EXPLANATION.

The U.S. Civil Survey is making a geologic map of the United States, which necessitates the preparation of a topographic base map. The two are being issued together in the form of an atlas, the parts of which are called folios. Each folio consists of a topographic base map and a geologic map of a small area of country, together with explanatory and descriptive texts.

THE TOPOGRAPHIC MAP.

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

Relief—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 delineate the horizontal outline, or contour, of all slopes, and to indicate their grade or degree of steepness. This is done by lines connecting points of equal elevation above mean sea level, the lines being drawn at regular vertical intervals. These lines are called contours, and the uniform vertical space between each two contours is called the contour interval. Contours and elevations are printed in brown.

The manner in which contours express elevation, form, and grade is shown in the accompanying sketch and corresponding contour map.

2. Contours define the forms of slopes. Since contours are continuous horizontal lines conforming to the surface of the ground, they wind smoothly about smooths of various sizes, 400, 1000, and 2500 feet.

3. The topographic sheet is formed by a detailed analysis of the ground. The shape and size of a hill or range are shown on the map. All contours and elevations used on the topographic map are unique to the area.

4. The topographic sheet is formed by a detailed analysis of the ground. The shape and size of a hill or range are shown on the map. All contours and elevations used on the topographic map are unique to the area.

The geologic map shows the Earth's surface as it was probably composed of igneous rocks, and all other rocks have been derived from them. The geologic map is a map of the surface of the Earth, and the structure section map shows the underground relations, as far as known, and in as much detail as the scale permits. Kinds of Rocks.

Rocks are of many kinds. The original crust of the earth was probably composed of igneous rocks, and all other rocks have been derived from them. The geologic map is a map of the surface of the Earth, and the structure section map shows the underground relations, as far as known, and in as much detail as the scale permits. Kinds of Rocks.

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DESCRIPTION OF THE BUTTE SPECIAL DISTRICT

GEOGRAPHY

The maps of this folio represent, on a large scale, the area of the Butte special district, which is situated in the northeastern part of Butte county. The district is of irregular shape, bounded on the east by the Butte river, on the south by the Deer Lodge river, on the west by the Anaconda district, and on the north by the Missouri river. The district is about 30 miles long and 15 miles wide, and contains an area of about 350 square miles, or 90,750 acres.

The district is characterized by its mineral wealth, with significant deposits of copper, silver, and gold. The region is also notable for its scenic beauty, with the Butte mountain range stretching along the eastern boundary of the district.

The Butte mountain range, which forms the eastern boundary of the district, is a prominent feature of the landscape. The range is composed of sedimentary rock, which has been uplifted and eroded over time, creating a series of peaks and valleys. The highest peak in the range is known as Butte mountain, which rises to an elevation of about 7,000 feet above sea level.

The Butte special district is characterized by a relatively flat terrain, with gentle slopes and rolling hills. The area is drained by a network of streams and tributaries, which flow into the Missouri river. The district is also home to a variety of vegetation, including forests of pine, aspen, and birch, as well as grasslands and meadows.

The climate in the district is continental, with cold winters and hot summers. The average annual temperature is about 50 degrees Fahrenheit, with temperatures ranging from below freezing in the winter to over 100 degrees Fahrenheit in the summer.

GEOLOGY OF THE SURROUNDING REGION

The geology of the district is characterized by a complex history of tectonic activity and mineral deposition. The area is underlain by sedimentary rock, which has been uplifted and folded over time, creating a series of folds and faults.

The sedimentary rock is composed of sandstone, shale, and limestone, which were deposited in a shallow sea that existed in the area millions of years ago. The rock is also characterized by the presence of ore deposits, which have been exploited for mining over the years.

The district is also home to a variety of mineral deposits, including copper, silver, gold, and lead. The mining activity in the area dates back to the 19th century, with the discovery of rich ore deposits by prospectors and miners.

The mining activity has had a significant impact on the landscape, with large open-pit mines and processing facilities dotting the area. The mining operations have also had a significant impact on the local economy, with mining being the primary source of income for many residents.

THE GRANITES

The granites found in the Butte special district are characterized by their high levels of silica and their relatively low levels of iron. The granites are also characterized by their coarse-grained texture, with large crystals of feldspar and quartz visible to the naked eye.

The granites are thought to have formed through the process of partial melting of the Earth's mantle, with the resulting magma rising to the surface and cooling slowly. The resulting granites are characterized by their high density and their resistance to weathering, making them a valuable resource for construction and other uses.

THE RHYOLITES

The rhyolites found in the Butte special district are characterized by their fine-grained texture, with small crystals of feldspar and quartz. The rhyolites are also characterized by their high silica content, with silica levels of over 70%.

The rhyolites are thought to have formed through the process of partial melting of the Earth's mantle, with the resulting magma rising to the surface and cooling slowly. The resulting rhyolites are characterized by their high density and their resistance to weathering, making them a valuable resource for construction and other uses.

THE VOLCANIC ROCKS

The volcanic rocks found in the Butte special district are characterized by their fine-grained texture and their glassy appearance. The volcanic rocks are also characterized by their presence of minerals such as plagioclase, pyroxene, and olivine.

The volcanic rocks are thought to have formed through the process of eruption of magma from the Earth's crust, with the resulting ash and cinders forming a layer known as volcanic ash. The volcanic ash is then compacted and cemented to form volcanic rock.

THE GLACIAL DEPOSITS

The glacial deposits found in the Butte special district are characterized by their presence of till and glacial drift. The glacial deposits are also characterized by their presence of rocks and boulders that have been transported by glaciers.

The glacial deposits are thought to have formed through the process of erosion of the Earth's surface by glaciers, with the resulting debris and rock being transported and deposited in areas downstream.

THE HYDROLOGY

The hydrology of the district is characterized by a network of streams and rivers, with the Butte river being the primary drainage feature. The streams and rivers are characterized by their presence of rapids and waterfalls, with the water flowing quickly through the area.

The streams and rivers are also characterized by their presence of fish and other aquatic life, with species such as salmon and trout being found in the area. The streams and rivers are also characterized by their presence of wetlands and other water bodies, which provide habitat for a variety of birds and other wildlife.

The water in the streams and rivers is characterized by its presence of minerals and other contaminants, with the water being used for a variety of purposes, including irrigation and domestic use.

THE LAND USE

The land use in the Butte special district is characterized by a combination of mining, agriculture, and other uses. The mining operations are the primary source of income for many residents, with the rocky and mineral-rich terrain providing a rich resource for extraction.

The agricultural activities in the area are characterized by the presence of crops such as wheat and barley, as well as livestock such as cattle and sheep. The agricultural activities are also characterized by the presence of irrigation systems, with pipelines and canals providing water for the crops and livestock.

The other uses of the land in the area include recreation and tourism, with the scenic beauty of the area attracting visitors from around the world. The area is home to a variety of parks and trails, which are used by hikers, joggers, and other outdoor enthusiasts.

The land use in the area is also characterized by the presence of infrastructure, with roads and other transportation networks providing access to the area.

THE ECONOMY

The economy of the Butte special district is characterized by its reliance on mining, agriculture, and other industries. The mining operations are the primary source of income for many residents, with the rocky and mineral-rich terrain providing a rich resource for extraction.

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The other industries in the area include manufacturing and other services, with the area home to a variety of businesses and industries.

The economy of the area is also characterized by its dependence on infrastructure, with roads and other transportation networks providing access to the area.

THE SOCIETY

The society of the Butte special district is characterized by its diversity, with a mix of cultures and ethnicities represented in the area. The area is home to a variety of communities, with concentrations of people from different backgrounds and cultures.

The society of the area is also characterized by its reliance on traditional knowledge and practices, with the local people using the resources of the area in a sustainable manner.

The society of the area is also characterized by its emphasis on community and cooperation, with the local people working together to solve problems and address challenges.

THE ENVIRONMENT

The environment of the Butte special district is characterized by its natural beauty, with the area home to a variety of plants and animals. The area is also home to a variety of ecosystems, with the forested areas providing habitat for a variety of bird and animal species.

The environment of the area is also characterized by its dependence on natural resources, with the area home to a variety of minerals and other resources.

The environment of the area is also characterized by its dependence on infrastructure, with roads and other transportation networks providing access to the area.

THE FUTURE

The future of the Butte special district is characterized by its reliance on mining, agriculture, and other industries. The mining operations are the primary source of income for many residents, with the rocky and mineral-rich terrain providing a rich resource for extraction.

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dark-colored rock occur in the granite in a few localities. These include a weather less rapidly than the rock containing them and they project sharply above the weathered surface. Such fragments have a much larger proportion of the dark-colored minerals and are fragmental in character. The basic contacts of the great granite mass, and are believed to represent portions of a partly hardened basic diorite phase of the Butte granite, the lower being termed "bowlder" contacts, and the upper "fault" contacts, and the slopes immediately east of the summit afford very striking examples of this peculiar weathering of granite.

At various places throughout the granite area occasional bowlders occur in situ, but it is seldom that rock is found within the district.

The fresh rock is found only in the railway cuttings and the mine workings. In all the natural exposures the rock is well jointed but is so loosely cemented that it may be easily cumbled between the fingers. This is the "common" granite throughout the district and often extends to a depth of 20 feet or more. Where rocky outcrops occur the surface levels off and the planes cumberable to the tires and broken by the heavy winds. The prevalence of extensive disintegration accounts also for the lack of outcrop. In the absence of precise definition of the eruction of the loose rock is rapid, and the drainage channels are checked with sand. The jointing of the granite absents water readily, which assists in the further disintegration of the rocks.

True alteration, or decomposition of the granite, as distinguished from disintegration, has also occurred extensively throughout the district. It is most marked in the bluish-mica schist, but it also occurs traversing the rocks or along the walls of minor veins, where it has produced changes in the mineral composition and physical composition of the rocks. In extreme cases the granite is altered to soft clays, and in many mines the hard waste rock is found on the dump-heaps at the small plastic clay after exposure to the air. This alteration is due to both surface and vein water, and is most marked by a rusty staining of the rock. When this alteration is more complete the bluish-mica plaque diminishes, the biotite granitic augen increase, and the sliver plates which occupy the place, and the felspathes are opaque white masses of clay-like material (generally termed "cloudy granite"). This alteration is known as the Ammona Hill district. The reason this area has been so altered by the mineralizing agencies which produced the great veins is due to the presence of the original character. Owing to the presence of much secondary silica the rock does not disintegrate into the usual clay-wand material, but breaks into sharp, angular fragments which cover the steep slopes of the hill.

The granite is traversed by joints and shear planes, which are prominent where fresh exposures are seen. These fissure systems are of different ages and bear various relations to one another. The oldest joints are in part filled by spilite; these fracture planes are wide, parallel, and bear the characteristics of the cooling granite. Later fractures which cross the spilite dikes were formed during several periods before and since the main period of the rock was deposited. In parts of the productive area these fissure planes are so close and so numerous that the rock is reduced almost to a breccia. In the northeastern part of the district, north of Mender-ville, the jointing is less abundant but is more apparent in its effects, and jointing planes which shoot the rock are from a few inches to many feet apart and furnish planes of ready weathering, separating secondarily formed monoliths and bowlders which form the very striking scenery noticed from the Great Northern train.

The rock is a fine-grained diorite, the rocks being sometimes occupied by veins, a few of which have been worked. Good exposures of the gray granite are seen at the northern end of the railroad. The exposure of the granite in the productive area may be seen.

Many of the railroad cuts in the slopes above the city.

The Butte granite has already been stated to be of post-Carboniferous age, for it is a part of the great granite complex of that date.

**Aplites**

Aplites occur in unusual abundance, covering large areas in the western half of the district. It is a granitic or finely granular, aldi-

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A dark-colored, glassy rock is the most prominent variety seen. A brecia composed of pieces of black glass cemented by a steel-gray or brownish-gray matrix. The black glass is glassy or vitreous, showing abundant quartz and glassy sandstone-feldspar crystals in a black, glassy groundmass; the pieces in the brecia vary in size, being commonly angular and well defined. The brownish or gray paste, when examined under the microscope, shows a delicate, white, needle-like substance that must be termed a dust. This is confirmed by chemical analysis which shows it to be a dust of potassium. Where the rocks are exposed the black glassy weathering relief.

Besides these fragments of glassy rock, other varieties occur. One form is banded rhyolite of a steely-gray color, dense, but showing slight variation in texture along prominent flow lines, and stipped with abundant minute phenocrysts of white feldspar. This type is common in the drift on the sides of The Butte. Fragments of rhyolite, red and gray, and more rarely green, are seen. Another or matrix of the vent breccia in pale-gray or brown, dense rock, which, when studied under the microscope, is seen to be a closely packed, fine-grained, rock. The grains are angular and black, and it is difficult to distinguish them in the field. The common feldspar, feldspar, is generally found in the breccia, and have been prospected on the southern flanks of The Butte. The contact between the granite and the breccia is well marked in nature. The breccia is very irregular, and the granite itself is in part a fault breccia, but shows recent alteration.

Extrusive rhyolite—Extrusive rhyolites are the common form of the rock in the northwestern part of the district. They are usually recognized by the yellowed as a fragment in character. They consist of angular fragments of lithoidal rhyolite firmly cemented together with fine particles of similar material. The rocks are of rather uniform types and appearance. Varieties rarely occur, and although remnants of massive form exist they are small in amount as compared with the breccia and are seldom over a few inches in diameter and are very uniform in size; neither tuff beds nor coarse breccia are noticable parts of the formation. The rocks are generally massive, and their weathering is very rapid. The extrusive rhyolites vary in thickness, but are often a few feet thick. They are very fine-grained, and the surface is usually rough, with a few small fragments of glass interspersed. The extrusive rhyolites near large areas are often very rich in silica, and they are recognized by their abundance of glassy fragments. The extrusive rhyolites near large areas are often very rich in silica, and they are recognized by their abundance of glassy fragments. The extrusive rhyolites near large areas are often very rich in silica, and they are recognized by their abundance of glassy fragments.

The slopes of the benches show horizontally stratified, thin, red-weathered, and the gravels are generally rounded, not flat but slightly lenticular. The pebbles show a slightly altered surface and are sometimes weathered, and the pebbles have been cemented by percolating water carrying iron, limonite or oxides of iron.

A peculiar feature is the material washed into a lake which covered the Silver Bow Valley west of Butte, extending south across what is now the Butte mining district. The lake filled the eastern basin of the region, and the shore line of this lake was within the district described, but the deposits were continuous westward and northward to places where the alluvial deposits have been washed away by the Silver Bow and Blacktail creeks. The terrane was then the alluvial deposits and, traces of these terranes later took place after the period of ore deposition, so that the area of the ore must be pre-Miocene.

The area shown on the map as covered by alluvium includes those parts of the district where the rock-bed is concealed by a mantle of recent detritus. This includes, therefore, the alluvium of the stream bottoms, the sand which covers the floor of the river which flows through the valley, the washes, and the gravel deposits along the stream banks and other water-laid material. The alluvium is the result of weathering and mechanical disintegration of the rocks in the surface strata, and is composed of composed of granite and aplite. The tuff beds are formed of fine rhyolite ash, which also enters into the composition of the sandstones and conglomerates. The stony clays show no bedding, or only such as are too subtle to be recognized in prospect. The surface of the material forming the tuff beds is discernible only under the microscope. It is a volcanic dust, the product of an escape from the fractures of a rock, and is composed of fine particles of glass and feldspar. It is composed of minute angular particles and shards of glass which chemical analysis shows to be quartz and feldspar.

These deposits form the level benches and almost flat slopes west of the district, only a small area being present in the immediate vicinity of the town. Topographically the area differs markedly from the rest of the district. The country covered by these deposits is the typical valley bench land, as common in the State, devoid of timber, but covered by sagebrush and from a distance looking like a burt-colored field. Natural outcrops are poor and are seen only in the cut banks of dry channels. The material washes down and is often available only by the bars, light-colored pools or spots on the slopes. Near the hills the surface is broken by numerous small streams. The deposit of mixed shale and sand is seen on the map by the lines.

The yellow clay is rich in iron and calcium. The Prospect shafts sunk in these benches to depths of over 60 feet show only stony clays. The yellow clays are made up of mixed sand and silt, which is deposited by the streams and is removed by the wind. The yellow clays are made up of mixed sand and silt, which is deposited by the streams and is removed by the wind.

ECONOMIC GEOLOGY OF THE BUTTE SPECIAL DISTRICT.

The Butte Special map, which represents the surface features of the Butte mining district, covers an area a little less than is the same size as Butte, but a more complete and accurate map shows the area of the town to be about 5.5 miles in extent, or about 333 square miles, which is included between 43° 30' and 44° 00' of north latitude and 120° 30' and 121° 30' of longitude west from Greenwich.

The town of Butte is the center of the district, which is formed of rock ejected since the period of mineralization, is a sharp one, almost in all its parts. The town of Butte is the center of the district, which is formed of rock ejected since the period of mineralization, is a sharp one, almost in all its parts. The town of Butte is the center of the district, which is formed of rock ejected since the period of mineralization, is a sharp one, almost in all its parts. The town of Butte is the center of the district, which is formed of rock ejected since the period of mineralization, is a sharp one, almost in all its parts.

Development—As has been seen with most of the important mining districts of the West, Butte was founded on the mining of copper. The first practical discovery of gold-bearing gravels was made in 1864 along Mio-

The town of Butte is the center of the district, which is formed of rock ejected since the period of mineralization, is a sharp one, almost in all its parts. The town of Butte is the center of the district, which is formed of rock ejected since the period of mineralization, is a sharp one, almost in all its parts. The town of Butte is the center of the district, which is formed of rock ejected since the period of mineralization, is a sharp one, almost in all its parts.
1879-190 for making copper matte or regal of the copper industry may be said to have been established on a permanent basis. In the following years the Parrott and Coons smelters were erected, to treat the ore respectively, and the Anaconda lead, which was first worked for silver, began to develop its enormous bodies of rich copper ore, the workings passed below the zone of oxidation.

In 1881 the first railroad reached the district. The expense of building the last link, from the town of Silver Bow up, was borne by the shareholders of the Anaconda.

From that time to the present the development of the copper industry has been steady and rapid. The town of Butte has become a city which, including the suburbs, has over 40,000 inhabitants. Several large smelting plants are busy reducing its copper ore, five within the city limits of the district and two outside, at Anaconda and Great Falls, while another is building up.

The present productive capacity may be estimated at 270 to 300 tons of copper daily. Bessemer converters are used for reducing the matte directly to the metallic state, and electrolysis for refining the copper. An interest in the largest company, the Anaconda, which produces one-third of the total copper product of the district, has recently been sold to English capitalists at a rate which is said to represent from 50 to 70 million dollars for the whole property. This company has enormous reduction works at Anaconda, another of which, at Chino, 7000 inhabitants have been built, and a railroad connecting the one houses of its principal mines with these works.

The principal copper mining companies of the company, the Anaconda, St. Lawrence, Neverest, Moun
tain Creek, Green Mountain, Wake-up-Jim, Diamond Bell, High Chief, Bond, Parrott, and Ground Squirrel. The next largest company is the Boston and Montana, whose most important mines are the Mountain View, Coeur d’Alene, and Pennsylvania. It has a large new smelting plant at Butte, which a town of over 7000 inhabitants has been built, and a railroad connecting the one houses of its principal mines with these works.

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There are many distinct districts of frac
turing of the rocks of this district, which have produced a multiple system of fissures so complex that it is not possible in all cases to distinguish between the fissures formed during the various periods. It is not possible to say whether the fissures are distinct from one another or whether they are connected.

All of the fissures are of great importance in the mining of copper, as they are the means by which the ore is brought to the surface. The direction of the fissures is also of great importance, as they are the means by which the water is removed from the mine.

The most striking feature in the vein system of Butte is its uniformity of direction. All the fissures are oriented in the same direction, and in all cases the fissure is perpendicular to the surface of the earth. This is especially true of those at considerable distances from the center of production, or on the edge of the district.

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There are two principal kinds of secondary veins. In the first, the secondary veins are not closely associated with the main veins, but are usually formed a short distance from them. In the second kind, the secondary veins are closely associated with the main veins, and are usually formed a short distance from them. In the first kind, the secondary veins are usually formed in the same direction as the main veins, and in the second kind, they are usually formed in a direction perpendicular to the main veins.

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and cross or dip faults, which are nearly at right angles to the vein's course.

The strike faults are generally seen as fissures or zones of trituration material containing well-rounded fragments of the surrounding material, from a few inches up to many feet in width. It very frequently happens, especially in the upper parts of country rock, that the fractures become so much that their filling becomes a soft, white pellable mud, which runs when the fissures are opened. They frequently conduct water, and when the vein as the vein, sometimes depart slightly from it, and in one instance produce a marked step-faulting of the vein along the strike. These fault planes in the footwall-country, but near the vein, is called the Footwall-vein. Its course is generally more direct than that of the vein itself, and in places it actually in contact with the footwall. It contains in this case a certain amount of secondary material. Where these strike faults cross the vein, as they sometimes do at a low azimuth angle, a slight amount of displacement of the vein is sometimes perceptible, and in others movement is indicated by striated surfaces, but it has not been possible to determine the actual distance of the slip and so no attempt has been made to indicate these faults on the map.

The claim faults are less frequent but more noticeable, because they generally cause a slight displacement of the veins. As far as observed they are always more frequent along the vein itself, and their plane lies rather flat, the dip being generally 60° and 45°. The inclining has been traced in some instances by the downthrow towards the footwall. The existence of the fault at the time of the examination, but few of these faults could be noted, and their planes probably exist in much greater proportion than is indicated by those represented on the map.

As will be shown later, there is evidence that both these systems of fissures have been channels for the entrance of solutions, probably descending from the surface, which have caused a much greater amount of secondary deposition and transposition of vein material.

**DISTRIBUTION OF ORE**

The economically valuable ore of the Butte district is found exclusively in the older rocks—plutonic, aplite, or quartz-pyrophyllite. A few prospecting shafts have been sunk on what appeared to be veins within the area of the recent rhyolite intrusion, but these in most cases have been proved to be vein-bearing ridges of the older rocks, from which the rhyolite has been removed more or less completely denuded. A slight secondary mineralization has apparently taken place on some joint planes in the rhyolite, but has thus far proved valueless.

The copper veins are found only in the granites, which is a very hard rock in which the ore is massively disseminated by a uniform chemical composition. The silver ore, on the other hand, occurs almost invariably in the basaltic grano or very asboid, but they are less extensively developed in the area of the latter rock. There is no distinctive feature in the area of either that can be with certainty ascribed to the influence of the cooling wall rock. Quartz-pyrophyllite, which is of relatively subordinate geologic importance, is found only in the copper ore, and the silica veins which have a general parallelism with the vein. It is, however, sometimes cut by them, thus proving its earlier intrusion. It is generally over foot wall, but as far as has been observed has had its strike and dip parallel to the vein.

It is with difficulty traced in the underground workings, owing to the universal alteration of the country rock, and is still more so at the surface, owing to distillation. Hence in certain places it may be more widespread than is indicated on the map.

From a commercial point of view the deposits are divisible into three classes. The silver deposit and the copper deposits, both of which contain a small proportion of gold values, which locally are so concentrated as to render them a part of the product as constitutes an important part of the ore. Mineralogically the distinction between these two classes of deposits is less sharply defined, for the copper veins always carry silver, and many of the veins which were originally open-cast in the north tend west in the most of the veins there is a gradual decrease in copper-bearing, so that the ore finally at the end of the fall becomes the silver and gold for copper. Yet the typical ores of either class are characterized by distinctive and well-marked associations, and each includes certain combinations that are not found in the other class.

The general distribution of the silver-bearing copper veins is graphically represented by the distinctive character of their respective tracts on the map, with the nearly parallel position of the eastern half of the district. No copper-bearing minerals are known in the area west and directly south of the Butte. As regards the vertical distribution of the ores, their limits in depth have not been determined.

The Alexie and Livingston mines have been opened to a depth below the surface of 1500 and 1450 feet (460). Respectively, the Moulinet to 800 feet, the Bluebird and the Nettie to 600 feet (1800). The other silver mines have not, as far as known, passed a depth of 400 feet. It is said that silver ore of the ores in these veins has been decreased with depth, but the deposit cannot be verified this statement, which is, in probably, not true as a general statement applicable to all these veins.

Most of the large copper mines, on the other hand, have gone to depths of 1000 to 1500 feet or more. The lowest workings in the principal copper ore is from 4400 feet (in the Gagnon) to 5600 feet, the lowest levels of the Alexie and Livingston are 700, Lawrence, Parrott, Mountain View, Leonard, Modes, Silver, East, and Gray Rock, mountains, Silver, Big Hill, Ground Squirrel, and Snow being all below the latter level.

**Ore deposits.** In the western part of the district, the copper veins separate into two distinct belts or groups, between which lies an intermediate or transitional area. The Alexie minerals are separated from the Alexie minerals by a series of barren veins. The northern belt consists of the Syndicate lode, on which are situated, commencing from the west, the Moscow, Pounin, Buffalo, Mountain Con, Ground, and Wakeup Jim mines. Farther east it is a multiple system of veins, consisting of the Speculator, Bell, and High Ore veins in the East Gray Rock and Bellon mines. On the other hand, the southern belt of the Mineralex mines is the same in the name of the mine. The southern belt commences on the west with the Magpie and Parrott lodes. It is then divided into two distinct belts or groups, between which lies an intermediate or transitional area. One extends eastward through the grounds of the original, Parrott, Anaconda, and Montana mines. The other extends toward the mountains, the Columbia rock, across the line of the Missouri. The southern belt of the mineralex mines is the same in the name of the mine. There is a distinct feature in the area of either that can be with certainty ascribed to the influence of the cooling wall rock. Quartz-pyrophyllite, which is of relatively subordinate geologic importance, is found only in the copper ore, and the silica veins which have a general parallelism with the vein. It is, however, sometimes cut by them, thus proving its earlier intrusion. It is generally over foot wall, but as far as has been observed has had its strike and dip parallel to the vein. The ore deposits are divisible into three classes. The silver deposit and the copper deposits, both of which contain a small proportion of gold values, which locally are so concentrated as to render them a part of the product as constitutes an important part of the ore. Mineralogically the distinction between these two classes of deposits is less sharply defined, for the copper veins always carry silver, and many of the veins which were originally open-cast in the north tend west in the most of the veins there is a gradual decrease in copper-bearing, so that the ore finally at the end of the fall becomes the silver and gold for copper. Yet the typical ores of either class are characterized by distinctive and well-marked associations, and each includes certain combinations that are not found in the other class.

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rock cemented by vein material (both included under Poirie’s general term, "dikes").
(2) Great irregularity in the width of the ore body, which sometimes reaches enormous dimensions in the copper lodes, in some cases exceeding 100 feet; an average in the prominent veins may be taken at 8 to 40 feet. (3) General lack of definition as to location of ore bodies, which are governed by variations in the chemistry of the rock. Under the bentonite gold deposit found in the North Branch of the river, its location is known only through the con
tinuous presence of the mineral shown by the assays. The copper vein of the same locality is known only through the tellurium content, which is constant and in such amount as to render it probable that the gold occurs as a telluride. It is not known whether the tellurium occurs in the silver veins.

Minerals of copper, except chalcocite, bornite, and chalcopyrite, form a well-developed clearness but no crystal outlines. In color, it is brownish-black. It is widely distributed through the copper veins, but is particularly abundant in the Huron and the lower levels of the Gagnon mine. It appears to have formed as an original vein mineral subsequent to the formation of chalcocite and bornite and is the most recent of the copper minerals to appear.

Bornite has been found only in the copper veins of the cuprian mass which show a well-developed clearness but no crystal outlines. In color, it is brownish-black. It is widely distributed through the copper veins, but is particularly abundant in the Huron and the lower levels of the Gagnon mine. It appears to have formed as an original vein mineral subsequent to the formation of chalcocite and bornite and is the most recent of the copper minerals to appear.

Chalcopyrite (cupro-nickel) has been found in both the copper and the silver veins, but is limited to the northwest silver belts and to the copper veins of the upper districts. The copper mineral is usually massive, but has been found in crystals. It is an original mineral which occupies a position in the formation of the ores subsequent to the formation of the copper minerals and prior to the development of the silver minerals corresponding to it.

Cuprite (red oxide of copper) is found only in the massive chalcopyrite of the cuprian mass. Although rare, it is usually associated with chalcocite and native copper, or occurs as a darker rim about the mass of cuprite, or forms a small proportion of the black powder immediately under the zone of complete oxidation. It is usually found in the altered country rock.

Molybdenite and molybdenite, both green and the blue carbonates of copper, molybdate and aurite, have been found, but they are no longer found in the veins of the mine which have been won away or covered up.

Chalcanthite (bluestone) is by far the most common accessory mineral of the cuprian mass of the oxide zone. It grows in all the old mine workings, forming either on the ore minerals or on the wall rock. It is a friable material, and as the oxidation of the older and less resistant of the copper veins has taken place, it has formed a large amount of chalcanthite, which is found in the cuprian mass of the mine.

Molybdenite has been found only in the Gagnon and Nevevres mine. It occurs in plates and crystals, is a greenish-gray thin in joint planes of fresh granites.

Quartz is the most abundant mineral of the cuprian mass of the mine. It is found in amounts varying from 1 to 80 per cent. It has both pre
ceded and succeeded pyrite and chalcopyrite, and its occurrence is governed by any extent of the rich copper minerals. In the silver veins quartz is even more abundant than in the copper veins. It is forming a large part of the growth of these veins, and with the exception of quartz is found enclosed and enclosed by all the other minerals, ordinary by the oxides of the molybdenite and the gangue minerals. It has formed most abnormally, however, just before and after pyrite and chalcopyrite.

Barite (barium spar) occurs sparingly, and in the majority of cases in the copper veins. It forms small, clear crystals, transparent, and tinged yellow, these crystals
forming in fractures of the vein and coinciding surfaces that have been or are distinct water channels. ‘Pleat’ is not unusual in such veins, but it has been reported from a number of mines, and several specimens were seen. It is associated with altered granite or country rock. It has formed subsequently to the original vein as the result of decomposition of the granite.

Celestite appears to be sparingly and has been observed in but one small vein as a gummy mineral. It is usually associated with quartz and in fractures of the vein or country rock, and has formed subsequently to the original vein as the result of decomposition of the granite.

Gypsum has been noted frequently. It occurs as incrustations on the walls of old mine workings or in mine dumps. The fractures or joints in the decomposed limestone and the atmosphere, and in the case of mine dumps to the south of the mine are the cause of variations in the color of the fracture or joint surfaces. The microscope is used to see the efflorescence. It is a product of the vein solution, but whether or not the vein solution contains efflorescence is not known.

Brazil occurs in both the silver and the copper veins. Magnesiochlorite is usually found in the quartz fracture surface and is depicted by the white, grey, and trace of these surfaces. Under the microscope it is seen to replace the efflorescence. It is a rare member of the efflorescence, but it is not known in the case of the vein.

**Pulpver—Loc.**—It was upon this locale that the first discoveries and earliest developments of copper ore were made. It has now been traced almost contemporary to the Shasta or the Shasta to Silver Creek, a distance of about 15 miles, and in the eastern part of the country for a distance of about 7 miles. The present development of the main vein is along a series of claims known as the North Star, which stands at 35° 30' 30" to 36° 30' 30", and is about 500 feet wide, carrying much copper. The mine is known as the North Star, and is located on the Main Vein, 1000 to 1400 feet below the surface, or about an elevation of 4600 to 4600 feet.

**Lagunitas—Loc.**—This is a small vein, which sometimes joins the vein at one end, thus constituting a sort of spur vein. Through the western part of the mine, it is known as the South Star, and it is 500 feet wide, carrying much copper. The mine is known as the South Star, and is located on the Main Vein, 1000 to 1400 feet below the surface, or about an elevation of 4600 to 4600 feet.

It is commonly used near east and west, and with a slight divergence to the south of this line at either end, constituting a series of veins, which become barren within a few hundred feet of the main vein. The lode has a dip of 35° at the surface, decreasing to 40° below the 800-foot level, and the 600-foot level at 900 feet above sea level. The mine is 400 feet wide, carrying much copper. The mine is known as the South Star, and is located on the Main Vein, 1000 to 1400 feet below the surface, or about an elevation of 4600 to 4600 feet.

**Mountains View—Loc.**—The lode consists of a series of spur veins in which the "eichholz" structure is more conspicuous than in any other lode. The lode is 40 feet wide, carrying much copper. The mine is known as the South Star, and is located on the Main Vein, 1000 to 1400 feet below the surface, or about an elevation of 4600 to 4600 feet.

**Silver Loops—Loc.**—This system comprises a series of parallel veins striking either east and west or about 45° E., and extends north and south, with a slight deviation to the north. It has been traced eastward to Silver Creek, a distance of about 5 miles, and is about 500 feet wide, carrying much copper. It is known as the South Star, and is located on the Main Vein, 1000 to 1400 feet below the surface, or about an elevation of 4600 to 4600 feet.

**Rainbow System—Loc.**—This system comprises a series of parallel veins striking either east and west or about 45° E., and extends north and south, with a slight deviation to the north. It has been traced eastward to Silver Creek, a distance of about 5 miles, and is about 500 feet wide, carrying much copper. It is known as the South Star, and is located on the Main Vein, 1000 to 1400 feet below the surface, or about an elevation of 4600 to 4600 feet.

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their dip is uniformly 70° to 85° S. Those near the Rainbow lode have thus far proved the rich test. The Valdemore and Moose are very productive, the Hawkseye only a little less so. They have been disturbed somewhat by secondary crossfaulting. At least four crossfaults were noted in the Belle of Butte mine, of which the largest threw the vein 60 feet southward on the east.

In the northwestern group the veins, northward, are the Silver Safe, Moulton, Amy, and Goldsmith. They are less uniform both vertically and strike dip. The dip is in the Silver Safe 45° S. at the surface; steepening to 45° at 200 feet. The Moulton and Amy have normal southern dips, and the Goldsmith dips 80° N. for 300 feet from the surface and then heads south. The strike changes to the westward, and finally assumes the bow to the west. The average width of the veins is 4 feet, the extreme variation from which is not over 3 feet.

The northeastern veins are observed just east of the Magna Charta shafts, where they connect with the Valdemore vein with the Rainbow lode. They dip south at a lesser angle than usual, and the most prominent one splits upward, one branch having a dip of 45° to the northwest. They have about the same average width as the southeastern veins.

Examination—The line of separation between the veins of this group and those of the Rainbow system is somewhat arbitrary. The veins have been traced continuously from Missoula Gulch eastward more than 5000 feet to the West Gap Rock mine. Though numerous, they do not seem to be closely related. The course of these veins forms a curve similar to that of the Rainbow lode, but without the minor distortions. The strike at the west end is N. 75° E., at the east end S. 65° E., and at the center nearly east and west. The dip is south at an angle which diminishes southward.

The Blue Wing lode forms the northern limit of the group. It consists of two veins 50 to 200 feet apart and has been cut in the workings of the Paymaster, Blue Wing and Lexington mines. The ninth vein splits between the 100-foot and 200-foot levels and forms two veins 20 feet apart. The dip is at 50° S. and vertical.

In width the vein rarely exceeds 5 feet. The south vein is parallel to the north vein and has been found to be throughout a single vein, varying in width up to 25 feet. Like the north vein, the ore, though irregularly distributed, is exceptionally rich in gold and silver. Between these veins, from 500 to 600 feet from the surface, there are a large number of small veins.

The Allie Brown vein, next south, has been worked through the Lexington Company’s shafts. It is parallel in course to the Blue Wing, but its dip is more nearly vertical, or even locally to the north at a high angle. It is a strong vein, averaging perhaps 5 feet in width, though locally 20 feet wide, and sometimes includes large lens-shaped bodies of granite.

South of the Allie Brown vein is the Wappello, which consists of a number of parallel veins, only one of which is persistent throughout the workings of the mine. Near the surface and north of the Lexington shaft the main vein splits into a number of small veins, which seem to diverge downward.

These veins are not persistent, and when they die out are frequently replaced by another smaller lens of vein matter in the adjacent country rock, which continues both longitudinally and vertically beyond the original spine. At its east end the main vein splits into a number of smaller veins which are nearly parallel to the main vein. These form the workings of the Sisters, the Flag, the Josephine, and the West Gray Rock, but in none of these mines does the vein have the size or richness of the parent lode. The Wappello lode dips south at an angle of 70°. It has an average width of 5 feet, but locally broadens to several times this width.

The last lode south was not well seen except in the Lexington mine. It parallels the Wappello, but dips to the south at a lesser angle. It splits at the east end, forming the two south veins of the West Gray Rock.

The Playa lode in the most southerly of the lodes in this group, and forms the southern limit of the northern silver belt. It consists of a series of short connecting veins which have been traced on the surface from Missoula Gulch to Main street.

Examination—North of the Rainbow lode are many veins which become gradually less numerous northward, until just beyond the northern limit of the district they cease. They are the Silver Lick, Glengarry Silver, Fricka, Waldo, Springfield, Black and others. They are small veins, rarely exceeding 5 feet in width, and have not been good producers. Their course is a few degrees north of east and their dip always at a high angle, whether to the north or to the south. None of these veins have been followed more than 400 feet in depth, and most of the workings do not exceed 200 feet.

In the eastern portion the outcrops rarely extend above the enclosing country rock; hence the veins, though numerous, appear to be much less persistent than they probably are. In the western portion the veins, though not numerous, are very persistent, and appear as narrow projecting ledges rising from 1 foot to 10 feet above the enclosing country rock. It is largely due to this fact that the crossfaults which dip the Blackstone and the Wabush veins could be recognized.

Interconnection—Between the western extension of the Patrocl and the Syndicate lodes is a small area of silver veins extending possibly 3000 feet east of Missoula Gulch. The veins of this area have two distinct directions. Those adjacent to the Syndicate lode have a southeasterly course, while those near the Patrocl lode run nearly east and west.

Of the latter, the Late Acquisitions is the most important. This lode consists of a single vein at the east end, with a steep southerly dip. At the west end it becomes complicated by a number of spurs and small, parallel veins. On this lode are the Late Acquisitions, Little Joe, Mount Moriah, Anselmo, Bernard, and Trölo mines. The veins rarely exceed 5 feet in width.

The Balm and Clear Gribe units are the prominent western lodes of this area, but they are not known to connect with the Late Acquisitions, toward which they converge easterly.

The Balm lode consists of four veins, of which the two southerly join longitudinally, and judging from their dips, also in depth. The two northerly veins seem to diverge eastward, but the more southerly one dips north at a small angle and probably joins the northern vein in depth. The Clear Gribe lode is an important mine in early days, but its workings are no longer accessible. The Ancient-Star-West group. In the southwestern corner of Butte and east of Missoula Gulch is a complex group of veins in which the prevailing strike is N. 45° E. and W. 45° E. To the north, the ancient part belongs the Ancient or Better of Missoula Gulch, a broad zone of highly altered and manganized rock, which forms a ridge 100 feet high and has been traced nearly 4000 feet from the gulch. The Neptune and Stevens, to the north, in a similar direction.

Among the more important is the Nettie lode, which has three veins that have been traced underground from the contact with the serpentine body westward about 2000 feet. They are broken and slightly displaced by three cross-faults whose plane dip east, and are cut diagonally by a dike of rhyolite, which is 200 feet thick on the 600-foot level of the Nettie mine and narrows upward. Westward the ore deposition has been resumed on veins arranged en echelon, the Independence to the north, and the Fredonia mine to the south. The Bluebird lode is a strong single vein, whose dip is very irregular, becoming in places flat for considerable distances. It was followed about 3000 feet and opened to a depth of 600 feet; in the last hundred feet the vein proved to be on the contact between aplite and granite.

At the Goldfield, in the northwest corner of the district, in an area of granite surrounded by rhyolite and aplite, is a series of short veins running in three different directions, which stand vertical or dip to the south. Their area is said to have been unusually rich in gold, but work on them ceased long ago.

SAMUEL FRANKLIN EMMONS, GEORGE WARREN TOSSER, JR., Geologists.
forming another gradation into sedimentary deposits. Some of this glacial wash was deposited in streams and channels in the ice, and formed the 'platoeone' ridges and drums, which are now gravelly or sandy, or talus, and is the material, deposited in the ice, and subsequently, during the retreat of the ice, formed a plateau, and later on modified, is now called a drift; that washed from the ice onto the adjacent land is called modified drift. It is similar to the drift formed by the ice, and made by the same river and streams and lakes that were made at the same time as the drift deposit.

**Ages of Rocks**

Rocks are further distinguished according to their relative ages, which are determined at one or more times, but from age to age in the earth's history. Classification by age is independent of origin; igneous, sedimentary, and surficial rocks 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 such a formation is the unit of geologic mapping.

Several formations considered together are designated a *system*. The time taken for the deposition of a formation is called an *epoch*, and the time taken for a system, or a longer portion of the system, a *period*. The rocks are mapped by formations and superimposed on the geologic map, and classified into systems. The rocks composing a system and the time taken for their deposition are given as the age of the surface instance, Cambrian system, Cambrian period.

As sedimentary deposits or strata accumulate the younger rests on the rocks that are older, and the relative ages of the deposits may be discovered by observing their relative positions. This relationship holds true for all the rocks and units of the earth's surface. The age of a rock is determined by the age of the next youngest rock that it rests on, and the position of the rock in the sequence of rocks that it is in. The age of the rock is thus determined by the relative ages of the rocks that are below it.

The rocks are then divided into systems and *epochs*: the older rocks are the beds that are at the bottom of the section, and the younger rocks are the beds that are at the top of the section. The age of the rock is determined by the relative ages of the rocks that are below it.

### The Various Geologic Sheets

- *History Sheet*
  - This sheet shows the areas occupied by the various formations. On the map, a gradient is shown, which is the key to the color map. The gradient is shown as a series of closely spaced parallel lines and a letter-size symbol, which is shown as a series of closely spaced parallel lines and a letter-size symbol, which is shown as a series of closely spaced parallel lines and a letter-size symbol.

### The Platteosum and the Archaean

In clays, cays, shales, and other natural and artificial cuttings, the relations of different beds to each other may be seen. Any cutting which passes through these relations is called a section, and the same name is applied to a diagram representing the relations. The arrangement of rocks in the earth's structure is shown, and a section exhibiting this arrangement is called a *section*.

### The Geologist's Map

The geologist is not limited to the natural and artificial cuttings for his information concerning the earth's structure. Knowing the nature of the formations of the rocks, and having traced out the relations among beds on the surface, he can infer their relative positions after they pass beneath the surface, draw sections 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.

### The Figures in fig. 3

- **Fig. 1:** Shows a vertical section in the front of the valley, with a landscape beyond.
- **Fig. 2:** Shows a perspective view of the valley, with a landscape beyond.
- **Fig. 3:** Shows a side view of the valley, with a landscape beyond.

The third set of formations consists of crystal- line schists and igneous rocks. At some point in the history of the earth, the igneous rocks were pushed by pressure and traversed by eruptions of molybdenum rock. But this pressure and intrusion of igneous rocks were not followed by any significant pressure of the strata of the earth. Then it is evident that an interval of considerable duration elapsed between the formation of the valley and the beginning of deposition of the strata of the earth. During this interval the schists suffered metamorphism; they were the scene of erosion, and they were deeply eroded. The contact between the second and third sets, marking a time interval between two periods of rock formation, is another unconformity.

The section and landscape in fig. 2 are ideal, but they illustrate relations which actually occur. The sections in the structure-section sheet are related to the maps as the section in the figure is related to the landscape. The profiles of the surface in the section correspond to the actual slopes of the ground along the section line, and the height of any mineral-producing or water-bearing stratum which appears in the section may be measured from the surface by using the scale of the map.

### Columnar-section Sheet

This sheet contains a concise description of the rock formations which occur in the valley. The diagrams and verbal statements form a summary of the facts relating to the character of the rocks, to the thickness of the beds, and to the character of the rocks.

### Columnar-section Sheet

The plate in fig. 5 presents toward the lower land an escarpment, or front, which is made up of some of the rocks forming the cliff, and shales, con- stituting the slopes, as shown at the extreme of the section.

The breadth of lower land is traversed by several ridges, which are seen in the section to correspond to beds of sandstones that rise to the surface. The upturned edges of these beds form the ridges, and the intermediate valleys follow the outcrops of limestones and calcareous shales.

Where the edges of the strata appear at the surface their thickness may be measured and the strata 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 eases, such as the section shows. But these sandstones, shales, and limestones were deposited beneath the seas in nearly flat sheets. That they are now bent and folded is regarded as proof that forces exist which have from time to time caused the earth's surface to wrinkle along certain lines.

On the right of the sketch the section is con- trolled by the contour lines, a description of its igneous rock. The schists are much contorted and their arrangement underground can not be shown at present. That part of the igneous rock which is described is probably true but is not known by observation or well-founded inference.

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**Charles D. Wallace, Director.**