EXPLANATION.

The Geological Survey is making a geologic map of the United States, which necessitates the preparation of a topographic base map. This paper will consist of a topographic base map and geological maps of small areas of country, together with explanatory and descriptive texts.

THE TOPOGRAPHIC MAP.

The features represented on the topographic map are as follows: (1) inequalities of surface, called relief, as plains, plateaus, valleys, hills, and mountains; (2) distribution of water, called drainage, as streams, lakes, and swamps; (3) the works of man, called culture, as roads, railroads, boundaries, villages, and cities.

Elevation.—All elevations are measured from mean sea level. The heights of many points are accurately determined, and those which are most important are given on the map in figures. It is desirable, however, to give the elevation of all parts of the area mapped, to delimit the horizontal outline, and to indicate, in all cases, the degree or grade of steepness. This is done by lines connecting points of equal elevation above mean sea level, lines being drawn at regular vertical intervals. These lines are called contours, and the uniform vertical space between two such lines is called the interval. Contours and elevations are printed in brown.

In a manner in which contours express elevation, form, and grade is shown in the following sketch and corresponding contour map:

The sketch represents a river valley between two hills. In the foreground is the sea, with a bay which is partly closed by a wooded sandbar. On each side of the bay, the land rises up to hills. Pointing the terrace on the right a hill rises gradually, while from that to the left the ground ascends steeply in a precipice. Contrasted with this precipice is the gentle descent of the left-hand slope. In each of these features is indicated, directly beneath its position in the sketch, by contours. The following explanation may make clearer the manner in which contours delineate elevation, form, and grade:

1. A contour indicates approximately a certain height above sea level. In this illustration the contour interval is 50 feet; therefore the contours are drawn at 50, 100, 150, 200, and 250 feet above sea level. Along the contour at 250 feet in all points of the surface 250 feet above sea level, and similarly with any other contour. In the space between any two contours are found all elevations above the lower and below the higher contour. Thus the contour at 150 feet just below the edge of the terrace, while that at 200 feet lies above the terrace; therefore all points on the surface are shown to be more than 150 but less than 200 feet above sea level. The summit of the higher hill is stated to be 670 feet above sea level, accordingly the contour at 650 feet surrounds it. In this illustration nearly all the contours are numbered. Where this is not possible, certain contours—say every fifth one—are accentuated and numbered. Such contours may be ascertained by counting up or down from a numbered contour.

2. Contours define the forms of slopes. Since contours are continuous horizontal lines conforming to the surface of the region, they smoothly approach smooth surfaces, recede into all extremities of angles of ravines, and project in passing over precipices. The spacing of contour curves and angles of the lines of the topographic map can be traced in the map and sketch.

The contours show the approximate grade on any slope. The vertical space between two contours is the distance that a point on the ground would have to travel if it remained at a constant elevation from one contour to another. On a gentle slope one must go farther than on a steep slope, and therefore contours are far apart on a gentle slope than on a steep slope. A map in which the intervals between contours are small indicates steepness of the surface, while a large map indicates a gentle slope.

For a flat or gently undulating country a small contour interval is used; for steep or mountainous country a large interval is necessary. The smallest interval used on the atlas sheets of the Geological Survey is 2 feet. This is used for regions like the Mississippi delta and the Delaware Swamps. In mapping great mountain masses, like those in Colombia, the interval may be 20 feet. For relief of mountainous areas, the interval of 10, 20, 25, 50, and 100 feet are used.

Drainage.—Watercourses are indicated by blue lines. In the stream flows the year round the line is drawn broken, but, if the channel is dry a part of the year the line is broken or dotted. On the map as a whole, and after the line surface the supposed underground course is shown by a broken blue line. Lakes, marshes, and other bottomless water bodies are shown in blue, by appropriate conventional signs.

Culture.—The works of man, such as roads, railroads, towns, county seats, and cities, are shown in black.

Topographical sheets of the United States (excluding Alaska) is about 3,253,000 square miles. On a map with the scale of 1 mile to 1 mile this would be about 650 by 970 miles. In order to accommodate the paper it was necessary to reduce the scale of the map to about 14 square miles.

Thus, as there are 63,500 miles in a mile, the scale "1 mile to an inch" is expressed by 1:63,500 on the map. This is the scale used on the maps of the Geological Survey.

Three scales are used on the atlas sheets of the Geological Survey. The smallest, the intermediate, is the largest. These correspond approximately to 4 miles, 2 miles, and 1 mile as the ground is on an inch on the map. On the scale 1:63,500 the area of map surface corresponds and represents nearly to 1 square mile; on the scale 1:24,000, about 4 square miles; and on the scale 1:63,500 to about 14 square miles. At the bottom of each atlas sheet the scale is expressed in three different ways, one being a line composed of ones representing miles and parts of miles in English inches, another indicating distance in the metric system, and a third giving the horizontal miles.

Alisno sheets and quadrangles.—The map is being published in atlas sheets of convenient size, each of which is bounded by two parallel lines of latitude at degrees of longitude; each sheet on the scale 1:63,500 contains one-quarter of a degree of latitude by a degree of longitude; each sheet on the scale 1:24,000 contains one-quarter of a degree of longitude by a degree of latitude; each sheet on the scale 1:63,500 contains one-sixteenth of a degree of latitude. The areas of the corresponding quadrangles are about 1, 2, and 4 square miles, respectively.

The atlas sheets, being only parts of one map of the United States, are laid out without regard to direction. A map of the United States may pass from a north edge to a south edge, from one meridian to another at various meridians. The intersection of the quadrangles may pass from a north edge to a south edge, from one meridian to another at various meridians. They form a very large part of the dry land.

The materials of which sedimentary rocks are composed are carried as solid particles by water and deposited as gravel, sand, or mud, the mineral grains of which may become cemented together to form sediment. These may be turned into conglomerate, sandstone, or shale. When the material is carried in salt or fresh water and is deposited without the aid of life, it is called a chemical sediment; if deposited with the aid of life, it is called an organic sediment. Many of the most important rocks, which are formed from chemical and organic deposits are limestone, chalk, gypsum, salt, iron ore, coal, lignite, and coal. Any one of the above sedimentary rocks may be separated from the others, and the different materials may be intermingled in many ways, producing a great variety of rocks.

Sedimentary rocks are usually made up of layers or beds which can be easily separated. These layers are called strata. Rocks deposited in successive layers are said to be stratified.

The surface of the earth is not fixed, as it seems to move along the sand which is carried away by the wind and washed away by the waves, and as its rises or subsides the shorelines of the ocean are changed; areas of deposition may be changed into areas of erosion, and vice versa. The moving of the Great Plains to the north by the action of the waves on the coast, the wind, and the ice action, is a very slow and continuous process, and it may be called "rocks" by the geologist, though popularly known as gravel, sand, and clay.

From time to time in geologic history igneous and sedimentary rocks have been deposited on the earth in different places. In these processes, through the agencies of pressure, movement, and chemical action, they are often greatly altered, and in this condition they are called metamorphic rocks.

Igneous rocks.—These are rocks which have been cooled and crystallized from a liquid state. As has been explained, sedimentary rocks were deposited on the original igneous rocks. Through long ages and sedimentary rocks of all ages enter into the formation of new molten material has from time to time been forced toward or near the surface, and there come into being new igneous rocks. The changes in the surface of the earth have often been caused by the melting and dissolving of the old rocks. Molten material has from time to time been forced forward or toward the surface, and there come into being new igneous rocks. The changes in the surface of the earth have often been caused by the melting and dissolving of the old rocks. Molten material has from time to time been forced forward or toward the surface, and there come into being new igneous rocks. The changes in the surface of the earth have often been caused by the melting and dissolving of the old rocks. Molten material has from time to time been forced forward or toward the surface, and there come into being new igneous rocks. The changes in the surface of the earth have often been caused by the melting and dissolving of the old rocks. Molten material has from time to time been forced forward or toward the surface, and there come into being new igneous rocks.
DESCRIPTION OF THE MOTHER LODGE DISTRICT.

INTRODUCTION.
In the preparation of the text of the Mother Lodge Special, it has been made to keep in mind the needs of mining men. The chief interest of the district centers in the gold veins of the Mother Lodge rather than in any of the more general problems of geology or petrology. The miner wishes to know what the country rock is, how it was formed, in what rocks the veins occur, how those rocks originated, and how they came to occupy their present position, whether a vein in one kind of rock is likely to prove richer than in another, why some veins are rich and others are poor, and to have many other questions of like importance answered. Some of these questions are still unanswered, but wherever actual knowledge has been gained the miner is made aware of the clearest way and in the simplest terms consistent with accuracy.

The present folio is intended, first of all, for use in the field by those interested in this district. Consequently, the different rock formations are described in such detail that they would be warranted by their general geological interest alone. As far as is practicable a distinct separation of regional and local detail is made. The area of general importance and those of local interest, the latter being printed in smaller type. The principal aim has been to present a working geological guide for use in the field.

The map forming part of this folio was originally intended to show the various vein systems of the district, by Dr. George F. Foot. This report has been unceremoniously delayed. The work is referred to the Sierra Nevada. Rocks of this region usually begin in October and are separated by days of delightfully clear weather free from the dust and heat of summer. The rainfall is heavy after the snows have melted, and the temperature frequently rises above 6°C during the daytime in July and August, but the nights are usually cold and very cold.

The title page of this folio is based on work which has been finished in 1898, and consequently mining developments of later date than this are not available for description or deduction.

GEOGRAPHY.
The district treated in the present folio comprises a comparatively narrow belt of country extending in a nearly north-west-south-east direction along the western foothills of the Sierra Nevada. The length of this area is very nearly 70 miles, and its width is 13 miles. It lies mainly within the Jackson and Mono counties, but parts extend into the northwest corner of the Calaveras County. The boundaries of the map are merely military lines, as chosen to permit the presentation, in convenient form, of the topography and geology of the region immediately adjacent to the surficial quartz veins of the Mother Lodge system. The general trend of this system is north-westwardly and south-eastwardly, corresponding to the trend of the more important structural features of this portion of the range, and accordingly the district mapped constitutes a long, narrow rectangle which the minima of longitude and parallels of latitude cross at angles of nearly 45°.

Located in a broad and general way, without regard for the moment to the topographical forms which have resulted from the very active post-Miocene epoch, the middle and western slope of the Sierra Nevada is a peninsula, a word in common geological use to indicate a surface which erosion has reduced almost to a plain. Its surface is of prevalently low and gentle relief and was carved in pre-Miocene times upon the older rocks which constitute the Red Rock complex ("Red rock series" of the earlier Gold Belt folio). Upon this worn-down surface the younger rocks of Stanislaus, Tuolumne, and Mariposa counties, have been eroded to the level of the Great Valley of California, and at the same time a narrow' zone of erosion has been cut from the pre-Miocene rocks of the area extending from the Great Valley of California to the crest of the range. It is a portion of what is known as the "Mother Lode district" of California.

The gold veins of the Mother Lodge are formed in the Mahogany formation of the Red Rock complex, and are associated with the granites and volcanic conglomerates, breccias, and shales.

Alluvial or bottom land is found only in a few relatively small patches. Grain and hay are grown, however, on the greater slopes of the foothills from the decay of the old volcanic rocks of the Red rock complex are well adapted for growing grasses and most of the old volcanic rocks of the area to be used for grazing purposes, and some are reported to be used for supplying other than a local demand for agricultural products.

GENERAL GEOLOGY.
For a general account of the geological history of the whole fault belt, of which the present area is but a part, the reader is referred to the Supplement. The origin of the Gold Belt is referred to in the Regular Gold Belt folio. Such portions of that history as apply to the limited area forming the subject of this folio will be, however, briefly summarized as they appear of interest after the rocks themselves have been described. It is sufficient for the present to keep in mind the fact that the rocks of the Sierra Nevada district are divided into two great groups: (1) A Devonian complex of steep-dipping schistose rocks, invaded by intrusive granite, and (2) a much younger group of flat-lying rocks, the Superspecies of the Red Rock complex (Red rock series of earlier folio), and a very much younger group of flat-lying rocks, the Superspecies of the Red Rock complex (Red rock series of earlier folio), and (3) a very much younger group of flat-lying rocks, the Superspecies of the Red Rock complex (Red rock series of earlier folio).

The Red Rock complex consists of both sedimentary and volcanic rocks. The sedimentary rocks were originally beds of mud, sand, and gravel. They represent the mechanical waste of ancient land surfaces which were long ago deformed and have been eroded by erosion into new forms or buried under later sediments and perhaps partly buried by invading, steeply dipping igneous intrusions. The sediments derived from this old land mass remain but the land mass itself has disappeared during the slow progress of geological change.

Carried down by the streams, this material was ground down and altered to a uniform matrix, forming the conglomerates, sandstones, and shales of the Red Rock series. These beds and the associated volcanic rocks have been folded and compressed chiefly in a northeast-southwest direction and have been intricately interbedded in masses of igneous rocks, such as granite, diorite, and aplites. These beds and the associated volcanic rocks have been folded and compressed chiefly in a northeast-southwest direction and have been intricately interbedded in masses of igneous rocks, such as granite, diorite, and aplites. These beds and the associated volcanic rocks have been folded and compressed chiefly in a northeast-southwest direction and have been intricately interbedded in masses of igneous rocks, such as granite, diorite, and aplites. These beds and the associated volcanic rocks have been folded and compressed chiefly in a northeast-southwest direction and have been intricately interbedded in masses of igneous rocks, such as granite, diorite, and aplites. These beds and the associated volcanic rocks have been folded and compressed chiefly in a northeast-southwest direction and have been intricately interbedded in masses of igneous rocks, such as granite, diorite, and aplites. These beds and the associated volcanic rocks have been folded and compressed chiefly in a northeast-southwest direction and have been intricately interbedded in masses of igneous rocks, such as granite, diorite, and aplites.
about one-eighth of a mile. For a distance of a mile, however, the bar is extremely narrow, and only extends about 300 yards across the shallow water. The banks of the river at this point are more prominent, and the channel is somewhat shallower, with abundant shallow water and abundant shoals and sand banks. The channel is characterized by the presence of numerous shoals and sand banks, which are separated by deeper channels and bays. The river flows through a region of low, rolling hills, with occasional small mountains and valleys. The banks of the river are lined with trees and shrubs, and the river itself is often bordered by marshland.

Some years ago, a group of young explorers decided to navigate the river to explore the area. They were accompanied by a experienced local guide who had grown up in the region. The guide knew the river well and was able to navigate through the shoals and sand banks with ease. The young explorers were amazed by the beauty of the landscape and the wildlife they encountered along the way. They saw herons, egrets, and other birds perched on the branches of the trees lining the riverbank. They also saw a variety of fish swimming in the river, including bass, catfish, and trout.

The guide explained that the river was an important source of food for the local community, who relied on it for fishing and hunting. He also told them about the history of the area, pointing out ancient petroglyphs and other archaeological sites that were believed to be over 2,000 years old. The guide then led them to a small island that was covered in wildflowers and had a small waterfall cascading down a cliff.

The young explorers were in awe of the beauty of the place and decided to return to the riverbank to take a closer look at the petroglyphs. As they explored, they noticed a small group of local people gathered nearby, who were fishing and chatting. The guide introduced them to the people, who welcomed them warmly and invited them to join in the fishing.

The young explorers accepted the invitation and spent the afternoon fishing with the local people. They caught several fish and shared their catch with the group, who were generous with their food and drinks. As the sun began to set, the local people led them to a small cabin where they spent the night, sharing stories and music around a campfire.

The next morning, the guide took them on a hike through the nearby mountains, where they saw a variety of flora and fauna. They also visited a small village that was built around a large waterfall, where they met the local chief and exchanged gifts.

The young explorers were grateful for the experience and promised to return one day to explore further and continue their adventures in the river valley. The guide waved them goodbye and disappeared into the forest, leaving them with a sense of wonder and excitement for the beauty and mystery of the place they had just explored.
The largest area of meta-andesite rocks in the district extends from the vicinity of Cappanna in the center of the area near the mouth of the Cossana River. These are the same rocks which form the northwestern corner of the Bathurst and Cape Breton District. The area is about 3 miles wide and about 10 miles long. The rocks are a massive, medium-grained granite, with minor amounts of felspathic and hornblende, and are very hard and tough. The contact between the granite and the meta-andesite is abrupt, and there is no gradation in the rocks. The meta-andesite is a dark greenish-gray, with patches of light gray and white, and is very fine-grained. The contact between the two rocks is sharp, and there is no gradation in the rocks. The meta-andesite is a dark greenish-gray, with patches of light gray and white, and is very fine-grained. The contact between the two rocks is sharp, and there is no gradation in the rocks.

The meta-andesite rocks are overlain by a series of volcanic rocks, including Tertiary and Quaternary lavas. The volcanic rocks are a massive, dark gray, with occasional greenish hues, and are very fine-grained. The contact between the volcanic rocks and the meta-andesite is sharp, and there is no gradation in the rocks. The meta-andesite is a dark greenish-gray, with patches of light gray and white, and is very fine-grained. The contact between the two rocks is sharp, and there is no gradation in the rocks.

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The large area of metastatis lying between Big Thicket and Caddo Mounds is usually a rather dark red of moderate intensity showing a tendency to darker areas where clays, quartzes, and locally chert and epidote. The fillipads and small outcrops of quartz are dark and the outcrop of quartz in the road is noted in white areas. Apatite is sometimes on an abundant serpentine nature.

Three miles a little south of west from Jackson is an area of intrusive rocks which contain veins with the meta-diorite. It is composed of a gneiss green granite rock of the same color and type as the meta-diorite. This rock containing the veins is definitely a fine granitic rock that is a prominent feature of the area. The exposure of the meta-diorite is apparently somewhat altered. The fine gneiss is evident and indicates that the rocks contain quartz, epidote, and rutile. The meta-diorite appears to be generally a medium-grained rock that is somewhat altered. The fine gneiss contains quartz, epidote, and rutile. The medium-grained rock is often intermixed with a small amount of white quartz, epidote, and rutile. The fine gneiss contains quartz, epidote, and rutile. This rock type is present in the area and is generally a medium-grained rock that is a prominent feature of the area.

Another area of somewhat similar kind occurs east of the Arkansas River. This area is generally a medium-grained rock that is a prominent feature of the area. The exposure of the medium-grained rock is generally a medium-grained rock that is a prominent feature of the area.

Northwest of Caddo Mounds is an area of medium-grained rock that is generally a medium-grained rock that is a prominent feature of the area. This area is generally a medium-grained rock that is a prominent feature of the area. The exposure of the medium-grained rock is generally a medium-grained rock that is a prominent feature of the area.

Serpentine—This rock has resulted from the alteration of basic gabbroic rocks, or of ultra basic rocks of the type that are commonly present in the region. It is usually a fine-grained rock that is a prominent feature of the area. This area is generally a medium-grained rock that is a prominent feature of the area.

The process of alteration whereby serpentine rock is developed is complex and involves the introduction of new minerals into the rocks which now include the serpentine. In general it occurs in elongated dikes of irregular shape and extremely varying width.

The serpentine of the district is fairly constant in character, and in the special area is of the same classification as in the special petrographic description. The rock is usually readily recognized by the miners and gives a distinctive color and a distinctive appearance. This is a medium-grained rock that is a prominent feature of the area. In nearly every serpentine area of any size, however, there occur isolated masses of gabbro and of pelitic schist. In most cases these represent facies of the original basic igneous mass which have escaped complete serpentinization.

The term serpentine from which serpentine has been derived means intrusive into the sediments, volcanic rocks, and amphibolite-schist of the Red Rock complex. The term serpentine is generally applicable to rocks that are metamorphosed by heat and pressure. These rocks are generally a medium-grained rock that is a prominent feature of the area. In nearly every serpentine area of any size, however, there occur isolated masses of gabbro and of pelitic schist.

Miscellaneous dike rocks—Dikes, usually of small size, are fairly abundant in the Mother Lode district. Like the other intrusive rocks, however, they are nearly always considerably altered and are of great petrographic interest. Some of these, from their close association with the gold-quartz veins, have great importance, as will be more fully shown when these latter are described. The greater number of the dikes are altered diorite-porphyries, or fine-grained diorites. The serpentine area, however, are sometimes cut by large porphyry-like gabbroic dikes that cut the rocks of the Red Rock complex. The process of erosion which has continued with out general interruption to the present day. A detailed examination of the geology of the western slope of the Sierra Nevada the Nucene is generally considered as being brought to a close with the cessation of the great volcanic eruptions. It was a period of rapid accumulation, chiefly of volcanic materials, during which the streams, overburdened and choked with the amount of debris thrown into them, were unable to establish stable channels.

At intervals, however, there were hills in the volcanic activity, during which some streams were able to erode channels of considerable depth and in some cases to cut down into the bed-rock complex. With the close of the Nucene the streams became again charged with the debris thrown into them and the process of erosion which has continued with out general interruption to the present day. A detailed examination of the geology of the western slope of the Sierra Nevada the Nucene is generally considered as being brought to a close with the cessation of the great volcanic eruptions. It was a period of rapid accumulation, chiefly of volcanic materials, during which the streams, overburdened and choked with the amount of debris thrown into them, were unable to establish stable channels.

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sank beneath the rhyolite of Bald Mountain, half a mile northeast of Altalite, that the famous Calaveras skull was found in 1866. If there were no doubt of the authenticity of this and similar discoveries in the Neocene surficial gravels, they would prove that man had inhabited the earth for a vastly longer period than there is combined evidence for in the other portions of the world.

South of the Stanislaus River the surficial ravel-gravels are of much less importance as regards area and former economic value than the deposits farther north. A well-defined channel is known to exist beneath a large part of the massive black lava (lava) [Image 0x0 to 1324x1556] cupping Table Mountain. These gravels, however, are much older than those of the Black Lava which caps the mountain. They represent an early Neocene stream channel which was buried underandesitic conglomerates and breccia. During a pause in the volcanic eruptions a new stream cut a channel in the anladesite and flowed for a portion of the course above the old limited gravels. This stream was busy eroding its bed, and did not deposit any new gravels. It was this newer channel which was found and walled up by the liquid lava, now congealed and forming the cap of Table Mountain. Thus the fact that the lava has covered and protected this relict-filled stream bed may be looked upon almost in the light of a curious coincidence. Above this deep gravel deposit occurs the conformable, variably colored silts, "pipe-clay" of the mines, which have been found at many points within the mountain to the rich in fossils water basin, a study of these plant remains, and of those from other similar deposits in the Gold Belt, has afforded the best evidence added to the fact of Miocene age of the surficial gravels which immediately underlie these silts. In Tuolumne Table Mountain silts the silt is formed without any stratigraphic break into coarser and finer sediments. North and east of Montesuma are considerable areas of gravels, which, although not capped by volcanic material, are probably of Miocene age. They are composed chiefly of pebbles of quartz and chert, with considerable light-yellow quartzose sand. As shown in the extensive pils by hydraulic workings they rest upon an uneven erosion surface of the nearly vertical Mariposa slates. A similar but smaller mass of gravels occurs just east of Chino Mine. Eikelight - Rhyolite does not occur in the Mother Lode district in the form of tabular flows or domes, but as volcanic ashes or rhyolitic tuffs. These tuffs are white or pink and are sometimes consolidated into a few thin beds. The microstructure shows them to be composed of crystals and crystal fragments of sanidine, quartz, epiderite, and feldspar. The groundmass is made up of glass spherulites and shards of pumice. The groundmass is usually more or less altered by secondary solution. The rhyolitic tuffs were thrown out in the first volcanic eruptions of the Neocene period. They appear never to have been so widely spread as the later andesitic breccias and tuffs, but were probably confined to the broad stream ways of the early Neogene. The andesite, on the contrary, appears to have completely filled the old valleys and to have buried the greater part of the territory now occupied by the river. Between Mokelumne Hill and Golden Gate Hill the rhyolitic tuffs overlie the earliest Neocene gravels and are more than 1,000 feet thick. The rhyolitic tuffs were thrown out in the air as volcanic ashes from volcanoes near the outlet of the range, washed into the stream valleys and redeposited by them over the earlier quartzite stream gravels. The streams of that time probably flowed slowly, in local depressions, and have been choked by the volcanic debris and forced to spread locally into broad, lake-like expanses. Mokelumne River is an example of this. There is evidence that the tuffs thus deposited were considerably eroded before the stream gravels were laid down. At Slate City occurs an area of very impure rhyolitic tuff, full of foreign fragments, including some pebbles of andesite. This is a product of a volcano located near the mouth of the San Joaquin River. The coast of the Pacific is about 100 miles north. From Altalite to the vicinity of the mouth of the Eel River, the coastal area is more or less covered with Neocene gravels. Strictly speaking the andesitic conglomerates are Neocene gravels, but as it would be identically impossible to map them separately from the andesitic breccias with which they are so closely connected, and as they are rarely if ever permanent, it seems best to include them in one series. Similar deposits, in which the andesitic material was laid down chiefly as andesite and gravel, are found in the vicinity of Montesuma and at a few other places in the area.

Massive andesite is known at only five points in the district. It forms the upper portion of the peak of known as Jackson Butte, occurs on Golden Gate Hill, and crops out on hills about 15 miles northeast of Golden Gate Hill. The highest of the latter is sometimes known as Tunnel Hill. It is a very conspicuous and picturesque outline to the mass of andesite, 450 to 500 feet in thickness, which forms its summit. The rock itself is rather light gray in color, with a slight reddish tint, and shows small pumiceous crystals of dark hornblende, marking the dark parts of the groundmass. It is seen to be a fresh hornblende-andesite, consisting of hornblende-feldspar, olivine, hornblende, and glass, with a minor amount of quartz. The groundmass shows flow structure. The form and isolated position of this andesitic mass have suggested that it has been extruded as a type of lava which has been intruded from below through the Calaveras rock. However, it is known that gravity does not cause such masses to be extruded by the streams gouging down from above their present high-water mark as they have sunk their beds deeper into the bed rock. These are areas which are occupied by coarse gravels, and the gravels of the present stream are usually andesitic. THE PLEISTOCENE PERIOD: In the Mother Lode district, the Pleistocene is a more or less uniform, rather thick, portion of the Pleistocene which Professor Le Conte has proposed to call the Siermon epoch, has been essentially a time of quiescence, but there are small areas of erosion and aluvium bordering some of the streams or washed down into valleys from the surrounding hills, as is shown by patches of gravel, in which cases above their present high-water mark as they have sunk their beds deeper into the bed rock. There are areas which are occupied by coarse gravels, and the gravels of the present stream are usually andesitic. GEOLOGICAL STRUCTURE. The problem of the detailed structure of the Red rock complex is an exceedingly intricate one, for it is known that the long belts of slaty and schistose rocks have been folded from nearly horizontal into nearly vertical positions by forces acting generally in a north-northeast-southwest direction. But the internal structure of the belts has yet to be fully uncovered. There is no doubt that the final compaction of the sediments and volcanic rocks of the Red rock complex were intrinsically folded, and not, as formerly supposed, tilted as a whole into their present position. Evidence of such folding is found in a careful study of the original folded formations may be seen in the excellent exposures of Mariposa rocks along Woods Creek. But such data does not yet suffice to reconstruct the original fold patterns in detail and to determine whether a given belt of rock now possessing monoclinal structure was evolved from an original anticline or a syncline. The modern belt of nearly horizontal schistose formations (slate and phyllite) called a basin, belongs to this group. It is characterized by abundant pumiceous crystals, a large amount of scoria, and a dark-gray fine-grained matrix. Vesicular facies occur in the upper portion of the flow, the vesicles being filled with air or vesicles. Examined under the microscope, thin sections of the Table Mountain lava show small pumiceous crystals of andesite, angular or subangular small olivine in a groundmass of lath-shaped olivine crystals, grains of olivine and antigorite, and some glass filled with the incipient Crystal forms termed globulites. There is always a little accessory magnetite and apatite present. These chemical analyses of specimens taken from outcrops of this flow show it to contain 6.1 to 50.9 per cent of silica, 1.5 to 5.5 per cent of lime, 2.5 to 5.0 per cent of potash and 46.5 per cent of water. The largest area of basin in the district is that forming the large mass of Table Mountain. Other areas occur to the northwest of the vicinity of Parrott Ferry. These mesas are much broader and extend much farther, and are separated by a long lava stream which plunged from some unknown vent near the crest of the range down to Knights Ferry and the mouth of the Green Valley - a distance of more than 60 miles. Portions of this lava flow have attained a thickness of about 300 feet, as shown in the columnar cliffs which constitute a picturesque feature of portions of Table Mountain.

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The region of the Mother Lode was then a sea bottom, which accumulated ooze and glomeratons, sands, fine, mud, and limestone. This sea bottom was apparently subject to oscillations, sometimes rising, sometimes sinking, and forming fringes. The pebbles and sands must have accumulated in shallow water, not far from shore, while the lime stones were deposited in relatively deep, clear water in which ostracods flourished. There were active volcanoes during this time, and the volcanic ashes thrown out during the eruptions must have drifted across the shallow bottom of the sea, where they fell as silt or as thin sheets of volcanic ash, accumulating in the form of silt or thin sheets of volcanic ash, accumulating in the paleozoic rocks of the region. The nature of this material has been described as the origin of the Neocomian sediments, the period in which the Neocomian region was being slowly worn down by erosion, and the sediments of the region were being transformed into the sedimentary rocks of the region.

During the period of Jurassic time, the region of the Mother Lode region was part of a large coastal plain, which extended from the present-day state of Oregon to the present-day state of California. This coastal plain was characterized by a series of long, narrow, coastal valleys, which were filled with sediments deposited by the streams that flowed from the mountains to the sea. The sediments deposited in these valleys included sand, silt, and clay, which were later transformed into the sedimentary rocks of the region.

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The larger structures are frequently hinged, as is the case with all the lower crust. The large and smaller species of the same size, and reduced to the physical size and condition of sandstone, form an inconspicuous mass. The smaller portion of the structure is thus of the same character as the larger species, and its condition is described and illustrated in the following sections. The smaller portion of the structure is thus of the same character as the larger species, and its condition is described and illustrated in the following sections.

The veins in the amphibole-shists resemble those in the marble and slate. In the former, the veins are usually small and insignificant, while in the latter, the veins are usually larger and more prominent. In both cases, the veins are usually yellowish or brownish in color, and sometimes a little chloritic. Such altered and pyritic country rock is often in poor condition for working alone, but it is often run through the mills for the sake of the iron-rich minerals which interest it, and from which it can not be economically separated. These veins are always accompanied by quartz veins, usually in those in the black slate areas, and in certain parts of the district are rich in tellurides. With the exception of the quartz veins, there are all free from the ore. In the veins occurring in or alongside serpentine areas are characterized by conspicuous outcrops of mica, usually in the form of small flakes. In some cases, however, constitute a part of the whole vein, which may be 200 or 300 feet in the productive area. A joint on the mass of rock masses and its general parallelism with the structural features of the range. It appears highly probable that much of the movement has affected the Sierra Nevada since the close of Jurassic time has been along this fault, and has resulted in the linear fault system of the Mother Lode system.

The veins of the Mother Lode system, without any known exception, dip northeasterly, generally at a less angle than the 15th parallel, and are exceptions to this general rule. The differences by which the fissures were originally opened, were of the kind known as jointing, and the hanging wall is a directly opposite to the foot wall, producing local erosion of earlier-formed veins, and resulting in ore bodies of irregular and broken character. There is evidence that this latter movement is still in progress, producing the gouge and irregularly shaped surfaces which accompany most of the veins. With the possible exception of serpentine there is no indication that the character of the wall rock is directly influenced upon the richness or poverty of the vein. Nevertheless, the veins traverse or are adjacent to some of the more complex strike leads, without conspicuous surface outcrops. The thickness of the vein, as its name implies, is a little calcium, or dolomite, and sometimes more of dolomite. The metallic contents of the ore are pyrites and gold, with small amounts of galena, selenide, and arsenopyrite, and chlorite, and chlorite. The ore body is generally a complex body of pyrites, gold, silver, and a silver fine-grained native silver. The pyrites and gold are generally associated and may be separated from one another by mechanical or chemical methods. The silver is generally separated from the gold, and may be separated from one another by mechanical or chemical methods.

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in character. Veins were formed, but they are neither continuous for a long distance nor strick- ingly parallel in direction. In 1889 no mines were established on any of the veins in this vicinity, although active prospecting was going on at the Ford mine, east of San Andreas.

The Utes, Sticks, Lightner, and Bovee mines are the oldest of the Mother Lode system. They are all located in the vicinity of San Andreas, with some mines in the north and others in the south. They are all of considerable size and are characterized by their abundant quartz, gold, silver, and other minerals. The Utes, Sticks, and Lightner mines are located near the upper part of the Mother Lode system, while the Bovee mine is further south. All of these mines are productive and have yielded large quantities of gold.

The Steeles and the Rockville mines are also important veins in the Mother Lode system. They are located near the upper part of the system and are characterized by their abundant quartz, gold, silver, and other minerals. The Steeles mine is one of the oldest of the Mother Lode system, and it has yielded large quantities of gold. The Rockville mine is located near the upper part of the system, and it is one of the most productive of the Mother Lode system. It is characterized by its abundant quartz, gold, silver, and other minerals.

The Sanger and the Rushville mines are also important veins in the Mother Lode system. They are located near the lower part of the system and are characterized by their abundant quartz, gold, silver, and other minerals. The Sanger mine is located near the lower part of the system, and it has yielded large quantities of gold. The Rushville mine is located near the lower part of the system, and it is one of the most productive of the Mother Lode system. It is characterized by its abundant quartz, gold, silver, and other minerals.

The Smith mine is located near the middle of the Mother Lode system and is characterized by its abundant quartz, gold, silver, and other minerals. It is one of the oldest of the Mother Lode system, and it has yielded large quantities of gold.

The Buckskin mine is located near the middle of the Mother Lode system and is characterized by its abundant quartz, gold, silver, and other minerals. It is one of the oldest of the Mother Lode system, and it has yielded large quantities of gold.

The Jumper mine is located near the middle of the Mother Lode system and is characterized by its abundant quartz, gold, silver, and other minerals. It is one of the oldest of the Mother Lode system, and it has yielded large quantities of gold.
The main body of Mariposa slates. Its veins have the character already described as belonging to veins in the clay slates. They are stringer-like veins without prominent outcrops, and the rock is chiefly white quartz, with a little greenish or rusty ribbon structure. They closely resemble the veins of the Plymouth district, in Amador County.

The prominent line of the veins is the southern slope of Maxwell Creek just below Coulterville. It is here about 300 feet wide and has the usual complex character of veins in or near a similar formation. It consists chiefly of dolomite and mariposa with stringers and lenses of quartz, streaks of talc, and horizons of altered in places in the stream cut by the quartz veins. Considerable work has been done on the veins near Coulterville, but the only one which is running on a paying basis is the quartz vein which crosses the quartzite just west of the mining district. This is working a vein on the foot-wall side of the main vein itself, and is mostly made up of a thin seam of quartz 30 to 40 feet wide with a width of about 30 feet, and dips 45° E. The ore averages about $104 per ton. Most of the vein is true free gold, the sulphides running about 8½ per cent. The ore consists of quartz, mariposa, talc, and graphite, often upon the same bedding planes as traces of talc or mariposa in the quartz.

All the veins hitherto described belong strictly to the Mother Lode system; but the district includes many others, some of them productive, which lie to the east or to the west of the Mother Lode. The course of these veins is usually in the general trend of those composing the Mother Lode, and in some cases they constitute separate and local systems of veins. The smallest may or may not have been formed simultaneously with the long system of Mother Lode fissures, but it is probable that their genesis was not so different from that of the latter by any very great interval of time.

About 2 miles northeast of Amador a conspicuous vein enters upon the same general trend from Quaker Mountain (not the Quaker Mountain in Tuolumne County) with so flat a dip (25°) that its hanging wall, which is eroded away and the vein forms the northern slope of a spur of the mountain. This heavy mass of quartz, 10 to 15 feet thick, has been extensively prospected, but it has not been profitably worked on a large scale. The vein is of interest on account of its northeast-southwest strike and northwest dipping.

The Caleb and Potambea mines, about 15 miles northeast of Sutter Creek, are examples of mines situated on minor fissure systems. The ore bearing ground of the former consists of quartz stringers of various sizes which traverse the country rock on the hanging-wall side of a massive vein of barren quartz 12 to 15 feet in thickness. The veined and impregnated country rock is a light-gray, finely stratified sandstone, and the stringers and pytrites of the vein are all sent to the mill, and the ore is low grade—usually less than $1 per ton.

The Starved Lode, near the old Calaveras mines, is a vein in the same slate. The general strike of the vein is N. 45° W., true, and the dip 62° NE. The ore is unusually base, some of it assaying 70 cents of silver per ton. It consists of quartz gangue carrying pyrite, galena, mine white, chalcopyrite, and a little pyrrhotite. The vein is rich in spots, but small, and is irregular in tenor.

The Espenmann (or Boston) mine, about 18 miles northeast of Jamestown there is a small group of veins in amphibolite-schist, upon one of which the Golden Clock and the one mine is operating. This vein dips at about 60° E. The gold occurs chiefly in the pyrite, in a gangue of quartz and calcite.

An interesting set of veins occurs near Big Oak Flat. These are most abundant within the quartz district, and have their contact at the quartz district and the Calaveras slates. It dips at angles varying between 25° and 35° NE. Northeast of this vein are some small, northwestly parallel veins in the quartz district, which also shows similar low dips (25°—45°) to the northeast. Northwest of the town of the Longellow and Macks are other veins which cross the quartzite and which consist of quartz, quartz schists and quartzites. The portion of the vein included in the Longellow claim is in the quartz schists, and dips 45° NE. The ore is white quartz containing occasional lenses of greenish quartz ("granite"). None of the Big Oak Flat mines have yet passed beyond the prospect stage of development. The richness of some portions of the Mother Lode district. This consists in the discovery and exploitation of the Mother Lode itself. It is stated that in this part of the district not a rule large enough or continuous enough to pay for heavy expenditures, may yet contain considerable masses of free gold. Men who follow this form of mining usually work alone or in pairs, and offer much display of practical skill and ingenuity in following up the indications of a pocket. The Jackson Hill area near Tuttletown has already been referred to, these veins being in amphibolite-schist. Another line of little pocket mines extends along the contact between the amphibolite-schist and Calaveras rocks between Calaveras and the Tuolumne River. This vein is mostly in thin leaves, often showing transitional andesitcal faces on the surface of the flat plates. The largest amount of gold taken along this contact is said to have amounted to $5000. There has also been considerable pocket mining along the contact in the southern section of Coulterville, in the metasandstone east of Horse- shoe Bend, and in Hunter Valley.

A few generalizations may be based upon a study of the Mother Lode veins of the area, and not necessarily applying to other areas, may be formulated as follows:

1. The ore bodies of the Mother Lode occur in various forms and conditions.

2. Paying veins may be found in any rock of the Big Bend-complex with the possible exception of serpentine. The most favorable rocks for the formation of large productive ore bodies are those possessing cleavage or schistosity.

3. In order to allow the depositation of ore, the country rocks must previously have been fissured in such a way as to produce open spaces. But many spaces of moderate size are more favorable to ore deposition than a single large lode. Thus the shorter leads and impregnated zones of the Big Bend complex are more productive than the large veins of solid quartz.

4. Very large solid workings of white quartz are common, and to cut out vertical or horizontal. They indicate, however, a strong line of fissuring and crystallization, and are often near the head of the tunnel or going out on the country rock edge or the hanging wall.

5. The ore is not uniformly distributed through the veins, but more or less concentrated into nearly vertical "shoots" or "chimneys," best referred to as pay shoots.

6. Veins must somewhere pinch vertically as well as horizontally. There is no evidence that any mine on the Mother Lode which has ever paid has been really worked out. A productive pay shoot followed down to a pinch will probably reappear again at greater depth. The extent to which the quartz veins may be advisable to work and the cost is determined by a thorough knowledge and study of the portion of the vein already exploited, worked by the economic engineer. In the case of the Mother Lode.

7. The gold usually occurs chiefly in the veins and stringers, not in the impregnated wall rock. The gold is said to be associated with Calaveras slates always associated with the gold. When the pyrite occurs in large crystals of cubical form it may be noticed that the contact between Calaveras slates and quartz is often sufficiently to distinguish the signs of rich ore in a given mine, but the same indications may hold in a mine a few miles away.

8. There is no evidence that mines grow and steadily richer at any arbitrary depth, such as 1000 feet, nor is there any recognizable regular growth. The gold occurs in small masses, which appear to indicate good ore. The free gold may occur embedded in pyrite, silver, or silver and gold, and is sometimes too small to mention or rich enough to be noticed.

The production of precious metals, as given in the table, probably does not greatly exceed the output of these counties, and it is therefore within the limits of the map described. Dedications must be made, however, for a few mines lying to the northeast of the district, such as the Sheep Ranch mine, which produced nearly $15,000 in 1852, and is credited to $50,000 in 1852. The bulk of the production of these two counties for the years given in the table has come from the large mines developed along the Mother Lode vein system, from Plymouth to the Sierras. The Kennedy mine, which has been a very steady producer of the precious metals, had an output of more than $8,000,000 from 1850 to 1855 inclusive, and the Urria group of mines (Urria, Stickle, Clover, etc.), which is about $6,000,000 in 1859. The last-named group, which is under one management, ranked in 1854 as the leading producer of gold bullion in the United States.

Tuolumne County is noted for its pocket mines, some of which have been considered, although erratic producers. The output of the country is therefore subject to fluctuations, and it is difficult to apportion the total yield among the different mines. The large product in 1857 was probably due chiefly to the general activity and development of the larger and more permanent mines, such as Rubyville, Shumway, Juniper, Dutch, and App, along the Mother Lode, and the Golden Gate, which may have been the result of the small mines which were probably responsible for the considerable increased production of the last three years.

Quicksilver.

Cinnabar, or sulphide of mercury, occurs in deposits, some of which are noted in the quartz vein east of Horse-shoe Bend. (See Sonora fault.) Neither deposit is of economic value.
Glossary of Rock Names.

The sense in which the names applied to igneous rocks have been employed by geologists has varied, and it is likely to vary as knowledge increases. The sense in which the names are employed in this folio are as follows:

**Andesite.** A granular intrusive rock generally composed principally of olivine and pyroxene, but sometimes of olivine alone.

**Basalt.** A granular intrusive rock composed chiefly of pyroxene.

**Diabase.** A granular intrusive rock consisting chiefly of hornblende.

**Hornblende.** A granular intrusive rock consisting chiefly of hornblende.

**Serpentine.** A rock composed of the secondary hydrous mineral serpentine. Serpentine is an alteration product of rocks of the peridotite and pyroxene series, and sometimes contains unaltered remnants of pyroxene or olivine.

**Gabbro.** A granular intrusive rock consisting of hornblende-feldspars (labradorite or orthoclase), pyroxene (more rarely hornblende), and sometimes olivine.

**Diabase.** A granular intrusive rock consisting chiefly of olivine-feldspar (oligoclase, andesine, or labradorite) with hornblende or pyroxene, and sometimes biotite. If quartz is present the rock is called a quartz-diabase. A melasdiabase is a partly recrystallized or altered diabase.

**Granodiorite.** A name used in the Gold Belt to designate a granular intrusive rock standing microscopically and chemically between a granitic and a quartz-diorite, but closely related to the latter and yet more closely to quartz-monzonite.

**Syenite.** A granular intrusive rock composed chiefly of alkali feldspars with amphibole, pyroxene, or migmatite. A syenite is one in which a soda feldspar is prominent.

**Granite.** A granular intrusive rock composed of soda or potash (alkali) feldspar, quartz, mica, and sometimes hornblende. Granitees usually contain some soda-like feldspar or plagioclase.

**Muscovite.** A rock in which albite or other soda-feldspars predominate.

**Diabase.** An intrusive or effusive rock having a mineralogical composition like gabbro, but differing from the latter in structure. The feldspars are lath-shaped, and the rock is often porphyritic and usually less coarsely and evenly crystalline than gabbro. A meta-diabase is an altered diabase in which the pyroxene is often changed into ilmenite green amphibole (uralite) and the feldspars into epidote and other secondary minerals.

**Diopside-syenite.** A rock possessing the general chemical and mineralogical character of a diorite, but with porphyritic instead of granular structure. Porphyry is merely a structural term.

**Nepheline-syenite and nepheline-granophyre.** A rock having the chemical and mineralogical characters of a syenite, but with nepheline instead of a feldspar.

**Nepheline-granophyre.** A nepheline-syenite in which the groundmass is felsitic.

**Basalt.** An effusive rock containing basic feldspars, much pyroxene, generally olivine, and frequently considerable glass. The silica content is usually less than 56 per cent. The basalts are the effusive equivalents of the gabbros.

**Andesite.** An effusive rock, usually of porphyritic structure, composed essentially of soda-like feldspars (chiefly andesine and labradorite) and ferromagnesian silicates (hornblende, pyroxene, or biotite), in groundmasses of feldspar microlites and magnetite, with some glass. The feldspar is ordinarily above 56 per cent. The andesites are usually gray in color. A meta-andesite is an altered andesite. The andesites are the effusive equivalents of the diorites.

**Lavite.** An effusive rock, usually of porphyritic structure, which is mineralogically closely related to the andesites, but contains more potash and soda. The lavites are the effusive equivalents of the granular intrusive rocks called monzonites. The lavite of Table Mountain consists essentially of labradorite-feldspar, augite, olivine, and glass. It contains about 36 per cent soda, 62 per cent lime, 2.5 per cent soda, and 4.5 per cent potash.

**Rhyolite.** An effusive rock, generally nearly white in color, consisting of alkali feldspar, quartz, and usually hornblende or biotite, in a groundmass which is often glassy. The rhyolites are the effusive equivalents of the granites.

**Amphibolite and amphibolite-olinth.** A massive or schistose rock composed principally of green amphibole, with quartz, feldspar, epidote, chlorite, calcite, and other minerals, and usually derived by metamorphic processes from andesites and diabases (often in the form of tuff), diorites, and other igneous rocks.

**Tuff.** A rock composed of small fragments of lava (basalt, andesite, rhyolite, etc.) originally thrown into the air by explosive action of volcanoes, or erupted from volcanic vents in the form of mud flows. The tuffites are often bedded, and may become cemented into a hard rock.

**Breccia.** A rock composed of angular fragments embedded in a finer clastic matrix. The breccias of the Mother Lode district are almost all of volcanic materials, and may be regarded as very coarse tuffs. If the fragments are water-worn and rounded the rock becomes a conglomerate.

F. L. RANSOME,
Quarister.
April, 1899.
forming another graduation into sedimentary deposits. The clastic matter was deposited in channels and other parts in sands and gravel, known as orms, or sands and those. The material deposited by the ice is called glacial drift; that which was washed off it is called the surficial drift. The former is usually of the same origin; igneous, sedimentary, and surficial drifts may be of the same age.

When the predominant material of a rock mass is essentially the same, and it is bounded by rocks of different materials, it is convenient to call the mass throughout its extent a formation, and each such a formation is the same, or Cambrian system, Cambrian period.

As sedimentary deposits or strata accumulate the younger are under the older, and the relative ages of the deposits may be determined by observing their relative positions. This relation holds except in regions of intense disturbance; sometimes in such regions the disturbance of the beds has been so great that their position is reversed, and it is often difficult to determine the relative ages of the beds from their positions; then fossils, or the remains of plants and animals, are guides which show which of the two or more formations is the oldest. Strata often contain the remains of animals and plants which lived in the sea or were washed from the land into lakes or seas or were buried in surficial deposits on the land. Rocks that contain the remains of life are called fossiliferous. By studying these remains we may determine the age of the rocks and the extent of the coaliferous and the igneous rocks. It has been found that the species of each period of the earth's history have a great extent differed from those of the same name, and only the simplest kinds of marine life existed when the oldest fossiliferous rocks were deposited. From time to time more complex kinds developed. The oldest rocks are the oldest formed; and the present are the oldest formed.

When two formations are remote one from the other and it is impossible to observe their relative positions, and the characteristic fossil types found in them may determine which was deposited first. Fossil remains are found in the rocks of different ages and periods, and the color and or colors and symbols assigned to each, are given in the table to the next column. The names of some of the most important localities are given in the table and the last column. The names of some of the most important localities are given in the table and the last column. The names of some of the most important localities are given in the table and the last column.

Colors and patterns. To show the relative ages of strata, the history of the sedimentary rocks is divided into periods. The names of the periods in order are early, middle, and late, and the color and or colors and symbols assigned to each, are given in the table to the next column. The names of some of the most important localities are given in the table and the last column. The names of some of the most important localities are given in the table and the last column. The names of some of the most important localities are given in the table and the last column.

To distinguish the formations of any one period from those of another the patterns for the formations of each period are printed in the appropriate space. The names of the periods in order are early, middle, and late, and the color and or colors and symbols assigned to each, are given in the table to the next column. The names of some of the most important localities are given in the table and the last column. The names of some of the most important localities are given in the table and the last column. The names of some of the most important localities are given in the table and the last column.

In fig. 10 there are three sets of formations, distinguished by their bedding patterns, the relations of which to one another may be seen. Any cutting which exhibits these relations is called a section, and the same name is applied to a diagram showing the relations. The arrangement of rocks in the earth is the earth's structure, and a section exhibiting the earth's structure is called a section. The geologist is not limited, however, to the natural and artificial cuttings for his information concerning the earth's structure. Knowing the manner of the formation of rocks, and having traced out the relations among beds on the surface, he can usually make them known by their relative positions after they pass beneath the earth, thus areas which represent the structure of the earth to a considerable depth, and construct a diagram exhibiting what would be seen in the side of a cutting many miles long and several thousand feet deep. This is illustrated in the following figure:

![Diagram of geological structure](image)

The various geologic sheets.

**Historical geology sheet.** This sheet shows the relations of the rocks to each other and to the landform. The margin is a legend, which is the key to the map. To ascertain the meaning of any particular color or pattern, its letter, and its relative position, the reader should look for that color, pattern, and symbol in the legend, where he will find the name and description of the formation. If it is desired to find any given formation, its name should be looked for in the legend and its color and pattern noted, when the area on the map corresponding in color and pattern may be traced out.

The legend is also a partial statement of the geologic history. In it the names and symbols are arranged, in columnar form, according to the origin of the formations—sedimentary, igneous, and metamorphic. The intermediate valleys follow the contours of landforms, and the intermediate valleys follow the contours of landforms. Where the edges of the strata appear at the surface their thickness can be measured and the angles at which they dip below the surface can be observed. Thus their positions underground can be inferred.

When strata which are thus inclined are traced underground in mining, or by inference, it is frequently observed that they form troughs or arches, such as the section shows. But those sandstones, shales, and limestones were deposited beneath the sea in nearly flat sheets. That they are now bent and tilted is a proof that faults which have from time to time caused the earth's surface to winkle along certain zones.

On the right side of the section the strata is cut by a large fault, and the section shows the relations of the formations beneath the surface. On the right side of the section the strata is cut by a large fault, and the section shows the relations of the formations beneath the surface.
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