DESCRIPTION OF THE GOLD BELT.

GEOGRAPHIC RELATIONS.

The Gold Belt of California includes that portion of the Sierra Nevada lying between the parallels of 37° 30′ and 40°. This area is bounded on the east by the Great Basin and on the west by the Great Valley of California, comprising about 17,000 square miles. The Sierra Nevada here forms a single range sloping somewhat abruptly towards the Great Basin and gradually towards the Great Valley of California. Within this area lie the chief gold deposits of the state, though by no means all of the area is auriferous. At the northern limit the deposits are scattered over nearly the entire width of the range, while to the south the productive region narrows down to small dimensions. The mass of the range south of Alpine county is comparatively barren. North of the 40th parallel the range is probably not without deposits, but the country is flooded with lavas which effectually bury them.

GENERAL GEOLOGY.

The rocks of the Sierra Nevada are of many kinds and occur in very complex associations. They have been formed in part by deposition beneath the sea, and in part by intrusion as igneous masses, as well as by eruption from volcanoes, and portions of them have been subsequently metamorphosed.

The southern portion of the range is composed of granite. The central and northern part, west of longitude 120° 30′, consists prevailingly of schists which have been produced by intense metamorphism of both ancient sediments and igneous rocks, and it is chiefly but not solely in these schists that the auriferous quartz veins occur. The trend of the bands of altered sediments and of the schistose structure is generally from northwest to southeast, parallel to the trend of the range, but great masses of granite and other igneous rocks have been intruded among these schists, forming irregular bodies which interrupt the regular structure and which are generally bordered each by a zone of greater metamorphism. These schists with their associated igneous masses form the older of two great groups of rocks recognized in the Sierra Nevada. This group is generally called the "Bed-rock series."

Along the western base of the Sierra occur beds of sandstone and clay, some of which contain thin coal seams. These are much younger than the mass of the range and have not shared the metamorphism of the older rocks. They dip gently westward beneath the later deposits which were spread in the waters of a shallow bay occupying the valley of California and which have been buried beneath recent river alluvium.

Streams flowing down the western slope of the Sierra in the past distributed another formation of great importance—the auriferous gravels. The valleys of these streams served also as channels for the descent of lavas which poured out from volcanoes near the summit. Occupying the valleys, the lavas buried gold-bearing gravels and forced the streams to seek new channels. These have been sunk below the levels of the old valleys, and the lava beds, with the gravels which they protect, have been isolated on the summits of ridges. Thus the auriferous gravels are preserved in association with lavas along lines which descend from northeast toward southwest, across the trend of the range. The nearly horizontal strata, together with the auriferous gravels and later lavas, constitute the second group of rocks recognized in the Sierra Nevada. Compared with the first group, the Bed-rock series, these may be called the "Superjacent series."

The history of the Sierra Nevada, even so far as it is recorded in the rocks, has not yet been fully made out; but the events of certain epochs are recognized, and these can be stated in a brief summary in the order in which they occurred.

THE PALEOZOIC ERA.

During the Paleozoic era, which includes the periods from the end of the Algonkian to the end of the Carboniferous, the State of Nevada west of longitude 117° 30′ appears to have been dry land of unknown elevation. This land probably extended westward into the present State of California and included part of the area now occupied by the Sierra Nevada. Its western shore was apparently somewhat west of the present crest, and the sea extending westward received Paleozoic sediments which now constitute a large part of the central portion of the range.

At the close of the Carboniferous the Paleozoic land area of western Nevada subsided, and during a portion or all of the Juratrias period it was at least partly covered by the sea. At the close of the Juratrias (according to the latest paleontological determinations) the Sierra Nevada was upheaved as a great mountain range, the disturbance being accompanied by the intrusion of large amounts of granite.

The Auriferous slate series comprises all of the sedimentary rocks that entered into the composition of this old range of Juratrias time. Formations representing the Algonkian, all of the Paleozoic periods, and those of the Juratrias, may therefore form part of the Auriferous slate series.

Fossils of Carboniferous age have been found in a number of places, and the presence of Silurian beds has been determined at the northeast base of the range. A conglomerate occurs in the foothills of Amador and Calaveras counties, interbedded with slates containing Carboniferous limestone; this conglomerate is therefore presumably of Carboniferous age. The conglomerate is evidence of a shore, since it contains pebbles of quartzite, diabase and hornblende-porphyrite, which have been rounded by the action of waves. The presence of igneous pebbles in the conglomerate shows that volcanic eruptions began at a very early date in the formation of the range, for the hornblende-porphyrite pebbles represent lavas similar to the hornblende-andesites of later age.

The Paleozoic sediments of the Gold Belt consist of quartzite, mica-schist and clay-slate with limestone lentils. Rounded crinoid stems, *Lithostrotion*, *Fusulina*, *Clisiophyllum*, *Spirifera* and other genera have been found, chiefly in the limestone, and indicate that the age of the rocks is lower Carboniferous. The Paleozoic sediments are finely exposed in Calaveras county and they will be designated on the Gold Belt sheets as the Calaveras formation. It is probable that some areas mapped as Calaveras may contain strata earlier or later than the Carboniferous.

During an epoch of upheaval some time after the close of the Carboniferous period, these sedimentary strata were raised, forming part of a mountain range. The beds were folded and compressed, rendering them schistose. Granite and other igneous rocks were intruded among them, and they assumed somewhat the relations which they now exhibit in the Sierra Nevada. But those masses which now form the surface were then deeply buried in the foundations of the range. They have been brought to the present surface by subsequent uplifts and prolonged erosion.

JURATRIAS PERIOD.

The areas of land and sea which existed during the earlier part of this period are scarcely known. Strata showing the former presence of the sea have been recognized in the southeastern portion of the range at Mineral King, where the sediments are imbedded in eruptive granite, and at Sailor canyon, a tributary of American river. Rocks of this age occur generally throughout the Great Basin and the Rocky mountains, but the interior sea or archipelago, in which they were deposited, was apparently separated from the Pacific by a land mass stretching the length of the Sierra Nevada. This land probably originated in the upheaval some time after the close of the Carboniferous, and toward the end of the Juratrias period its area became so extensive that the waters of the Pacific seem to have been completely separated from the interior seas. This conclusion is based upon the fact that fossils of Jurassic age in California, so far as known, have closer relations with those of Russia than with those of eastern America of the same age.

The genus *Aucella*, whose shell occurs in Russia, flourished on the Pacific coast until well into the Cretaceous and is distributed from Alaska to Mexico. In the Juratrias strata it is associated with ammonites of the genera *Perisphinctes*, *Cardioceras* and *Amaltheus*, closely related to forms of the European upper Jurassic age.

The strata in which these fossils occur are prevailingly clay slates which are locally sandy and contain pebbles of rocks from the Calaveras formation. Thus it is evident that they were deposited near the shore of a land composed of the ancient schists, and the generally fine character of the sediment shows that the land which occupied the area of the Sierra Nevada can not have been very mountainous. These strata now occur in two narrow bands along the western base of the range and are called the Mariposa formation, from the fact that they are well exposed near that place.

Soon after the Mariposa formation had been deposited the region underwent uplift and compression. The result of uplift was the development of a mountain range along the line of the Sierra Nevada. The Coast Range also was probably raised at this time. The action of the forces was such as to turn the Mariposa strata into a vertical position, shattering the rock and deforming it, and producing some metamorphism. The clay shales now have a slaty structure, produced by pressure, which appears to coincide usually with the bedding.

The Mariposa beds carry numerous gold veins, the most important group of which constitutes the famous "Mother lode." It is believed that a great part of the gold veins were formed after this upheaval and as a consequence of it, occupying fissures opened during the uplift. It was a time of intense eruptive activity. The Mariposa beds were injected with granite, and vast masses of diabase, associated with other basic igneous rocks, date from this time. There is evidence that igneous rocks were intruded in varying quantities at different times, but that the great mass of the intrusive igneous rocks accompanied or immediately followed the upheavals.

The epoch of disturbance following the deposition of the Mariposa beds was the last of those which produced the vertical arrangement of the Auriferous slate series. The strata of succeeding epochs are sediments and tuffs. Lying nearly horizontally or at low angles they prove that since they were accumulated the rock mass of the Sierra Nevada has not undergone much compression. But the fact that they now occur high above sea level is evidence that the range has been raised in more recent time.

CRETACEOUS PERIOD.

By the close of the Juratrias the interior sea of North America had receded from the eastern base of the Sierra Nevada eastward beyond the Rocky mountains. From the western part of the continent the waters of the Pacific had retired in consequence of the Juratrias uplift. The valley of California was then partly under water and the Coast Ranges seem to have been represented by a group of islands, but during the later Cretaceous the region subsided and the sea substantially overflowed it. Through gradual changes of level the areas of deposition of marine sediments were shifted during the Cretaceous and Neocene periods, and late in the Neocene the sea once more retreated west of the Coast Range. The deposits laid down during this last occupation of the valley of California belong to the "Superjacent series."

The advance of the sea spread a conglomerate over the eastern part of the valley in later Cretaceous time, and sandstone and shale were subsequently deposited. This formation is well developed near Chico, California, and at Folsom on the Sacramento sheet. It has been called the Chico formation.

EOCENE PERIOD.

In consequence of slow changes of level without marked disturbance of the Chico formation, a later deposit formed, differing from it somewhat in extent and character. The formation has been called the Tejon (Tahone). It appears in the Gold Belt region only at the Marysville buttes, but it is extensively developed in the southern and western portions of the valley of California.

NEOCENE PERIOD.

The Miocene and Pliocene ages, forming the later part of the Tertiary era, have here been united under the name of the Neocene period. During the whole of the Neocene the great valley of California seems to have been under water, forming a gulf connected with the sea by one or more sounds across the Coast Range. Along the eastern side of this gulf was deposited during the earlier part of the Neocene period a series of clays and sands to which the name Ione formation has been given. It follows the Tejon and appears to have been laid down in sensible conformity to it. Marine deposits of the age of the Ione formation appear within the Gold Belt only in the Marysville buttes. Along the eastern shore of the gulf the Sierra Nevada, at least south of the 40th parallel, during the whole of the Neocene, and probably also during the Eocene and latest Cretaceous, formed a land area drained by numerous rivers. The shore line at its highest position was several hundred feet above the present level of the sea, but it may have fluctuated somewhat during the Neocene period. The Ione formation appears along this shore line as brackish water deposits of clays and sands, and frequently it contains beds of lignite.

The drainage system during the Neocene had its sources near the modern crest of the range, but the channels by no means coincided with those of the present time. The auriferous gravels for the most part accumulated in the beds of these Tertiary rivers, the gold being derived from the croppings of veins. Such gravels could accumulate only where the slope of the channel and the volume of water were sufficient to remove the silt while allowing the coarser or heavier masses to sink to the bottom with the gold.

The climate of the late Neocene was warm and humid, much wetter than it would have been if the great valley had been above water, and erosion was correspondingly rapid.

A mountain-building disturbance occurred during the Neocene period. This was caused by pressure acting from the S.-SW. toward the N.-NE. with a downward inclination. One effect of this pressure was to induce movements on a network of fissures, often of striking regularity, intersecting large portions of the range. It is not improbable that this fissure system originated at this time, but there are fissures of greater age. This disturbance also initiated an epoch of volcanic activity accompanied by floods of lavas* consisting of rhyolite, andesite and basalt, which continued to the end of the Neocene. These lavas occupy small and scattered areas to the south, increasing in volume to the north until, near the 40th parallel, they cover almost the entire country. They were extruded mainly along the crest of the range and often followed fissures belonging to the system mentioned above. The recurrent movements on the fissures were probably accompanied by an increase in the development of the fissure system. An addition to the gold deposits of the range attended this period of volcanic activity.

When the lavas burst out they flowed down the river channels. Sometimes they were not sufficient to fill the streams, and are now represented by layers of "pipe clay" or similar beds in the gravels. These minor flows were chiefly rhyolite. The later andesitic and basaltic eruptions were of great volume, and for the most part completely choked the channels into which they flowed. The rivers were thus obliged to seek new channels—substantially those in which they now flow.

Fossil leaves have been found in the pipe clay and other fine sediments at numerous points. Magnolias, laurels, figs, poplars and oaks are represented. The general facies of the flora is thought to indicate a low elevation and has been compared with that of the flora of the South Atlantic coast of to-day.

PLEISTOCENE PERIOD.

During Cretaceous and Tertiary time the older Sierra Nevada mountains had been reduced by erosion to a range with gentle slopes. An elevation of the range doubtless attended the Neocene disturbance above referred to, and minor dislocations probably recurred at intervals; but at the close of the Tertiary occurred a greater uplift which was accompanied by the formation of normal faults widely distributed through the range, particularly along the eastern escarpment, where they form a well marked zone to the west of Mono lake and Owen lake. As a consequence of this

*The term "lavas" is here used as including not only such material as issued from volcanic vents in a nearly anhydrous condition and at a very high temperature, but also for tuff-flows and mud-flows, and, in short, all fluid or semifluid effusive volcanic products.

elevation, the streams, having greater fall, cut new and deep canyons in the hard but shattered base of the preexisting mountains.

A period of considerable duration elapsed between the emission of the lava flows which displaced many of the rivers and the time at which the higher Sierra was covered by glaciers. In the interval most of the deep canyons of the range were cut out. Such, for example, are the Yosemite valley on the Merced river, the great canyon of the Tuolumne and the canyon of the Mokelumne. The erosion of these gorges was often facilitated by the fissure system referred to above, and many of the rivers of the range follow one or other set of parallel fissures for a long distance.

It is a question at what point the limit between the Neocene and Pleistocene should be drawn. In the eastern United States it has become usual to regard the beginning of the Glacial Epoch as the close of the Neocene. If it could be shown that the glaciation of the Sierra was coeval with that of northeastern America a corresponding division would be adopted. It is believed, however, that glaciation was a much later event in California than in New England, and that the close of the Neocene can not be put later than the great andesitic flows.

The Sierra, from an elevation of about 5000 feet upwards, was long buried under ice. The ice did not to any notable extent erode the solid rock in the area which it covered. It seems rather to have protected it from erosion while intensifying erosion at the lower elevations, just as the lava cap would do. Small glaciers still exist in the Sierra.

There is no valid reason to believe that the Sierra has undergone any great or important dynamic disturbances since the beginning of glaciation. The whole mass, however, has risen bodily a few hundred feet during that time, as is shown by the raised beaches along the coast line of California, recent shells in the Contra Costa hills, and other significant indications.

IGNEOUS ROCKS.

Rocks of igneous origin form a considerable part of the Sierra Nevada. The most abundant igneous rock in the Sierra Nevada is granite, embracing under this term both granodiorite and granite-porphyry. Rocks of the granitic series are believed to have consolidated under great pressure and to have been largely intruded into overlying formations at the time of great upheavals. Thus granite is a deep seated rock and is exposed only after great erosion has taken place.

The rocks called diabase and augite-porphyrite on the Gold Belt maps are not always intrusive, but to some extent they represent surface lavas and correspond to modern basalt and augite-andesites. In like manner some of the hornblende-porphyrites correspond to hornblende-andesites.

GLOSSARY OF ROCK NAMES.

The sense in which the names applied to igneous rocks have been employed by geologists has varied and is likely to continue to vary. The sense in which the names are employed in this series of sheets is as follows:

Gabbro.—A granular intrusive rock consisting principally of diallage, or allied monoclinic pyroxene, or a rhombic pyroxene, together with soda-lime and lime feldspars.

Gabbro-diorite.—This term has been used to indicate areas of gabbro containing primary and secondary hornblende, and for areas containing intimate mixtures of gabbro and diorite.

Pyroxenite.—An intrusive granular rock principally composed of pyroxene.

Peridotite.—An intrusive granular rock generally composed principally of olivine and pyroxene; frequently of olivine alone.

Serpentine.—This is composed of the mineral serpentine, and often contains unaltered remains of feldspar, pyroxene or olivine; serpentine is frequently a decomposition product of rocks of the peridotite and pyroxenite series.

Diorite.—A granular intrusive rock consisting principally of soda-lime feldspars and hornblende.

Granodiorite (quartz-mica-diorite).—A granular intrusive rock having the habitus of granite, and carrying feldspar, quartz, biotite and hornblende. The soda-lime feldspars usually are considerably and to a variable extent in excess of the alkaline feldspars. The granitic rock might be called quartz-mica-diorite, but this term, besides being awkward, does not sufficiently suggest its close relationship with granite. It has therefore been decided to name it "granodiorite."

Granite-porphyry.—A granite with large porphyritic potash-feldspars.

Amphibolite, amphibolite-schist.—A massive or schistose rock composed principally of green hornblende with smaller amounts of quartz, feldspar, epidote and chlorite, and usually derived by dynamo-metamorphic processes from diabase and basic igneous rocks.

Diabase.—An intrusive or effusive granular rock composed of augite and soda-lime feldspars. The augite is often partly or wholly converted into green fibrous hornblende or uralite.

Augite-porphyrite.—A more or less fine grained rock of the diabase series, with porphyritic crystals of augite and sometimes soda-lime feldspars.

Hornblende-porphyrite.—An intrusive or effusive porphyritic rock consisting of soda-lime feldspars and brown hornblende.

Quartz-porphyrite.—An intrusive or effusive porphyritic rock consisting of quartz and soda-lime feldspar, together with a small amount of hornblende or biotite. It is connected by transitions with granodiorite and with the following:

Quartz-augite-porphyrite.—This is the same as the above excepting that it contains augite. It is connected by transitions with augite-porphyrites and with quartz-porphyrites.

Quartz-porphyry.—An intrusive or effusive porphyritic rock which differs from quartz-porphyrite in containing alkali-feldspars in excess of soda-lime feldspars.

Rhyolite.—An effusive rock of Tertiary or later age. The essential constituents are alkali feldspars and quartz, usually with a small amount of biotite or hornblende.

Andesite.—An effusive porphyritic rock of Tertiary or later age. The essential constituents are soda-lime feldspars and ferro-magnesian silicates. The silica is usually above 56 per cent.

Basalt.—An effusive rock of Tertiary or later age, containing soda-lime feldspars, much pyroxene and usually olivine. The silica content is less than 56 per cent. It is also distinguished from andesite by its structure.

DESCRIPTION OF THE PLACERVILLE SHEET.

TOPOGRAPHY.

The Placerville sheet comprises a part of the middle slope of the Sierra Nevada in Placer, Eldorado and Amador counties. The elevations above sea level range from 300 feet in the southwest corner to 5,400 feet in the northeast. The prevailing character of the topography between the rivers is that of irregular and undulating plateaus cut by steep ravines and gulches; in the higher eastern parts gently sloping tables are formed by the surfaces of the Neocene volcanic flows. The high bed-rock ridges of the Slate mountains rise above these flows in the northeastern part of the sheet. The three forks of the American river and the three forks of the Cosumnes have cut precipitous canyons through this table land. These canyons attain a maximum depth of 2,500 feet and their slopes are inclined at a maximum angle of about 40°.

GEOLOGY.

BED-ROCK SERIES.

[This series consists of the sedimentary rocks which were driven into a nearly vertical position at or before the post-Mariposa upheaval, together with the associated igneous masses.]

AURIFEROUS SLATES.

Calaveras formation.—This group, which includes the oldest strata in the region, consists of two belts of rocks, one lying to the east and one to the west of the main belt of Mariposa slates. The series to the west consists of highly compressed black slates and black sandstones, and fine grained siliceous rocks (pthanites), the latter at least in many cases intimately connected with and derived from limestone; the black slates are not very fissile, but weather into irregular fragments. In the northwestern corner of the sheet there are a few isolated limestone masses. The one crossing the north fork of the American river is about 300 feet wide and about two miles long. Fossils indicating Carboniferous age have been found in the limestone masses southeast of Applegate's near the Central Pacific railroad, and also in the limestone mass exposed in the middle fork of the American river, two miles above Mammoth bar. In both places the characteristic forms are corals. This western belt of the Calaveras formation contains areas of fragmental volcanics and dikes and massifs of basic igneous rocks, chiefly diabase and hornblende-porphyrites. The Calaveras formation east of the Mariposa beds consists of a succession of clay slate, sandstones and quartzites with lentils of limestone, and along the south fork of the Cosumnes river there is a good deal of mica-schist. The clay slate is, when fresh, very black and fissile, weathering into smooth fragments with sometimes almost a silvery luster. The basic igneous rocks, so abundant in the western belt, occur to a minor extent in the rocks of the Calaveras formation east of the Mariposa beds.

All of the limestone masses are more or less crystalline and the fossils are very poorly preserved. In the limestone area, four miles southeast of Placerville, frequently occur crinoid stems which by their rounded forms indicate Paleozoic age.

The whole series up to the eastern margin has a steep easterly dip. Although differing in details the series is essentially similar in character throughout and might be described as the siliceous series. The strike of this siliceous series is north and northwest, except in the region southwest of Grizzly Flat, where the strike for a considerable distance is northeast. This change of strike appears to be due to the intrusion of the granodiorite.

Mariposa slates.—The Mariposa beds consist almost entirely of black slates not so much altered as those of the Calaveras formation. When fresh they are of a deep black, but weathering changes them quickly to a light rusty brown. A little south of the Mile Hill toll-house in the northwest corner of the sheet appears a series of dark, partly volcanic sandstones and breccias, intercalated among the slates. This series continues up towards Colfax. It is well exposed along the canyon of the north fork of the American river, where it enters from the Colfax sheet adjoining at the north. The belt of the Mariposa slates contains numerous highly auriferous quartz veins. Ammonites and belemnites are found in these slates in Eldorado county. These fossils are similar to upper Jurassic forms of Europe. Another belt of Mariposa slates occurs in the lower foot-hills, extending southeast from Folsom. There are small patches belonging to this belt on the southwest corner of the sheet. The quartz veins in this western belt seldom contain gold in paying quantities.

IGNEOUS ROCKS.

Diabase and amphibolite-schist.—In the Carboniferous of the northwestern corner of the sheet are numerous dike-like masses of a fine grained dark green diabase usually partly or wholly uralitized (that is, with the pyroxene converted into hornblende).

The amphibolites of the large area near the western margin of the sheet are dark green rocks, medium to fine grained, sometimes consisting almost entirely of amphibole, and are usually distinctly schistose with steep eastern dip. A part of them, especially north of Latrobe, are quite coarse grained. Although the larger part of them have been derived from diabase, it is not improbable that in many cases the original rock was gabbro. The two areas of light colored amphibole and talc rocks crossed by the road from Oleta to Bridgeport were probably pyroxenite originally. Some specimens contain pyroxene altering to tremolite and serpentine.

The long dike of diabase which follows the western contact between the western belt of the Calaveras formation and the Mariposa slates is quite variable in composition; the southern part, up to the granodiorite area of Coloma, is principally composed of a massive, dark green diabase-breccia; while to the north of this area of granodiorite it is roughly schistose and consists partly of massive dark green diabase and diabase-porphyrite with large white feldspar crystals, and partly of breccia of varying fineness made up of these rocks. The large area of amphibolite-schist north of Greenwood which is inclosed in the black Mesozoic slates is derived from diabase and diabase-porphyrite by dynamo-metamorphism, that is, metamorphism induced by intense pressure and movement. Near Greenwood there is altered diabase-porphyrite going over into normal amphibolite-schist. The Mesozoic slates contain a great number of similar smaller streaks and masses of amphibolitic rocks.

Gabbro-diorite.—West of Shingle Springs occurs an area of coarse grained gabbro, the pyroxene in which is partly converted into uralite; it is a compact and hard rock presenting great resistance to weathering. Large parts of this area are occupied by rough and rocky hills covered with grease wood (*Adenostoma*). Along the contacts with the amphibolite it is plain that the gabbro-diorite is the younger rock and intrusive in the former.

Serpentine, pyroxenite, peridotite, gabbro and garnet-pyroxene rock.—The Carboniferous slates north of Coloma contain several areas of serpentine in many places intimately mixed with amphibolite-schists. Smaller masses of pyroxenite and peridotite occur in them, and from these rocks the serpentine has probably been derived. The Coloma area of granodiorite cuts off the serpentine masses in the same manner as it has cut off the diabase dike near Placerville. South of that area the serpentine continues as lenticular and dike-shaped masses in the amphibolite with which it is intimately connected; so much so, indeed, that frequently it is difficult to outline the areas. East of Shingle Springs the serpentine contains small masses of a dark colored gabbro as well as a dike of quartz-porphyrite. A small mass of garnet-pyroxene rock occurs four miles southeast of Latrobe.

The large dike in the slates of the Calaveras formation entering the Placerville sheet near Volcanoville is in many respects interesting and complex. It is usually referred to as the "serpentine belt," and is continuous for about forty miles north of this sheet. The primary rock of this dike varies from gabbro or diorite to pyroxenite and peridotite, although on this sheet no considerable areas of either of the two latter rocks are present. Masses of serpentine and amphibolite-schist, often very difficult to separate from the gabbro, occur at frequent intervals along the belt. Both must be considered as alteration products of the rocks mentioned above. Near the mouth of Rock creek on the south fork of the American river the dike is cut off by granodiorite; south of that area it appears again somewhat narrower and principally composed of serpentine, although along with it occur small masses of peridotite and gabbro. The serpentine area that lies just southwest of Bridgeport may perhaps be considered as part of this serpentine belt.

Granodiorite, quartz-porphyrite and hornblende-porphyrite.—Intrusive in the slates of the Calaveras formation on the eastern part of the sheet are several large isolated areas of granodiorite. This rock usually metamorphoses the surrounding slates into micaceous and quartzitic schists; the width of the contact zone varies from several hundred feet up to three-quarters of a mile, or in some cases even more; near Grizzly Flat the contact metamorphics frequently carry andalusite. At Grizzly Flat there are near the granodiorite contact small masses of a gabbroitic rock going over into granodiorite. The Coloma area of granodiorite is similar to the others in most respects, except that in some places the black mica is absent, and it has a tendency to grade into quartz-porphyrite. There is without doubt a gradual transition between the two rocks, as shown in the long projecting offshoots or apophyses at the southern end of the area.

The quartz-porphyrite is a light colored rock with porphyritic feldspars and quartz crystals in a groundmass of grayish or greenish color and of somewhat variable texture, though it is usually fine grained. The quartz-porphyrite, as well as the granodiorite, here contains much more sodium than potassium.

Closely connected with the granodiorite is the hornblende-porphyrite; it is a medium grained rock with porphyritic feldspars and hornblendes in a groundmass of the same composition. It occurs at several places along the contacts, going over into normal granodiorite; it also occurs as dikes and isolated massifs in the serpentines and other rocks of the vicinity. The hornblende-porphyrite massifs and dikes of Big Sugar Loaf and vicinity in places contain augite and grade into rocks of the diabase series containing no hornblende.

SUPERJACENT SERIES.

[This series consists of late Cretaceous, Eocene, Neocene and Pleistocene sediments lying unconformably upon the Bed-rock series, together with the igneous rocks of the same periods.]

NEOCENE.

Auriferous gravels.—During the Neocene period the general topography of this sheet was that of a sloping table land, relieved by hills of moderate elevation. This area was drained by two river systems, one more or less closely corresponding to the forks of the present American river, and the other representing the branches of the present Cosumnes. The gravels accumulated in them are now largely covered by volcanic material. The general direction of the Neocene drainage was as follows:

The old channel of the south fork of the American river enters the eastern margin of the sheet north of Pacific House and, crossing over, passes under the lava flow at Pacific House; from there it runs under the masses of Neocene andesite for about ten miles in a west-southwest direction down to a point between the two forks of Webber creek, northeast of Newtown; crossing the south fork of Webber creek it follows the present course of that creek for a considerable distance. The center of the old channel is here eroded, but there are numerous benches remaining to indicate its approximate course. In the vicinity of Placerville there is a complicated system of channels running south or southwest and tributary to the main fork. From a point between Placerville and Diamond Springs the channel was cut in a northwesterly direction, touching Granite Hill and entering the Sacramento sheet near Pilot Hill.

In Neocene time, the north fork of the American river followed a course which is now represented for a short distance by the divide north of Long canyon. The old channel again enters the sheet under the volcanic flow somewhere west of Todd valley and emerges from beneath the southern end of the volcanic area. Its course below this point is somewhat uncertain, but must have followed the present canyon of the middle fork pretty closely. Tributary to this former course are the Neocene channels north of Georgetown and between Volcanoville and Kentucky Flat. These tributaries flowed in a general north and northwest direction. In Neocene time, as now, the Georgetown divide formed a ridge between the two forks.

The course followed by the Cosumnes during the Neocene period is not perfectly known. It is certain, however, that one of the Neocene branches corresponding to the present Cosumnes headed near Grizzly Flat, and, flowing in a southwesterly direction across the present drainage, passed Henry diggings, Omo House and Indian diggings.

The auriferous gravels in this sheet consist of strata of quartzose and metamorphic gravel resting on the bed rock and usually overlain by finer sediments, such as clay and sand. The maximum thickness is not more than one hundred feet; usually it is much less.

The accumulation of auriferous gravels probably went on throughout the Tertiary, and may have begun even earlier.

Rhyolitic beds.—The first volcanic flows which during the Neocene period came down the slopes of the Sierra from the volcanoes near the summit were rhyolitic in character. The rhyolitic beds directly overlie the auriferous gravels and are composed of white or light colored tuff usually fine grained and occasionally containing scales of black mica. This volcanic fragmentary material doubtless came down in the form of many successive mud flows. Intercalated in the tuffs are beds of quartzose and metamorphic gravel and of light colored clays and sands partly of volcanic origin. The gravels are usually somewhat auriferous. The total thickness of the rhyolitic beds is about 300 feet on the divide north of Long canyon and 400 feet in the vicinity of Newtown. Unlike the subsequent volcanic flows, the rhyolite did not spread over large areas, but only filled the valleys of the principal streams. During the interval between the rhyolitic and the subsequent andesitic eruption the former beds were considerably eroded and in places new channels were worn down to the bed rock. These, usually referred to as "cement channels," occur both north of the middle fork of the American river and in the vicinity of Placerville; in them the andesitic breccia ordinarily rests directly on shallow but rich gravel.

Andesite.—The andesitic eruptions in the high Sierra flooded the larger part of the lower slopes with volcanic mud. Substantially the whole of the area of the Placerville sheet must have been thus covered, excepting the high bed-rock ridges of the Slate mountains and, probably, the hills in the southwestern corner.

The andesitic beds, which are entirely fragmental in character, attain a maximum thickness of 700 feet on the divide north of Long canyon; in the vicinity of Placerville the thickness does not exceed 400 feet, while east of Placerville it again increases to 700. The lower part consists of heavy volcanic gravel, frequently somewhat auriferous, together with volcanic sands and tuffs; the upper part consists of a hard andesitic breccia and usually contains angular or subangular bowlders of andesite often more than a foot in diameter. The andesite is dark gray to dark brown and contains porphyritic crystals of pyroxene and hornblende, the latter slightly prevailing; the cement uniting the bowlders is light gray to light brown and consists of finely comminuted volcanic material. Nearly all of this rock has the rough and porous character which has been called asperitic.

PLEISTOCENE.

Earlier Pleistocene.—Along the rivers, and especially in the vicinity of Coloma, there are patches of gravel, from twenty to sixty feet above the present channel, which have been referred to the earlier Pleistocene. Along their upper courses below the limit of glaciation the canyons of the rivers usually are so narrow and steep that there is no room for these deposits.

Moraines resulting from Pleistocene glaciers are found in the extreme northeastern corner of the sheet. The morainal deposit here consists of a thin layer of angular fragments of granite and other rocks covering the surface of the Neocene volcanic flows, and partly the slopes of the canyons.

Alluvium.—There is but little alluvium on the Placerville sheet. Very shallow alluvial soil covers some of the valleys of the plateaus.

MINERAL RESOURCES.

Gold-bearing gravels.—J. W. Marshall's discovery of gold in 1848 was made at Coloma, on this sheet. The alluvial accumulations of gold-bearing gravels in the present rivers and creeks were the first deposits worked. They were soon exhausted and the attention of the miners was turned to the gold in older deposits. A few bars along the American and Cosumnes rivers are still washed. The Pleistocene gravel benches along the present rivers have been and are now in part worked by sluicing and hydraulic mining. The hydraulic process is applied to the Tertiary auriferous gravels near Todd valley, on the divide north of Long canyon, near Placerville and Newtown, and at several places in the neighborhood of Georgetown, as well as at Mendon, Henry diggings and Indian diggings. The largest part of these gravels is, however, covered by volcanic flows, and is usually mined by drifting along the bed rock. Drift mines are at present worked in several places near Placerville, and also near Indian diggings.

Gold-quartz veins.—By far the most important mines on the Placerville sheet are located along the so-called Mother lode in the area of the Mariposa slates, traversing the sheet from north to south. The Mother lode, which must not be considered as a continuous vein, but rather as a belt of parallel though sometimes interrupted quartz-filled fissures, can be traced continuously as far north as the St. Lawrence mine on the Georgetown divide, and along it are found many celebrated mines, such as the Church Union, the Pacific and the Gopher-Boulder. The veins run parallel to the strike of the slates or cut them at a very acute angle. The dip is nearly always to the east and usually at a somewhat less steep angle than that of the surrounding slates. Along the veins of the Mother lode frequently run narrow streaks of amphibolite-schist and serpentine. The eastward bend in the strata caused by the intrusive granodiorite in the vicinity of Placerville is closely followed by the veins.

North of the St. Lawrence mine the Mother lode is not well defined. The quartz veins are more frequently interrupted and are replaced by a peculiar kind of deposit, the seam diggings. In these a certain belt of slate is impregnated with minute irregular quartz veins, frequently very rich in gold. Such seam diggings occur at Georgia Slide, Spanish Dry Diggings, Greenwood and other places. From the St. Lawrence one branch of auriferous quartz deposits runs up towards Georgetown and Georgia Slide. Another belt begins by the Esperanza mine, north of the St. Lawrence, and continues with frequent interruptions to the Sliger vein and Oregon bar, both on the middle fork of the American river. The quartz mines near Butcher ranch, and the seam diggings in Codfish canyon on the north side of the north fork of the American river, may be considered as belonging to the same belt, but it is not possible to trace the auriferous veins of the Mother lode further.

On both sides of the great serpentine belt running from Volcanoville to the Cosumnes granodiorite area, there are near the contact numerous small quartz veins, very rich in scattered bunches and pockets of gold. Few permanent mines are found, however, along these contacts.

The only important mining district in the eastern part of the sheet is that of Grizzly Flat. A long stretch of the contact of slates and granodiorite, from the middle fork of the Cosumnes to the "Buttes," is mineralized and accompanied by a great many auriferous quartz veins, the most prominent of which is that of the Mount Pleasant mine.

Copper deposits.—Copper ores are found in very few places on the Placerville sheet, and nowhere in any considerable quantity. They occur as vein deposits along the granodiorite in the zone of contact metamorphics, and one prospect lies south of Deer creek in the amphibolite-schist. Small masses of copper pyrites occur in serpentine and amphibolite about two miles west of Greenwood.

Quicksilver deposits.—Quicksilver was formerly mined near Fanny creek, south of Big Sugar Loaf. Traces of Cinnabar are said to occur near the mouth of Hastings creek and in Clark's creek ravine one mile north from its mouth.

Chrome iron.—Deposits of chrome iron occur in California only in serpentine. On the sheet showing the economic geology two deposits are noted. Along the area described above as the "serpentine belt" many small pockets have been found.

Building-stones.—When massive, the granodiorite makes very good building-stone and is used in many places. Certain kinds of more massive rhyolitic tuffs, found at Smith's Flat and other places near Placerville, make a most excellent and easily dressed building-stone.

Black clay roofing slates are quarried at Chili bar, 4 miles north of Placerville, in the canyon of the south fork of the American river. There are at present several quarries, and the slate, which is of excellent quality, is used in many places in California. Good roofing slate could doubtless be obtained at other points in the Mariposa beds.

Militating against the development of the quarry industry is the lack of cheap transportation.

SOILS.

As previously stated, there is very little bottom land (alluvium) on the Placerville sheet.

The soil of the hills and ridges formed by secular disintegration of the underlying rock, is deep only on some slopes and lava plateaus. Many of the ridges have but a thin coating of soil. The soils formed by secular disintegration may be classed under three general heads, as red, granitic and slate soils.

Red soil.—In part derived from diabase, gabbro-diorite and amphibolite, and in part from the andesitic lavas. The two kinds differ somewhat, but both are rich in plant food and admirably adapted to horticulture.

Granitic soil.—Derived from granodiorite. This soil is somewhat poorer than the red soil, but being usually deeper, warmer and easier to work, it is often preferred.

Slate soil.—Derived from the sedimentary slates. It is usually shallow and the poorest of the three.

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