ビュッテ鉱山に於ける應用地質並に鉱床について

APPLIED GEOLOGY AND ORE DEPOSITS IN THE BUTTE MINE*

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伊藤清和： ビュッテ鉱山に於ける應用地質並に鉱床について

Applied Geology in the Butte Mine

The object of this presentation is to report a brief outline of the methods of geologic mapping employed in the Anaconda Copper Mining Company at Butte Montana and to show by means of a few typical examples the practical nature of the results obtained.

Case 1

The pump station originally selected for it would have been errosed by certain faults and much difficulty would have been met both in the excavation and in future maintenance. In the West Gray Rock Mine, it was estimated by projection that the faulted segment of a certain vein between two faults would only be a few feet in length on the 800 ft. level.

The development work at the time was limited on this level, and the calculations had to be made from positions known on the 1,000 ft. level, where the faulted segment was considerably longer. In order to make the raise in ore continuously from the 1,000 to the 800 ft. level, it had to placed in accordance with these calculations. The result was entirely successful.

Case 2

The dip of the vein was steeper than that of the fault, so that in the stope the fault generally encroached upon the work and presented all the appearance of hanging wall of the vein. When the ore was finally cutt off raises were continued from the top of the stope, but designed to cross through the fault and to make the fault a foot wall rather than a hanging wall. But this means, the ore above the fault was encountered at its lowest point and the stope continued to the level above.

An important discovery which was proved the correctness of the theory with being run a crosscut was made. After this discovery, the development of several other levels become merely a matter of projection.

The portion of stope where the important discovery was made. No. 1824 would appear to be a drift on a continuous vein.

Fig. 1

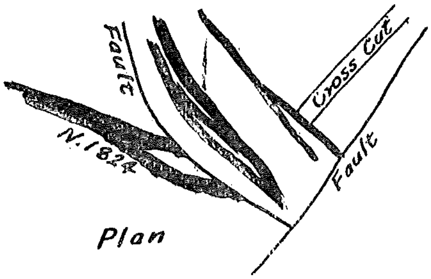


Fig 2

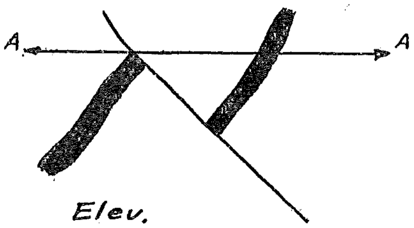
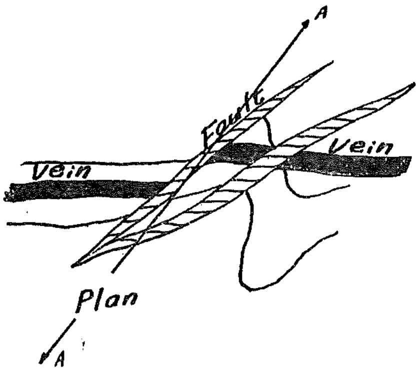


Fig 3



Case 3 Fig *2* & *3*

An example which a cross section clearly showed a displacement of the vein by the fault.

Case 4

An example which underground work between the three different levels was continued with the map shows the accuracy which the intersection was located and with drifting in order to reach this determined point.

Case 5

An example which in correlating with other parts of the mines, the fault was identified, and three valuable ore bodies were won.

The examples of geologic work given above are typical of the work carried on in the Butte Mines, although many more might be cited. Graphic determination of the direction and amount of movement in the planes of the principle faults has been made, and the knowledge of these displacement is very helpful in locating faulted veins, or identifying faulted segment of veins. In addition to these discussion, four diagrams represent the four possible cases in the methods.

Ore Deposits at Butte. Montana.

General Geologic Structure

In general they may be grouped into two main series, such as

a) Those having a general East-West strike,

b) Those having a NW-SE strike.

The dip is to the west at a steep angle, Butte being on the downthrown, or hanging wall side. The amount of vertical displacement is probably in the neighborhood of 1,500 ft. Structure of the Butte District.

Locally the rocks of the district are intersected by many separated and distinct periods of fissuring.

Classification of fissures :

Grouped according to their relative ages the fissures of the Butte district may be divided into six distinct systems as follows ;

1. Anaconda fracture system

   The Anaconda system includes the earlist formed fracture of the district. In the copper producing area they may be divided into two groups; north and south. The northerly group embrace the Syndicate, Bell Speculator and nearly fractures, and southerly comprises Anaconda, Moonlight, O'Neill and others.

2. Blue system of fissure

   In the Blue system of fissures it is included a series of NW-SE fault fissures. The general strike is in the neighborhood of N55W, with extreme variation within a range of N30W, to N75W.

   The important fissures of the Blue system, named in order of their occurence, beginning on the south-west, are the No. 2, No. 1, Clear Grit, Blue, Diamond South or Dernier, High Ore, South Bell, Skyme, Edith May, Jessie, Gem and Crasus, all of which are mineralized and most of which contain ore bodies of immense value.

3. Mountain View Breccia Faults

   These breccia faults, or veins, are persistent angular fissures filled with fragmental materials composed of country rock or with some fragments of the earlist vein. The general strike of the Mountain View Breccia Fault is about N75E.

4. Steward Fissure System

   In this system, a series of NE-SW fault fissures extending across the district is included. The strikes of this fissures are slightly more northwesterly than the view of the Anaconda system. The dip is uniformly to the south, ranging from 50 degree to 75 degree, average 55 degree. Steward fault carries no ore.

5. The Rarus Fault

   This fault is a complex fissure of later age. This fault has not been found to carry ore.

6. The Middle Fault

   The latest fault, and no ore.

Rock Alteration

Extensive alteration of the rock have taken place in the Butte district. There are two principle zones associated with the copper veins. These areas are closely related to the more important development of the earlist formed veins or those of the Anaconda system. The largest and most important area of altered granite is in the vicinity of Anaconda Hill. One of the alteration zones follows rather closely the Syndicate and other early veins are in the Mountain Con., Gray Rock and Diamond Mines.

In these two general zones intense alteration has taken place not only within and along the veins and faults, but the entire rock mass, where granite, aplite, or quartz, porphyry have been invaded by active metasomatic processes resulting in the product differing markedly both in chemical and physical character from the original rock.

The alteration in the Butte rocks may be traced to three general causes,

1. Vein formation

   Vein formation process has altered large area of rock within and tributary to the

Anaconda fissures ; the Blue vein shows less alteration of the wall rock than the Anaconda fissures, and similary the Steward fault exhibits less alteration of the wall rock than the Blue vein.

2. Common hydro-metamorphism
3. Oxidation

Oxidation progress acting upon veins and altered granite tends to transform the sulphide into oxide and native metals.

Superficial alteration of the Butte veins

1. Outcrop of copper vein

A number of copper veins, notably the Anaconda Syndicate, and Colusa, has more prominent outcrops characterized by unusual amount of strong iron stained quartz and vein matter projecting well above the wash. The outcrop of a typical copper vein of the Anaconda system is marked by altered granite, quartz and oxides of iron. The outcrop of a fault vein of the Blue or Steward system consists of a slightly iron stained mass of soft crushed and altered granite with one or more seams of fault clay of a blue gray or yellowish color. Almost without exception the copper veins are practically barren of copper at the outcrop and in the zone of oxidation below. There is no visible copper material and it rarely happens that an assay of the oxidized material yields more than a trace of copper.

2. Outcrop of Manganese-Silver veins

In market contrast to the ill-defined copper vein outcrops are the bold projecting outcrops of the manganese-silver veins, which may be traced for hundreds or even thousands of feet over the surface.

3. Oxidation and disintegration of the granite

In the granite zones of altered granite associated with the copper veins there are but few, if any, actual outcroppings of solid granite or bed rock.

4. Zone of oxidation

The depth of the zone of oxidation in the Butte district is extremely variable in different localities.

5. Ground water

Source of the ground water is now found in the rocks and veins of the Butte district as a meteoric water and uprising water of deep seated origin.

Minerals of the veins

The important copper minerals of the Butte ores, named in order of their relative abundance, are chacocite, enargite, bornite, chalcopyrite, tetrahedrite, tennantite, and covellite. Of the oxidized products, chrysocolla, malachite, cuprite and nature copper are the most common.

The ore deposits

The ore deposits of Butte are essentially of the fissure vein type. They have resulted from the mineralization of fissures accompanied by replacement of the country rock. The fissure vein structure is the rule throughout the district The valuable metal content of the ores, if chiefly copper, is subordinate but important amount of silver, gold and zinc.

In brief, distribution of ore types may be grouped as follows,

1. A main or central copper zone.
2. An indeterminate zone of irregular width.
3. An outer or peripheral zone of undetermined width.

Vein systems of the six distinct periods of fissuring are known to be ore producing in only three systems,

1. Anaconda System, 2. Blue System, 3. Steward System.

The Anaconda System is the most extensively mineralized, the Blue System is less so, but is extremely important as an ore producer, while the Steward fissure seldam contains workable ore bodies.

Ore Origin

The source of the ores at Butte was the granite magma. Heated water and gas escaping from the cooling magma were the carries of the metals to their place of deposition.
The elements thus transported and deposited in the veins were silicon and oxygen as SiO_2, Sulphur, Iron, Copper, Zinc, Manganese, Arsenic, Lead, Calcium, Tungsten, Antimony, Silver, Gold, Tellurium, Bismuth and Potassium.

Applying the above reasoning to the facts of ore occurence, it is found that chalcocite as a primary mineral is the latest important copper sulphide of the ore. It is, moreover, found only in association with the highly altered phases of the granite.

Structurally there is no good evidence for distinct periods of mineralization in the Butte veins. It is here held that was but one period of mineralization, varying in intensity, possibly, from time to time with important changes in chemical character of solutions.

At the closure of this article, I should acknowledge those of the facts that :

Practical instruction and actual observation of geological survey of the Butte Mine, operating to produce copper ore mainly, were given me by means of lecture in the classroom of mining geology and inspection trip during which I have been in the Missouri School of Mines, Rolla, Mo., 1952—3 under the guidance of Dr. D. J. Forrester, Chairman of the Mining Department of the University.