deposit in region. Rests on Ione formation. [The deposits mapped and described as Tuscan formation in the preliminary proof-sheet edition of the Lassen Peak folio (1892) are divided into Tuscan formation and Ione formation in the completed Lassen Peak folio.]

The Tuscan tuff reaches a maximum thickness of more than 1,000 feet.

Named for exposures at or near Tuscan Springs, Lassen Peak quadrangle.

Vaqueros sandstone.

Miocene (lower): Southern California (Salinas and San Joaquin Valleys).

H. Hamlin, 1904 (U. S. Geol. Survey Water-Supply Paper 89, p. 14). *Vaquero sandstone.*—Rather coarse, uniformly gray, white, or light-yellow quartzose sandstone, with an occasional stratum of granitic pebbles. In Salinas Valley it is a well-defined formation. So far as observed in this region it rests unconformably on the Basement complex and on stratified terranes older than the Neocene, being thus in this locality the oldest known member of the Neocene, but in other localities Neocene formations are found below the Vaquero sandstone. Is of great thickness along eastern slope of Santa Lucia Range, especially in Los Vaqueros Valley, hence the designation proposed by the writer for this series of sandstones. [Lists fossils. Los Vaqueros Creek is shown on Hamlin's map.]

The present generally accepted definition of Vaqueros sandstone is for the oldest *known* Miocene deposits in southern California, which range in thickness from 500 to 6,000 feet or more and are characterized by the *Turritella inezana* fauna. In the Santa Cruz Mountain region the Vaqueros is unconformably underlain by the San Lorenzo formation, of Oligocene age. In the Coalinga and neighboring districts it is unconformably underlain by the Kreyenhagen shale, of probable Oligocene (early Oligocene?) age. In Ventura and Los Angeles Counties it is underlain, in places unconformably, by the Sespe formation, of probable Oligocene (late Oligocene?) age. In the Salinas Valley region it is conformably overlain by the Salinas shale. In the northwestern part of Kern County it is overlain by the Maricopa shale. In Ventura and Los Angeles Counties it is overlain, probably conformably, by the Topanga formation, which is characterized by the *Turritella ocoyana* fauna. The Vaqueros sandstone is now generally considered to be older than the Temblor sandstone or *Turritella ocoyana* zone. The United States Geological Survey treats the Vaqueros as the basal formation of the Monterey group.

Named for exposures on Los Vaqueros Creek, Monterey County.

Ventura sands.

Pliocene: Southern California (Ventura County).

C. M. Carson, 1925 (Pan-Am. Geologist, vol. 43, pp. 265–270). *Ventura sands.*—The Ventura formation of Ventura County is well exposed in the foothills between Ventura and Santa Paula, in the Las Posas Hills, near Camarillo, on the south and west flanks of South Mountain, and in Simi Valley. The formation is from 500 to 1,000 feet thick and is composed of coarse and fine yellowish sand, which in places becomes quite gravelly. It is in general only moderately consolidated, although locally hard beds occur. [Fossils listed.] "This fauna is a cold-water facies, but its habitat is not so cold as that of the Santa Barbara fauna which follows." Is younger than San Diego clays.

Wagonwheel formation.

Oliogocene(?): Southern California (McKittrick-Sunset region).

H. R. Johnson, 1909 (Science, new ser., vol. 30, pp. 63–64). Local occurrence of sandstones and several layers of white diatomaceous shales, which appear, upon paleontologic evidence, to be of Oligocene age. Underlie Vaqueros sandstone and overlie Tejon sandstone. Occur in the isolated group of hills south of Bartons and northeast of Point of Rocks, in the Devils Den district.

Named for exposures north and southwest of Wagonwheel Mountain, Kern County.

Walker Ridge sandstones.

Post-Franciscan and pre-upper Miocene: Northern California (Humboldt County).

W. Stalder, 1915 (California State Min. Bur. Bull. 69, pp. 447–449). *Walker Ridge sandstones,* upper formation of Rainbow series in Humboldt County. Overlie Walker Ridge shales. Thickness 50 to 750 feet. Are mostly siliceous and well cemented. Vary in color from green to gray; weather yellowish. Older than upper Miocene. Named for exposures on Walker Ridge, Humboldt County.

Walker Ridge shales.

Post-Franciscan and pre-upper Miocene: Northern California (Humboldt County).

W. Stalder, 1915 (California State Min. Bur. Bull. 69, pp. 447–449). Bluish to black to gray soft shale beds alternating with fine to medium grained gray to bluish sandstones varying from 3 inches to 10 feet. Minor bands of limestone, some chert, and lenses of calcite at a few localities. Thickness 500 to 1,500 feet. Basal formation of Rainbow series. Underlies Walker Ridge sandstones. Named for Walker Ridge.

"Wallala beds."

"Wallala group."

Upper Cretaceous: Northwestern California (Mendocino County).

G. F. Becker, 1885 (U. S. Geol. Survey Bull. 19, pp. 7–17). *Wallala beds.*—A series of sandstones and conglomerates extending along the coast from near Fort Ross at least to Wallala. In some places they rest unconformably on metamorphosed rocks thought to belong to Knoxville group. Fauna not decisive as to age. Fossils collected near Wallala are regarded by C. A. White as probably pre-Chico and younger than Knoxville.

C. A. White, 1885 (U. S. Geol. Survey Bull. 22, p. 8). *Wallala group.*—"Since so little is known of the stratigraphical relations of the Wallala and San Diego beds with other formations I can not now discuss them fully, but I shall give them the provisional name of the Wallala group, referring those of both localities to one and the same formation."

The beds referred to belong to the lower part of the Chico formation.

Warner basalt.

Tertiary: Northeastern California (Modoc County).

R. J. Russell, 1928 (California Univ. Pub., Dept. Geol. Sci. Bull., vol. 17, No. 11, pp. 416–425, map). *Warner basalt.*—A thin sheet of basalt flows. The most widespread surface rock in Modoc County, probably covering half of the county. Thickness 0 to 600 feet. Named for exposures on sides of Warner Valley and for widespread distribution in Warner Lakes Range and Warner Range. Underlies rhyolite and overlies Cedarville series, the upper part of which contains flora considered to be Mascall (Upper and Middle Miocene). The Warner basalt is therefore considered much younger than Columbia River basalt.

Weitchpec schists.

Age (?): Northwestern California (Humboldt County).

O. H. Hershey, 1904 (Am. Geologist, vol. 33, p. 357). "The Weitchpec schists resemble the most highly metamorphosed Calaveras schists."

O. H. Hershey, 1906 (Am. Jour. Sci., 4th ser., vol. 21, p. 63). "In approaching the western border of the belt, the strata are bent up, and presently there appears under them a formation made up of white sericite and green chloritic schists that are evidently sheared rhyolites and andesites. In a very short distance another fault brings down the Bragdon slates. This may be repeated several times in 20 miles, but far the larger portion of the area is Bragdon. The shearing becomes more pronounced toward the west until traces of the bedding planes are virtually destroyed. I now consider the Weitchpec schists, formerly classed as pre-Bragdon, as a portion of this series. Indeed the apparent ancient schists of Redwood Mountain in the Korbel-Hoopa trail are probably Bragdon, although undoubted pre-Devonian schists occur in South Fork Mountain."

Probably refers to schist exposed at or near Weitchpec, Humboldt County.

White Pine shale.

Mississippian (probably upper and lower): Northern Nevada and Inyo County, Calif.

Arnold Hague, 1883 (U. S. Geol. Survey Third Ann. Rept., pp. 253, 266–267). Black argillaceous shales, more or less arenaceous, with intercalations of red and reddish-brown friable sandstone, changing rapidly with the locality. Plant impressions. Thickness 2,000 feet. Conformably overlies Nevada limestone and is overlain by Diamond Peak quartzite. Named for exposures in the White Pine mining district [now known as Hamilton], White Pine County, Nev.

This formation, with a thickness of 1,000 feet, has been identified by E. Kirk (U. S. Geol. Survey Prof. Paper 110, 1918) in the Inyo Range of eastern California.

Whiterock Bluff shale member.

Miocene (upper): Southern California (Cuyama Valley).

W. A. English, 1916 (U. S. Geol. Survey Bull. 621, pp. 191–215). Middle member of Santa Margarita formation. Conformably overlies Redrock Canyon sandstone member of Santa Margarita formation and is unconformably overlain by Morales member of the Santa Margarita. Near Whiterock Bluff, on the north side of Cuyama Valley, it consists of not less than 1,500 feet of white "chalky" diatomaceous shale, which rests (unconformably, it is believed) on the Monterey group. On south side of Cuyama Valley it consists of interbedded white clay shale, diatomaceous shale, and sandstone, and apparently grades into the underlying sandstone and shale beds mapped as Maricopa shale, the line of separation being drawn at the lowest horizon at which Santa Margarita echinoderms occur. Three zones of white sandstone and two zones of shale are present, aggregating 2,000 to 2,500 feet, of which about one-third is shale.

Wilbur zone.

A petroliferous zone, about 200 feet thick, lying 1,000 feet below top of Fernando group in the Long Beach field, Los Angeles Basin.

Wildcat series.

Pliocene: Northern California (Humboldt County, along the coast to Eureka).

A. C. Lawson, 1894 (California Univ. Pub., Dept. Geology Bull., vol. 1, pp. 255–263). Evenly bedded yellow and brown clays, silty clay shales, sandy clays, argillaceous sands, compact yellow sandstones, and pebbly conglomerates, 4,600 feet thick. Contain Pliocene fossils and are correlated with the Merced formation. "The region occupied by the terrane is commonly known to the people of Humboldt County as the 'Wild-cat Country.'" Occupies large part of Humboldt County to the north of Bear River Ridge and east of Humboldt Bay and is also doubtless extensively developed in the coastal region north of Eureka.

Wildrose formation.

Lower Paleozoic (?): Southeastern California (Inyo County).

See under *Telescope group.* Derivation of name not stated.

Wildwood limestone.

Permian: Northern California (Trinity County).

J. P. Smith, 1910 (Jour. Geology, vol. 18, chart opp. p. 217, p. 218). "Limestones of Trinity County with Guadalupian fauna, *Stacheoceras*, etc." Assigned to Permian.

Named for Wildwood (Landis's ranch), on Hay Fork.

Wilmington group.

Late Pleistocene: Southern California.

R. T. Hill, 1929 (Science, new ser., vol. 69, pp. 379–380). *Wilmington group.*—Has hitherto included Lower San Pedro, Upper San Pedro, and [Los] Cerritos stages of Arnold, or their equivalents. Contains Pleistocene marine invertebrate fossils. Structural and physiographic evidence proves that these beds are older than the Pleistocene invertebrate-bearing beds of La Brea pits, but both belong to Later Pleistocene stage, and not to Earlier Pleistocene. [Derivation of name not stated.]

Wilson Ranch beds.

Pliocene: Western California (Sonoma County).

V. C. Osmont, 1904 (California Univ. Pub., Dept. Geology Bull., vol. 4, p. 74). West of Santa Rosa Valley, sandstones and small proportion of shales and fine volcanic conglomerate, with marine fauna. East of Santa Rosa Valley, sandstones, shales, and a large proportion of coarse volcanic conglomerate; no fossils; coarseness of gravel and close bedding indicating fluviatile origin. Believed to be older than St. Helena rhyolite and younger than Sonoma tuff.

Probably named for exposures on a ranch in Sonoma County.

Wymer beds.

Miocene (upper), Pliocene, or Pleistocene: Northwestern California (Del Norte County).

J. S. Diller, 1902 (U. S. Geol. Survey Bull. 196, pp. 32–35, 47). Neocene marine deposits occur "on the edge of the plateau at an elevation of about 2,200 feet, along the old Wymer stage road, in sec. 20, about 13 miles northeast of Crescent City. North of the old Harvey place, where Thomas Haley now lives, a thin coating of the soft iron-stained, slightly indurated shaly sand is exposed on the banks of the road for several miles and has furnished numerous imperfect casts of mollusks as well as impressions of leaves. A short distance farther eastward, in an excavation made by Mr. Williamson near his barn, in sec. 22, a very fine, soft gray sandy clay, very slightly indurated, is rich in shells. The deposits of the two localities just mentioned will be called for distinctness the Wymer beds. They are very thin, resting on schists, peridotite, sandstone, and other rocks." [Fossils described.] Flora said to be upper Miocene by F. H. Knowlton. W. H. Dall says fauna is not characteristic but not older than Tertiary. "If on further study the Wymer beds should turn out to be Pliocene or Pleistocene the age of the Klamath peneplain would be correspondingly reduced."

"Yuha reefs."

Miocene (lower): Southern California (Imperial County).

G. D. Hanna, 1926 (California Acad. Sci. Proc., 4th ser., vol. 14, p. 435). "Above these [Coyote Mountain] clays, and interbedded with them near the top to some extent, are extensive deposits of oyster shells for which the name *Yuha Reefs* has been selected. The type locality has been chosen as a prominent hill made up of the material, thoroughly cemented and partially metamorphosed, located on the east end of the Coyote Mountain uplift. The same reefs are found on Yuha Buttes." Overlain by Coahuila silt. Assigned to Pliocene, probably middle or upper Pliocene.

Are interbedded at different horizons in upper part of Imperial formation. See W. P. Woodring, 1931, under *Imperial formation*.