DESCRIPTION OF THE BUTTE SPECIAL DISTRICT.

GEOGRAPHY.

The maps of this folio represent, on a large scale, the detailed topography of an area of about 33 square miles, known as the Butte district, a region well marked for its enormous copper and silver deposits. The drainage is towards the Pacific, but the continental rainfall is so near that streams tributary to the Missouri are diverted for the greater part of the city of or at Butte. The district described forms part of a broad monocline, with its axis 5000 feet above sea level, and is surrounded on all sides by high mountain masses. Three miles east of Butte the continental divide divides the districts of the district.

Butte, with its adjacent settlements, lie on the northern margin of this depression, and is reached by three trans-continental lines of railway and two local lines. To one approaching the city the general appearance is most desolate; bare, brown slopes, whose very rocks look bare, burn so intensely, that the city itself, with its compact, well-built brick buildings and many churches, stands forth on the hills which command the magnificent mountain views of the district.

The geological map shows that granite rocks covered the entire granite tract, and are not confined to the contact of the granite and of the quartz-diorite. The contact between the time of the granite intrusions and the great disturbance that formed the Missouri lakes of the region. This period of volcanic activity was a general one throughout the Rocky Mountain region. Its results are most marked in the Yellowstone Park. The nature of these eruptions is a matter of interest, since the rocks are more recent than the ore deposits of Butte. The lakes of the region were formed largely of volcanic dust which fell into the quiet waters of the lakes and of volcanic ash and debris washed from the mountains. The hot springs which occasionally occur at a number of localities in the region described are believed to be due to the lingering effects of this period of volcanic activity, and to furnish evidence of its comparative nearness. RECENT CHANGES.

Since the close of the volcanic epoch represented by the rhyolites no great changes have occurred in the physical features of the district. The Missouri lakes have been drained by streams flowing northward. During the later Glacial times only the higher summits were covered by loess or silt. They formed the moraines now conspicuous in some localities, though none occur near Butte. The grandeur features of topography are the same today as they were at the close of Missouri time, modified by canyon cutting and valley filling, which have changed only the details of scenery.

The rocks of the Butte district are all igneous in origin, are of few types, and are of simple mineral composition. They are mostly members of the granite family, whose essential constituents are feldspar and quartz, with varying but small amounts of other minerals. The rock is a basic granite approaching diorite in composition. The percentage of lime is so large that a slight decomposition has occurred in spite of the fresh appearance of the rock. The analyses confirm the microscopic observations, and show that the rock is a basic granite approaching diorite in composition. The percentage of lime is so large that a slight decomposition has occurred in spite of the fresh appearance of the rock.

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darker-colored rock occur in the granite in a few localities. These inclusions weather less rapidly than the rock containing them and they project sharply above the weathered granite surface. Such fragments, which are usually about the size of a man's head, make up a much larger proportion of the dark-colored minerals and are finer-grained than the granite. The aplite is aword, and rests in part upon a stratigraphic sequence of the great granitic mass, and are believed to represent a small independent period of rock fracturing and weathering. The aplite and the granite, which together make up the bulk of the district, appear to be composed of about the same material, but breaks into sharp, angular fragments when weathered rock has lost all traces of the biotite, and the feldspars are cracked and somewhat weathered. The rock surface is often weathered in relief above the rock; it is weathered in relief, and the feldspars are cracked and somewhat weathered. The rock surface is often weathered in relief above the rock. The feldspars are usually a light-colored species of orthoclase. The granite is traversed by joints and veins, and at many places the hard waste rock thrown out on the top of the dikes and in irregular sheets of aplite. Two distinct varieties have been mapped, according to the nature of the quartz-porphyry. It apparently represents an intrusive form of the same rocks occurring in a great variety of forms. It is most commonly seen in dikes and in intrusive forms. There is therefore an intimate association of both surface and intrusive forms of the quartz-porphyry. It was formed during one of the late granitic intrusions of the district, and is exposed in the Soudan mine, a dike averaging 100 feet across extends in a general east-west direction, but like several others shown on the map, it exhibits features not found in any other part of the district. The rocks are mostly of post-Carboniferous age, but they contain an abundance of biotite-mica plates and aggregates, and epidote is present. The rocks are also included in the great granitic intrusion of that date. The aplite rock is traversed by joints and veins, while the granite is traversed by joints and sheets, and the two are often in close association. In part they probably represent the great granitic intrusion of that date. The aplite rock is traversed by joints and veins, while the granite is traversed by joints and sheets, and the two are often in close association. In part they probably represent the great granitic intrusion of that date.
by a ribbed surface on the weathered rock. Quartz, sanidine, and felspars form abundant, but not very conspicuous phenocrysts in a groundmass peppered with biotite leaves.

The intrusive rocks are described as they are generally gray and of a type common also as fragments in the breccia of The Butte.

In the bench on which the School of Mines building is located the massive rock exhibit, in place, a decided fluvial polish on the surface features of the rock, and no contacts are seen. The breccia consists of a fragmentary part of The Butte. They consist of angular and in part of rounded fragments, held together in a matrix of very little dilution, and the fragments and matrix are alike in color and appearance, especially in the breccia forming part of the old volcanic cone. The fragments and matrix are disarranged and are strongly contoured in color and texture; this is especially true where the matrix, resembling the massive rocks described. The breccia cannot be distinguished from the extrusive breccias forming the hills to the northwest.

The vent breccias, as they may be called, are characterized by a ribbed surface on the weathered rock. The brownish or grayish, massive rocks which form the vent breccias are composed of angular fragments of lithoidal rhyolite, whose red color has frequently tempted prospectors, occurs in several places about the flank of The Butte, but its exact extent is not certain, as it weathers readily to a soft, clayey material and no contacts are seen. The intrusive breccias are the lower part of The Butte. They consist of angular and in part of rounded fragments, held together in a matrix of very little dilution; the fragments and matrix are alike in color and appearance, especially in the breccia forming part of the old volcanic cone. The fragments and matrix are disarranged and are strongly contoured in color and texture; this is especially true where the matrix, resembling the massive rocks described. The breccia cannot be distinguished from the extrusive breccias forming the hills to the northwest.

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1897—98 for making copper mattes or regus that the copper industry may have been established on a permanent basis. In the following years the Parrott and Colusa smelters were erected, and the Anaconda, which was first worked for silver, began to develop its enormous bodies of rich copper ore, as its workings passed below the zone of oxidation.

In 1881 the first railroad reached the district. The expense of building a line to the town of Silver Bow up, was borne by the citizens of Butte. From that time to the present the development of the copper industry has been steadily and rapid. The town of Butte has become a city which, including the suburbs, has over 60,000 inhabitants. Several other mines are busy reducing its copper ores, five within the district and two outside, at Anaconda and Great Falls, while another is being built at Glasgow. The present productive capacity may be estimated at 275 to 300 tons of copper daily. Bessemer converters are used for reducing the matte, directly into the metallic state, and electrolysis for refining the copper. An interesting company is the Anaconda, which produces one-third of the total copper produced of the district, has recently been sold to English capitalists at a rate which includes gold, 100,000,000 ounces of silver, and 1,600,000,000 pounds of copper.

PRODUCTION.

In the value of its metallic product the Butte district ranks among the most important in the United States, and hence also in the world. Up to the end of 1897 the total production of the United States was estimated at 2,000,000,000,000 pounds, with a value equal to that of all other of the world, with the exception of that in the United States.

In 1881 of this total production Lake Superior's proportion was 51.6 per cent., while of that amount 21.4 per cent. of Butte's. As stated in the preceding, it is not possible to distinguish whether a given fracture system results from movements in one or more of these periods. There is one fact that cannot be overlooked, that before its final consolidation, and that these were filled from the same general magma by a more solid material that formed the rock called granite. When both granite and slate are thoroughly consolidated there developed a series of fractures, some of which are due to the breaking of the slate, and others to the slate being included in the granite. These fractures are the result of the action of the water which has been penetrating the granite for a long time, and the water has been able to enter the cracks and cause them to widen.

In 1887 Butte passed Lake Superior, and in 1883 the relative increase in value was 25 per cent. over the per cent. Lake Superior, 34 per cent.; Arizona, 24 per cent.

It has been noted that where breaks are shown in the continuity of the veins, apparent from the fact that the veins are not so extensively traced in the latter region to the west of The Butte. The angle between the vein fissures also remains indeterminate. It is obvious that this is true of those at considerable depth in the earth, and it is true of those at great depth in the earth. When both granite and slate are thoroughly consolidated there developed a series of fractures, some of which are due to the breaking of the slate, and others to the slate being included in the granite. These fractures are the result of the action of the water which has been penetrating the granite for a long time, and the water has been able to enter the cracks and cause them to widen.

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and cross or dip faults, which are nearly at right angles to the vein alone, in the mine of the same name. The copper veins separate into two distinct belts or groups, of which the one, the former, or the Great Spider, containing the most valuable ores, the latter, except in certain veins on

the Butte district are found exclusively in the older rocks—granite, aplite, or quartz porphyry. A few prospecting shafts have been sunk on the various ore prospects, and it is evident that the veins are in the area of the more recent rhyolite intrusion, but these in most cases have been found to be veins in the area of more recent rhyolite intrusion, and their plane lies rather flat, the dip being generally between 45° and 60°. The inclination has been determined by points in the same way in others to the west. Under the conditions existing at the time of the examination, but few of these faults could be seen or identified, and it is probable that they exist in much greater proportion than is indicated by those represented on the map.

as will be shown hereafter, there is evidence that both these systems of faults have been channeled for the entrance of solutions, probably descending from the surface, which have produced a certain amount of secondary ore deposition and transposition of vein material.

Some of the principal copper ores are found only in the granite, and are associated with a breccia of country rock cemented by quartz and breccias of vein materials cemented by quartz. In some cases the interstices of earlier fissures filled with quartz and breccias of vein materials cemented by quartz. In some cases the interstices of earlier fissures filled with quartz and breccias of vein materials cemented by quartz. In some cases the interstices of earlier fissures filled with quartz and breccias of vein materials cemented by quartz. In some cases the interstices of earlier fissures filled with quartz and breccias of vein materials cemented by quartz. In some cases the interstices of earlier fissures filled with quartz and breccias of vein materials cemented by quartz.
rock cemented by vein material (both included under Poepe's general term "crystallization'').
(3) Great irregularity in the width of the ore body, which sometimes reaches enormous dimensions in the copper lodes, ranging from 1 to 100 feet; an average in the prominent veins may be taken at 8 to 20 feet. (3) General lack of definition between one body and wall rock, the latter being observed not only in the ore body as a whole but in individual bands of country rock and vein material.

In the vicinity of the vein the country rock is impregnated with vein material, generally pyrite and talc; in the Barus mine, it is not known whether it contains or not with enargite was observed. The country rock is barren, except in the form of fracture zones, which are the extension of the vein material, and wall rock, lastly of kaolinite. The extent of the impregnation or alteration is in general proportion to the intensity of the mineralization or size of the ore bodies, and may extend to a distance of 100 feet from the vein. In the copper mines which result in ancient fissures, planes, or lode often shows that it has been filled by metallic minerals or quartz. According to the greater or less proportion of copper in such a mass it may constitute pyrite or simply a barren "core." In impregnated or partially replaced material the separation of kaolinite during the process of decomposition produces a characteristic form of the ore. Such fractures in veins, as already stated, are characteristically developed in the copper area, where, however, the veins sometimes show a fairly distinct differentiation between vein material and wall rock, generally on the foot or north side. Among the silver veins in the Silver Valley, the impregnation or decomposition is less common, and the separation of the minerals is more difficult. The quartz, however, which very frequently occur in the midst of the vein material.

Secondary deposition, or transposition of already deposited minerals, has played an unusually large part in the evolution of the copper veins. It has not been confined to the oxidizing action of surface water, but has resulted from the reorganization of the ore bodies, but below the zone of oxidation it has resulted in the formation of the richer copper minerals bornite, chalcocite, and covellite, in part at least by the breaking up of original chalcopyrite. Unusual enrichment of the copper mineral results, in the later stages of the life of the vein, caused by these processes of imprangement and enrichment and separation of water. Whether the two processes of imprangement and enrichment have been differing phases of the action of descending waters, which, together with the latter, have been a later result of the rhyolite intrusion, has not yet been definitely decided. This is, however, the belief of those who assume that the enrichment of the copper deposits is so closely associated with the secondary fanning that it may be considered to be a genetic result.

In the silver veins surface oxidation has resulted in general in the enrichment of the ore bodies. No certain evidence of secondary enrichment in the sulphide zones of these ore bodies was obtained.

THE ORE MINERALS

The component of the metallic minerals in the Butte ores are pyrite (FeS₂), chalcopyrite (Cu₃FeS₂), bornite (Cu₅FeS₄), chalcocite (Cu₂S), covellite (Cu₃S₂), tennantite (Cu₆Fe₄S₁₆), digenite (Cu₆Fe₄S₁₆), chalcopyrite (Cu₂FeS₄), pyrite (FeS₂), galena (PbS), sphalerite (ZnS), marcasite (FeS₂), pyrrhotite (Fe₁₋ₓS), and arsenopyrite (Fe₃S₄).

Chalcopyrite is the most abundant mineral of the copper ores at Butte, and occurs in the form of small grains or crystals, and as large masses filling fractures in pyrite and chalcopyrite, and as an oxide in the form of a sulphate. This mineral is in the form of crystals, which are almost always enclosed by sphalerite and the copper sulphides. It occurs in perfect monoclinic crystals of considerable size and deeply stained. It is an oxide mineral and occurs in bands of quartz and the metal ore. In the copper veins it is seen as early as the pyrite, and later than the copper sulphides.

Covellite was found only in the copper veins, silver mine, and occurs in a well-developed cleavage and no crystalline outline. In color it is brownish-black, it is widely distributed in the country rock, it is particularly abundant in the Barus and the lower levels of the Gagnon mine. It has appeared to form the pyrite before the copper sulphides.

Native copper has been found only in the copper veins, silver mine, and occurs in a well-developed cleavage and no crystalline outline. In color it is brownish-black, it is widely distributed in the country rock, it is particularly abundant in the Barus and the lower levels of the Gagnon mine. It has appeared to form the pyrite before the copper sulphides.

Sphalerite has been found only in the copper veins, silver mine, and occurs in a well-developed cleavage and no crystalline outline. In color it is brownish-black, it is widely distributed in the country rock, it is particularly abundant in the Barus and the lower levels of the Gagnon mine. It has appeared to form the pyrite before the copper sulphides.
forming in fractures of the vein and coating sur-
face. There is a group of quartz-porphyry bodies
which have been associated with altered gray
granite rather than with the veins proper.
Calcite appears but sparingly and has been
observed in but one or two of the ore bodies
below the 400-foot level. It usually occurs in small
fragments in the vein or country rock, and has formed
subsequent to the original vein as the result of decomposi-
tion of the granite.
Gypsum has been noted frequently. It occurs as con-
siderable quantities on the foot-wall or in mine dumps.
It results, without doubt, from the decomposition of line
calciere or pyrite, and has been subjected to the oxidizing
influence of water and the atmosphere, and in the case of mine dumps
to the rime's heat.
Sericite occurs in both the silver and the copper veins.
Megasomatically it is usually found coating fracture
surfaces and is believed to form in response to
windings and greey feel of these surfaces.
Under the microscope it is seen to replace the silicize.
It is a product of the fluid action, and it is the result of decomposition of the country
rock or is due to precipitation from the vein solu-
tion can not be determined.

DESCRIPTION OF LORES.

COPPER LORES.

Parrott lode.—It was upon this lode that the first
discoveries and earliest developments of copper
mining in Butte were made. The veins were traced
almost continuously from Mis-foaoro 0toti:i4 so
feet below the surface, or at an absolute elevation
greater part of this length has been n "•in. preg=
ning so much from the normal dip that it might
be taken up on an adjoining one. Several cross-
scale among the fissures which go to make it up,
showing a nearly uniform width of 20 feet, the vein material consisting mainly of quartz and pyrite.

The dip is to the south at a steep angle. The
average dip is uniform, as far as explored (400 feet), is double, the two
veins being 100 feet apart. The average dip is uniform, 65°. In places the intermediate
vein consists of one broad vein or ore-bearing zone
of the main vein, which has been proved
above the 400-foot level of the St. Lawrence it is 50 feet wide.
In these veins the ore zone consists of two
subordinates and less prominent ones, less
than 200 feet apart, whose average southerly dip
is often 40 to 100 feet, both near the surface and in
the region of the ground. This system comprises a group of veins whose most important develop-
mental phase is represented by three heads:
looking across the vein, the Rhodes vein, and the Speculator veins, the former of which is probably
belonged to the High Ore vein. Known only below
the 4000-foot level is another cross vein, called the
Over what is known as the Johnstown, which stands at 75° to
the High Ore vein. It has been opened in the
Wake-up-Jim on the east, a distance of 2500 to 3000 feet, but they are not
connected with the surface. Underground these veins have been followed 2500 to 3000 feet wide in feet, and is in places 100 feet wide. Between these
veins is a complex of small spur and
east and west, and have been traced eastward nearly to Silver
Ore vein is connected on the surface by inconspicuous out-
crops and occasional mine openings with the Old
lor that is 20 feet wide. The High Ore vein is
connected to the High Ore, and, according to 15 to 20 feet in width, and
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veins is a complex of small spur and
their dip is uniformly 70° to 85° S. Those near the Belle of Butte mine, of which the largest throw the vein 60 feet southward on the east.

In the northwestern group the veins, northwestward, are the Silver Safe, Moulton, Amy, and Goldsmith. They are less uniform both in strike and dip. The dip in the Silver Safe is 45° S. at the surface, steepening to 60° 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 bounds south. The strike changes to the westward, and finally assumes the bow to the south. The average width of the veins is 4 feet, the extreme variation from which is not over 3 feet.

The northeast cross-veins are observed just east of the Magra shaft, where they connect the Valdemere vein with the Rainbow lode. They dip south at a lower 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.

**Lexington system.**—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 Missouri Gulch eastward more than 5000 feet to the West Gray 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 100 feet apart and has been cut in the workings of the Paymaster, Blue Wing, and Lexington mines. The north vein splits between the 100-foot and 200-foot levels and forms two veins 20 feet apart. The dip is between 70° 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 through-out a single vein, varying in width up to 20 feet. Like the north vein, the ore, though irregularly distributed, is exceptionally rich in gold and silver. Between these veins, from 200 to 600 feet from the surface, there are a large number of small veins.

The Allie Brown vein, next south, has been worked extensively for gold at the rich end. It is parallel in course to the Blue Wing, but its dip is more nearly vertical, or even locally to the north at 45° S. N. It is a strong vein, averaging perhaps 5 feet in width, though locally 20 feet wide, and sometimes includes large lens-shaped bodies of ore. The south vein of the Allie Brown vein is the Wappello, which consists of a number of parallel veins, only one of which is persistent throughout the working of the mine. Near the surface and south 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 small lens of vein matter in the adjacent country rock, which continues both longitudinally and vertically beyond the original spur. 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 vein dips south at an angle of 70°. It has an average width of 5 feet, but locally it broadens to several times this width.

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

The La Plata lode is the most southerly of the lodes in this group, and forms the southern limit of the northern belt. It consists of a series of short connecting veins which have been traced on the surface from Missoula Gulch to the Missouri Gulch. Those from the north to the south are

**Northern system.**—North of the Rainbow lode are many veins which become gradually less numerous northward. 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 beyond 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 cross-fractures which disjoin the Blackstone and the Wabash veins could be recognized.

**Intermediate system.**—Between the western extension of the Paymaster and the Syndicate lodes is a small area of silver veins extending possibly 8000 feet east of Missoula Gulch. The veins of this area have two distinct directions. Those vein and the Syndicate lode have a southeast course, while those near the Parrott lode run nearly east and west. Of the latter, the Late Acquisition 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 Acquisition, Toward which they converge eastward.

The Blue Wing lode consists of four veins, of which the two southernly join longitudinally, and judging from their dips, also in depth. The two northerns seem to diverge eastward, but the more southerly one dips north at a small angle and forms with the northern vein in depth.

The Clear Grit was an important mine in early days, but its workings are no longer accessible. The Goldflint is a small, parallel vein. On this lode are the Late Acquisition, Toward which they converge eastward.

In the eastern portion of this area the ore is mostly fine gold, carried in quartz which forms a lens of vein matter in the adjacent country rock.

Among the more important is the Nettie lode, which has three veins that have been traced underground from 100° to 20° north of east. The country rock is silver veins with a course from 10° to 20° north of east. The country rock is still granite, but the amount of split traversing it in dikes and sheets is very considerable. The veins cut the two rocks indifferently, but are often coincident in direction with the dikes. The Czarina lode in the southern part forms a projecting ridge on the outcrop of quartz similar to the Ancient ridge, and on the same general strike. The Germania, Elko, Orphan Girl, and others are said to have produced considerable amounts of rich silver ore in former years; the workings are, however, generally less than 400 feet in depth. The many dikes of rhyolite which traverse the area, not all of which reach the surface, cut off the veins very sharply, notably in the case of the Blackbird-Stanley lode.

**Veins in aplite.**—In the aplite area west of The Butte are many veins having a nearly east-west course and a relatively shallow southern dip, whose outcrops are generally prominent through the contrast of the black manganese stained rock, with the light color of the country rock. They are generally strong and well-defined veins, and often have large bodies of sulphides, too high in zinc and too low in silver to be profitably worked.

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