Mine File No. 6506

On the east side of the range, due east of Santa Fe, are several copper prospects, among them the Dalton, on the creek of the same name, and the Jones and Mailleuchet prospects on Macho Creek, 5 and 4 miles, respectively, above its confluence with Pecos River. At the Mailleuchet prospect a fresh pre-Cambrian granite outcrops in the creek; it contains microcline, quartz, and oligoclase, with biotite and some large grains of titanite; in places this granite shows a dioritic facies. Beginning at the tunnel and continuing downstream for about 1 mile is a mass of dark-green amphibolite, schistose in places, and there containing garnets. The granite is probably intrusive into this rock. Quartzose streaks in this amphibolite contain the ore, which under the microscope is seen to be a quartzitic schist of irregular quartz grains, intergrown with aggregates of light-green mica and grains of pyrrhotite. chalcopyrite, and much zinc blende. As in the Mikado prospect, previously described, the metallization appears to be directly connected with the metamorphism.

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HAMILTON MINE. = Pecos Mine

The Hamilton copper mine of the Pecos Copper Company is situated in the canyon of Pecos River at the confluence of Willow Creek, 13 miles north of Pecos town and 17 miles east-northeast of Santa Fe. The elevation is 8,000 feet. The deposit was opened about 1882, but the more extensive development has been undertaken only during the last few years. It is also known as the Cowles mine, from the name of the principal owner in the company. In 1905 the developments consisted in a tunnel at the level of Willow Creek, just east of the river, and a vertical shaft 180 feet deep, its collar being 70 feet above the creek. Since then developments have been continued and the shaft sunk to the 400-foot level. A few carloads of selected ore have been shipped.

At the mouth of Willow Creek is exposed a small area of the basement rock upon which the prevailing Carboniferous beds rest. The dip of the sediments is about 7° W., so that at the west bank of Pecos River they reach down to the water level. A small area of pre-Carboniferous (and also pre-Cambrian) rocks is exposed on both sides of Willow Creek at its mouth, and was followed for 1,000 feet upstream. The croppings of the deposit are contained in this area of old rocks. The prevailing rock is an amphibolite, locally with foils of biotite and showing more or less perfect schistose structure. The microscope reveals small bluish-green prisms of hornblende extending in all directions; there are also imperfect crystals of a colorless epidote. Between these grains lies a mosaic of feldspar grains, in part certainly andesine or labradorite. There is some pyrite in fine division, also veinlets of quartz, pyrrhotite, and pyrite, as well as serpentinoid aggregates, products of decomposition of the hornblende.

The deposit forms a zone or belt 60 feet wide in this amphibolite parallel to its strike, or N. 50° E.; in this belt the amphibolite is in places changed to chloritic schist; it contains large scales of biotite and needles of tourmaline, as well as irregular masses of pyrite, chalcopyrite, and zinc blende. The best ore, of which some has been shipped, is said to contain 17 per cent of copper; the average of the whole mass would doubtless be of low grade. The ore in places carries gold to the extent of a few dollars to the ton, especially where it is more quartzose, as in the croppings. Encouraging gold values are said to have been obtained on the fourth level. The silver content is said to average 5 ounces a ton.

The actual croppings form a bluff on the north side of Willow Creek, at the tunnels; they have a highly variable appearance, being gray or brown, in part cherty, with transitions to amphibolite; in other places they are honeycombed, with clear evidence of oxidation and dissolution of sulphides. The croppings are said to contain no zinc and very little copper.

The tunnel level penetrates the ledge obliquely in a north-northeast direction for 75 feet, the actual width perpendicular to the schistosity being at least 60 feet. The tunnel shows much zinc blende but little chalcopyrite. In 1905 the first level of the shaft extended 180 feet N. 50° E.; largely in fair-grade copper ore, and about parallel to the schistosity. A crosscut to the northwest about 40 feet long reached the barren amphibolite, but a crosscut 40 feet long on the southeast was still in ore. The water level in the shaft is 20 feet below collar. Some of the ore consists of coarse dark-green hornblende of varying grains, intergrown with pyrite and

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chalcopyrite. Quartzose streaks of unoxidized ore contain a mosaic of quartz grains with cubes of pyrite, the latter intergrown with a pale-green mica, probably a biotite, identical with that from the Mailleuchet prospect. Other specimens contain, in a fine-grained amphibolite, well-developed prisms of bluish-gray tourmaline, inclosing grains of pyrite and hornblende. A zinc blende of very dark color accompanies the hornblende and chalcopyrite, and adds a difficult question to the problem of treating this ore. Galena occurs sparingly. Small seams of fluorite and yellow zinc blende form apparently secondary segregations.

The intergrowth of the ore minerals with the hornblende of the amphibolite and the absence of well-defined fissures make it evident that the metallization was almost contemporaneous with the metamorphism which produced the amphibolite from some dioritic or diabasic rock, and in this respect the deposit is similar to the prospect previously described. The appearance of biotite and tourmaline as gangue minerals indicates, moreover, the presence of conditions of high temperature and pressure during ore formation. It is suggested that the metals may originally have been contained in the basic magma and that their concentration was effected during metamorphism.

The most interesting feature of this deposit is its relation to the Carboniferous strata. Its croppings are immediately overlain by these rocks, and the contact is well exposed on the surface and in several cuts and short tunnels. The lowest sandstone stratum rests directly on the level surface of the oxidized ore. This sandstone is made up chiefly of quartz grains, but the microscope shows the presence of chloritic and serpentinoid cement, as well as of many rounded fragments of a brown cherty material which looks exactly like the oxidized ore. Nearer to the river the sandstone is replaced by a fine-grained conglomerate, with partly rounded pebbles reaching at most 1 inch in diameter. Most of these pebbles are of quartz, but some consist of a brown chert identical with that of the croppings. In places the cherty brown croppings are brecciated near the contact with sandstone and indistinctly show partly rounded fragments, conveying the impression that the uppermost part of the deposit consisted of subangular fragments at the time of the deposition of the Carboniferous strata. The Carboniferous in this vicinity contains no ores of any kind.

It is thought that these exposures prove conclusively the pre-Carboniferous age of this deposit. As the early Paleozoic formations, both in southern New Mexico and southern Colorado, are conformable with the Carboniferous and no epoch of mountain building and regional metamorphism intervened, it follows that the Hamilton copper deposit must be of pre-Cambrian age.

ROCIADA DISTRICT.[a]

GENERAL FEATURES.

The Rociada district takes its name from the town of Rociada, which is situated in the northwestern part of San Miguel County, close to the Mora County line. The Las Vegas topographic sheet of the United States Geological Survey shows the town, formerly known as Rincon, to be about 20 miles northwest of Las Vegas, but the mail and stage route, via Los Alamos and Sapello, is 32 miles. Mineral deposits are said to have been discovered in the region in 1900. Only a small amount of mining work has been done. All properties were idle when visited in August, 1905.

The geology of this region, although rather simple, is nevertheless interesting as throwing much light on the structure of the ranges of northern New Mexico. Las Vegas, situated at the western edge of the deeply dissected plains country, is built upon the Cretaceous shales. Immediately to the west rises the prominent north-south ridge formed by the upturned and steeply dipping strata of the Dakota (?) sandstone. West of this the red sandstones and sandy shales which have commonly been referred to as the "Jura-Trias" lie at a gentle angle, in places overlain by caps of the Dakota (?) rock to form prominent buttes. Still farther west the Carboniferous strata are exposed and with increasing easterly dips give way finally to the pre-Cambrian core of the Las Vegas and Mora ranges. These disturbances of the strata are in several places

[a] By L. C. Graton.

Economic Geology

by Arthur Montgomery

MINERAL DEPOSITS OF PRECAMBRIAN AGE

Introduction

In the Picuris Range, the economic minerals of Precambrian age are chiefly white beryl, muscovite, minerals of tantalum and lithium in pegmatites, and minerals of copper, gold, lead-silver, and bismuth in quartz veins (Montgomery). The ore-bearing quartz veins, as well as the pegmatites, are related genetically to the Embudo Granite. Tourmaline is common to nearly all these occurrences. Metallic minerals of copper and bismuth are found in some pegmatites, as in the Harding pegmatite, and such minerals also typify many ore-bearing quartz veins. Tourmaline, characteristic of ore-bearing quartz veins and pegmatites, is always present in Precambrian rocks near intrusive Embudo Granite.

Mineral deposits of possible economic value in the Precambrian rocks of the quadrangle are similar in mineralogy to all those mentioned above, except that bismuth minerals have not been observed. The ore deposits of the Pecos Mine are unique in this area for their immense concentrations of zinc, lead, copper, silver, and gold.

Ore Deposits in Pegmatites

South of the Picuris Range, some of the larger pegmatites contain abundant muscovite mica and small quantities of white beryl and columbite-tantalite. Only one pegmatite is believed to be of possible economic importance, that of the mica mine in the Kept Man group of claims two miles northeast of Elk Mountain. Mica was produced from this pegmatite during World War II and some coarsely platy muscovite remains. This deposit has been mapped and described by Jahns, who also discussed several other mica-bearing pegmatites near and west of Elk Mountain.

Muscovite-rich pegmatites are common south and east of Cordova, where patches of muscovite schists and amphibolites are surrounded by Embudo Granite. During recent years, there has been considerable mining in this area and even some small-scale milling. Very little mica, scrap or otherwise, appears to have been produced and marketed; much of the activity has been of an uneconomic and promotional nature.

Ore Deposits in Quartz Veins and Related Occurrences

Pale-greenish stains of secondary copper minerals in translucent, snow-white, hydrothermally metamorphosed quartzite of the lower quartzite member of the Ortega Formation are present in the northern Picuris Range and in the easterly Truchas area. Some quartz veins in rocks of the Vadito Formation farther south in the Truchas area show traces of mineralization, usually observed as coatings of green and blue copper carbonates on fracture surfaces. Rarely, these coatings are found on fracture surfaces of brecciated and silicified amphibolites and of other rocks of the Vadito Formation. Black tourmaline is typically associated with these occurrences. A number of such occurrences of slight copper mineralization were observed in amphibolites and felsites near and north of Doctor Creek three miles west of the Pecos Mine. Copper minerals and zinc and lead sulfides in highly brecciated Precambrian rocks have been mined on a small scale at the Johnny Jones Mine, five miles southwest of the Pecos Mine and two miles south of the south border of the quadrangle. The mineralogy of this deposit is similar to that of the Pecos Mine.

Ore Deposits of the Pecos Mine

The dumps of the abandoned Pecos Mine are near the mouth of Willow Creek two miles north of Tererro. This mine, one of the large deposits of the Southwest, was worked extensively by the American Metal Company (now American Metal Climax, Inc.) from about 1927 to 1939 for zinc, lead, and copper sulfides. Appreciable amounts of gold and silver were also recovered. A million and a half tons of ore running up to 16 percent zinc, four percent lead, one percent copper, three ounces of silver to the ton, and 0.1 ounce of gold to the ton were mined, then milled near the town of Pecos. Much ore, but of lower grade, was said to be still left in the deposit when the operation terminated.

The geology of the ore deposits has been discussed by Krieger and earlier by Stott (1931). Chief ore minerals were sphalerite (mostly black and iron-rich), galena, and chalcopyrite. The mineralization is pre-Mississippian. This conclusion is based on the fact that oxidized ore underlies unmineralized beds of Mississippian limestone. Two extensive, flattened-lenticular, pancake-shaped ore bodies were discovered, tilted up almost vertically and trending N. 45° E. along a great shear zone in the brecciated Precambrian rocks. The country rock is chiefly amphibolite. Most of the ore minerals appear to have replaced finely micaceous, chlorite-rich rocks which Krieger believed to be hybrid rocks formed by the partial assimilation and replacement of amphibolite (called diabase by Krieger and others) by intrusive granite.

The cause of the shearing and the location of the great breccia zone (said to be up to 500 feet wide), along which the ore deposits were formed, are most difficult problems to solve. The trend of this breccia zone, N. 45° E., is not parallel to the strike of regional foliation in this area, which runs about N. 10° E. It is parallel, however, to a principal steeply-dipping joint direction very prominent in the Precambrian rocks of this area, including the dike-like body of pink granite crossing Willow Creek two miles east of the mine.

The mineralogy of the ores of the Pecos Mine is similar to that of the many uneconomic deposits found in the mapped region. Copper minerals, traces of gold and silver, and abundant tourmaline are characteristic of many of these deposits which are presumably related genetically to late-stage differentiation of Precambrian granitic magma. The mineralogy of all these occurrences is typical of high-temperature ore mineralization related to granite. The high concentration of zinc and lead sulfides found at the Pecos Mine is unique for this general area, but small amounts of these minerals do occur in other places, such as near the head of Hondo Canyon in the northern Picuris Range (Montgomery).