Geology of the Cochiti Mining District, New Mexico

Ancient Mineralization of the Veins, Which Was Active in the Alteration of the Monzonite Formation —Not True Fissures But Replacement Deposits.

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In the immediate vicinity of Bland, N. M., the rocks are all tertiary volcanics or sedimentary tuffs belonging to this period, and composed partly of ash and partly of silt derived from the erosion of the lavas.

The oldest rock outcropping in the immediate vicinity of the camp is a monzonite or monzonite porphyry, a greenish gray granular rock having plagioclase feldspar as its most important constituent.

Subsequent to the eruption of this rock, fractures were formed in it and these became the channels for circulating solutions, probably ascending hot waters, closely connected with the volcanism. The waters were remarkable for intensity of action. The rocks they traversed have been chemically transformed, the chief process being silicification, so that they are now found more or less completely altered to quartz. Along fractures the rocks have been replaced almost entirely by quartz carrying gold and silver, and these constitute the veins by which Bland is known.

There is some evidence that this event was followed by a considerable period of erosion, long enough to bring the veins to the surface. Then another eruption of a similar rock occurred. This later rock differed from the earlier monzonite in that it contained as dark minerals hornblende and amphibole, and it also differs in some structural and textural points.

Following probably another period of erosion and volcanic rest eruption was renewed and there were outbreaks at many different points. The lava was rhyolite. This period was long and a number of different flows alternated or mingled. The eruptions were often explosive, as shown by a considerable quantity of pumiceous and fragmental material in the breccias of this period. Even occasional fragments of feldpathic sandstone occur in the breccias. They are pieces which were hurled out from the volcanoes at the time of their eruption. Thus it is shown that at an uncertain depth below the present surface the ascending lavas broke through the rocks of this age.

Before the eruption of the later rhyolite occurred an event of great economic importance, the faulting. A considerable number of important faults have been found in the district. Their age, as denoted by their relations to the different formations, seems nearly uniform. All the rocks up to the overlying tuffs have been displaced by the faulting. This faulting might have been initiated by the intrusion of the rhyolite. After this intrusion there was a collapse and a sinking at the various vents. The still liquid lava sank, dragging downward with it the adjacent blocks of rocks. The economic interest in the faulting lies largely in the fact that the veins have been cut and displaced thereby.

To complete the geologic history, we have to conceive of a considerable period of erosion which stripped from the surface a great thickness of volcanic material, leaving the resistant volcanic necks, and the silicified veins standing out as hills and strong ridges, and laying bare the present surface.

Nature of Mineralization.—The most important veins of the district, and all those that have proved of economic importance, occur in the monzonite, and do not extend into the overlying rocks. Hence when the monzonite is not exposed on the surface, showing strong silification, the later rocks form a capping to the veins, which capping must be passed through before anything can be known of the presene or nature of the veins beneath. This circumstance shows pretty plainly that the vein deposition took place before the eruption of the rhyolite and immediately after that of the older rocks. Indeed there is every evidence that the veins were formed by ascending hot waters succeeding and connecting with the monzonite porphyry, and that these waters became inactive by the time of the rhyolite intrusion.

The mineralization of this period was extraordinarily active, as the profound alteration of the monzonite testifies. Among the known veins formed at this period those of the Iron King, Lone Star, Washington, Crown Point, Albermarle and Palmlico are the most important, though certainly there are others which have not yet been discovered. The ore so far developed carries about two ounces of silver to one ounce of gold. The sulphide ores show primary blende, galena, pyrite and occasionally chalcopyrite.

Mineralization subsequent to the rhyolite intrusion has only been noted toward the eastern boundary of the field, where there has been considerable alteration and mineralization, which must be attributed to a cause similar to that which produced the veins in the older monzonite, namely the action of hot ascending waters immediately succeeding and genetically connected with the rhyolite intrusion. This alteration is in the form of silicification and the formation of pyrite, and has acted on the rhyolite, as much as on the intruded rock. Quartz veins have been formed, but in this case the veins are relatively small. These veins contain precious metals, but usually very irregularly distributed. High assays, especially on the surface, may be obtained, but it is likely that some of these are the result of the well known process of increase in value at the surface during oxidation. Specimens of the vein material have a general resemblance to those of the veins in the older rock, therefore it is often difficult to distinguish them from the monzonite veins without a study of the rocks in which they lie.

To sum up, at least two distinct periods of mineralization have taken place. Each of these periods was consequent upon a lava intrusion, and the mineralization was the result of a process which is known to accompany and follow volcanic eruption at the present day. Although ascending hot waters are not known to deposit more than traces of metals at the surface, it is supposed that an important precipitation takes place at some depth, so that it may be the case that there are important rich ore bodies in the district that erosion nor development has not yet exposed.

Vein Groups.—The only productive veins thus far discovered are those of the monzonite porphyry. On account of the later rhyolite flows, which cover the underlying rocks in most of the district, these productive veins outcrop only on a few strong ridges. Outside of these veins little is known as yet. It is probable, however, as indicated by the great amount of alteration in the monzonite, that the vein formation has been extensive, and the veins

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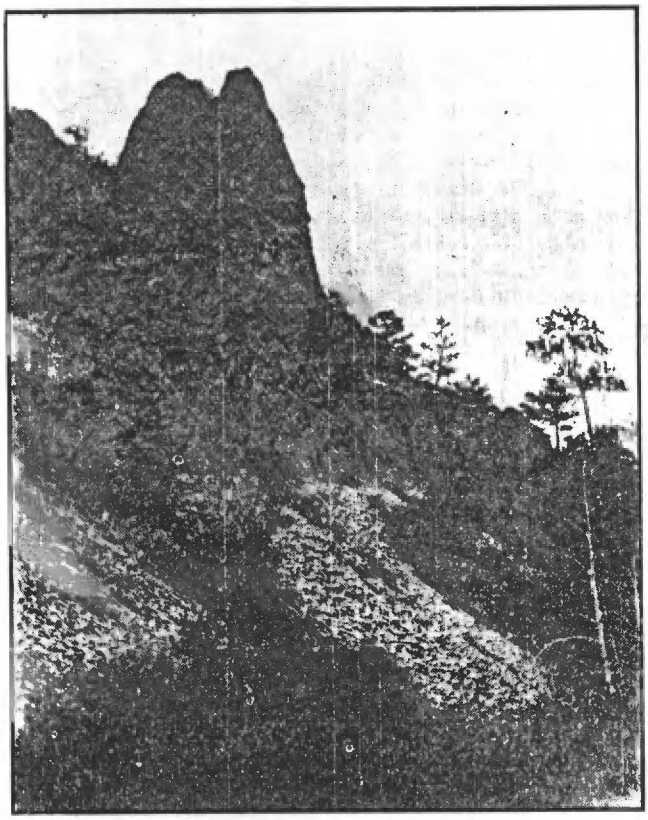
known at present are only a small portion of those that will eventually be developed.

The veins already discovered belong to the type of linked veins. Their physical characteristic is that they branch and reunite in both a horizontal and vertical direction. There is generally in each group a main or mother vein from which the smaller veins branch. These smaller veins again may subdivide and so finally die out.

Veins of the monzonite group have been discovered in various mines. Among those developed to some extent may be mentioned the Washington, Lone Star, Iron King and Crown Point in Pino canyon; and the Albermarle Palmlico group in Colla canyon.

The Iron King vein lies near the center between the Colla canyon group and the Casino group. The trunk vein of the group may be called the Iron King-Lone Star vein, which crosses Pino canyon in a north-south direction, showing a very strong outcrop. This outcrop is cut off on the north by the fault of Pino canyon and on the south by Washington hill. From this vein a succession of branches depart, running chiefly in a southerly direction, the chief of these branches being known as the Washington, Last Chance and Legal Tender. The more these branch veins run parallel to the main vein the stronger



Rhyolite and Phonolite Outcropping in Colla Canyon.

they are, and the more they diverge from the general strike of the main vein the weaker they become. The intersections of the branches with the main vein usually pitch to the east at a moderate angle. These easterly pitching intersections are significant, since they have the same general course as certain ore shoots of especially rich ore in the same vein, and correspond also in direction with some post mineral faulting.

Occurrence of Ore in the Vein.—The veins are usually strong, straight and well defined, yet they are not fissure veins. They have at first sight all the appearance of fissure veins, but a little close examination shows that they have been formed almost entirely by replacement of originated along zones of especially strong fracturing in the monzonite, formed during a period of movement subsequent to the consolidation of this rock. These zones of maximum fracturing, which are usually four to six inches wide but may be much wider or narower, became the chief channels of circulation for the mineralizaing waters. The monzonite in which the veins occur has been almost wholly altered to silica, and the veins themselves seem to be the final stage of alteration. In many cases the ore itself consists simply of a zone of more or less silicified monzonite. This zone is cut by parallel fractures having the same strike and dip as the walls, and the walls are nothing more than stronger fractures of the same kind.

Refinery Production of Copper in 1911

The refinery output of copper in the United States during 1911 was made by 13 plants, 9 of which employ the electrolytic method and 5 employ the furnace process on Lake Superior copper, the Buffalo plant employing both the electrolytic and the furnace refining method. Six of the large electrolytic refineries are located on the Atlantic tidewater, 5 Lake refineries are on the Great Lakes, 4 in Michigan and 1 in New York. Only 2 plants are located west of the Great Lakes; 1 at Great Falls, Mont., and 1 at Tacoma, Wash. In addition to these refineries, there are numerous plants in different parts of the country that make a considerable output from old copper, brass and other alloys of copper.

The output of the regular refining plants is in the form of casting, Lake and electrolytic copper.

Blister copper that is low in precious metals and sufficiently free from impurities for certain uses is refined by the furnace process and ordinarily cast into ingots. This copper is usually unfit for the uses requiring a high grade copper, such as electric transmission, brass manufacture and rolling, but is suitable for copper castings, and a large part of it is put to that use. Lake copper excepted, a comparatively small percentage of the copper output carries such low values in precious metals that, together with the value added to the copper by electrolytic refining, these values will not more than pay for the electrolytic refining of the copper; consequently the output of casting copper is small. Some blister or pig copper low in precious metals is exported without further treatment and is probably consumed without electrolytic refining. A large percentage of the casting copper is from the Morenci-Metcalf district, Arizona. The pig copper is from this district and the Ducktown, Tenn., district. Both districts produce a rather high grade of blister carrying low values in precious metals, and it is found profitable to market much of it without electrolytic refining. During 1911 the production of new casting copper amounted to 22,977,534 pounds, and pig copper amounted to 36,600,269 pounds.

By Lake copper is meant the output of the Lake smelters. Considerable of this output is refined electrolytically, but most of the electrolytically refined Lake copper is mixed with furnace refined copper or sold as some brand of Lake copper. Of the 218,185,236 pounds of copper produced by the Lake smelters, about 43,700,000 pounds were refined electrolytically either to free it from impurities or to recover the silver content.

Under electrolytic copper is included all new copper that was refined electrolytically, except that from the Lake district. In 1911 the production of electrolytic copper from primary materials of domestic origin amounted to 823,507,764 pounds, and that of foreign origin to 332,604,223 pounds. Electrolytic copper to the amount of 19,