THE YERINGTON COPPER DEPOSITS*

By Frederick Leslie Ransome

Yerington lies 12 miles to the north of the station, Wabuska, on the Hazen Mine branch of the Southern Pacific Railroad. It occupies the middle of the fertile Mason Valley through which the Walker River flows northward on its way to Walker Lake. The camp is reached by stage and automobile lines but the mines for the most part are somewhat scattered over the Singatse Ridge (called the Smith Valley range by J. E. Spurr), to the west of the camp as shown in Fig. 1. This ridge has an average width of about 4 miles and the elevation of its crest varies from 1,600 to 2,600 feet above the valley of Yerington, or from 6,000 to 7,000 feet above the sea.

Distribution of the Mines—The Classes of Deposits. A Description of Some of the Mines

Classification of Deposits.—As will appear from the subsequent description, the copper deposits near Yerington are of three kinds: (1) irregular bodies formed by metasomatic replacement of limestone, and genetically associated with metamorphism of a kind usually attributed to the contact action of intrusive rock; (2) metasomatic vein deposits in altered limestone; (3) metasomatic vein deposits in granodiorite.

What are apparently the most important deposits belong to the first class, and include those mines mentioned as constituting the 2-mile north to south chain.

The only important deposit of the second class is the Ludwig ore body, while the deposits of the third class include those of the Inter Valley, Blue Jay, Yerington and other less important prospects. A brief abstract of the author's geology of the district will make clear the distinction between these classes of deposits.

Geology.—The formations of the district may be divided

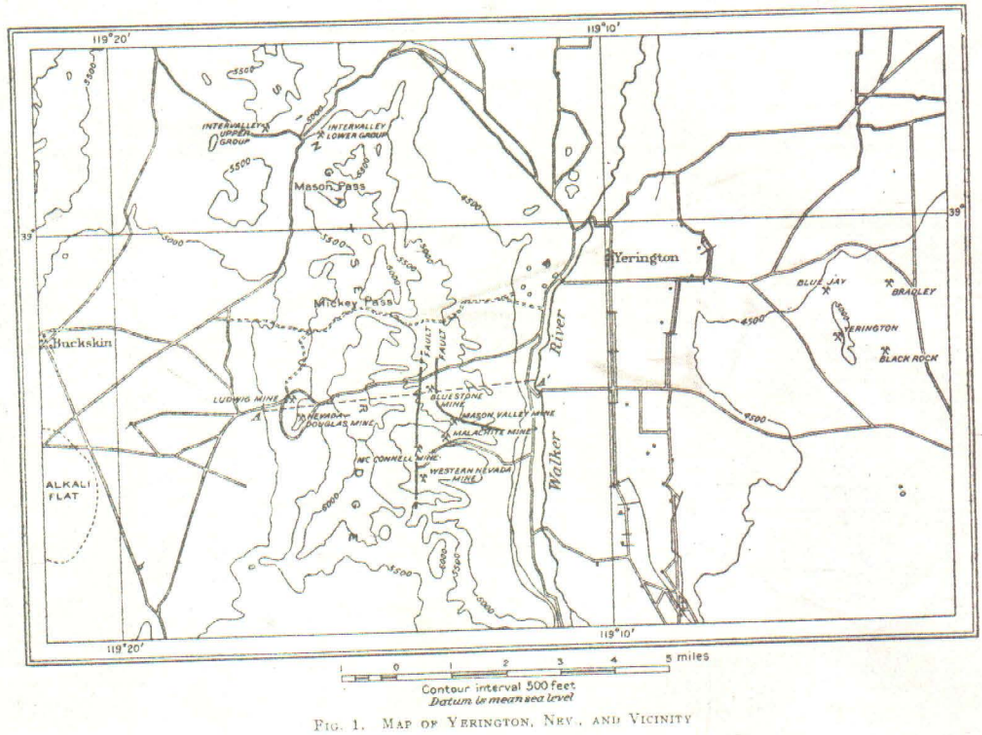

FIG. 1. MAP OF YERINGTON, NEV., AND VICINITY

Distribution of the Mines.—What is perhaps the most important group of mines in the district constitutes a chain 2 miles in length whose center is about 4 miles southwest of Yerington. The chain begins on the north with the Bluestone Mine, and extending south includes the Mason Valley, Malachite, and McConnell, and ends with the Western Nevada. These mines are all reached by wagon road, the distances varying from 4 to 8 miles from Yerington.

To the west of this chain, at the western foot of the Singatse Ridge, are the Nevada-Douglas and Ludwig mines, now under one management since the purchase of the latter in 1907 for about $500,000. The steep direct road from Yerington, leading past the Bluestone Mine, to these mines is about 7 miles long. About 9 miles northwest of Yerington by road are the shallow workings of the Inter Valley Mine. Another group of prospects occupies the low hills, 4 to 5 miles southwest of Yerington, of which the Blue Jay and the Yerington are the most important.

into two groups, an older so-called "bed-rock complex," and an overlying volcanic series resting unconformably upon the older. The older group consists of schists and limestone with intrusive masses of granodiorite or quartz monzonite, whose relations are shown by Fig. 2. The younger group may be, in turn, divided into two parts: 1, a series of rhyolitic flows and tuffs, bedded volcanic grits, andesitic tuff and breccia; and, 2, an unconformably overlying flow of basalt.

The so-called "bed-rock complex" series is of the pre-Tertiary age. The schist is shown by a microscopic examination to be a metamorphosed igneous rock, probably an altered andesite. The schist is cut by many irregular dikes of granodiorite and is in places stained by salts of copper. On both slopes of the Singatse Ridge, masses of limestone are intricately infolded with the schist. While some of these limestone masses are small and isolated, there is one irregular but fairly continuous band of limestone that stretches north and south about half-way up the eastern slope and contains the Western Nevada, McConnell, Mason Valley, and Bluestone

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mines. This belt is about 1,000 feet wide at the McConnell Mine, and ends a few hundred yards north of the Bluestone. A similar band near the west base of the ridge contains the Ludwig and Nevada-Douglas mines. In places the limestone is a pure gray crystalline variety not noticeably metamorphosed, and in which the bedding is distinct. Other parts are intensely metamorphosed, containing abundant garnet, pyroxene, amphibole, epidote, and pyrite.

The intrusion of the granodiorite and closely related porphyries is responsible for the metamorphism. The relation found between the limestone and andesitic schists is so intimate as to leave little doubt that a series, consisting originally of andesitic rocks, limestones, etc., has been folded, squeezed, and mineralogically changed at the same period and by the same set of metamorphic processes. Along the summit of the ridge, the contact of the intrusive granodiorite with the schist and limestone to the west of it is irregular, and as a whole indefinite, as dikes of the intrusive invade the latter and also include many masses of them. On the east, however, the line of contact between the intrusive and the limestone of the Bluestone and Western Nevada belt is fairly straight, and runs nearly north and south, corresponding, at least in part, to a fault which has dropped the limestone against the intrusive rock.

Just east of the Bluestone Mine, and extending south, is the fault, partly shown in Fig. 1. North of the Mason Valley mine the fault line curves sharply to the southeast. Along this line the younger Tertiary rocks have apparently been faulted down into the older series, as seen at the right of Fig. 2, so that the strike of their beds is nearly north and south, and their dip about 45 degrees to the west.

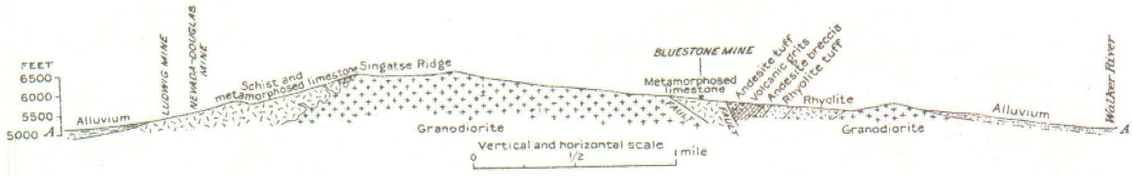

FIG. 2. GENERALIZED GEOLOGICAL SECTION ACROSS SINGATSE RIDGE

The deposits of the third class, located mainly to the southeast of Yerington, may be briefly disposed of as follows: The prevailing rock of the hills containing these deposits is granodiorite or quartz monzonite, similar in texture to that of the Singatse Ridge, but fresher. The deposits are characterized by the development of pyrite with subordinate chalcopyrite in the granodiorite or monzonite, along zones of fissuring, and are believed to represent a stage of mineralization later than those in which the first and second classes were formed. The economic importance of the deposits of the third class is as yet unproved.

The mines belonging to the other classes may now be briefly described.

IRREGULAR REPLACEMENT DEPOSITS

The Bluestone Mine.—The Bluestone Mine is situated 4 miles southwest of Yerington, half way up the east slope of Singatse Ridge, at an elevation of about 5,300 feet. It was worked about 30 years ago, and for a time supplied natural bluestone (chalcanthite) to the amalgamating mills at Virginia City. A small smelter was built at the mine and ran for a few years on partly oxidized ore stoped above the 100-foot level; but no great production was attained, and operations of late have been restricted to systematic exploration and to experiments in ore treatment.

The mine is opened on three levels, approximately 100, 200, and 275 feet below the surface. There is also a sublevel 25 feet below the 275-foot level. The principal drifts and cross-cuts are within the ore body, which is of a generally elliptical plan with a length between 300 and 400 feet and a width between 200 and 300 feet. No regular structures are followed by the drifts, which are devious and have been so laid out as to leave no large blocks of the ore-bearing ground unexplored. The 100-foot and 300-foot levels connect with the surface through adits. The lower or main adit runs westward and cuts the ore body at 780 feet from the portal. It then turns toward the northwest and continues for nearly 400 feet, through the ore and into the country rock on the other side. The total development work is from 6,000 to 8,000 linear feet.

The ore lies in limestone near the contact of this rock with granodiorite, which is widely exposed just west of the mine. The contact, as previously mentioned, is due to faulting; the fissure at this place strikes a few degrees east of north and dips 35° E. Both granodiorite and limestone are crushed and sheared in its vicinity. The ore is wholly in the limestone, being from 50 to 100 feet or more east of the fault zone, which shows no mineralization. The belt of limestone containing the ore is here about 700 feet wide and is bounded on the east by the down-faulted block of Tertiary volcanic rocks already described. This fault, crossed by the main adit 190 feet from the portal, is a clean-cut unmineralized fissure with an easterly dip of 65 degrees. It has no connection whatever with the deposition of the ore.

The plan of the ore body, as already stated, is roughly elliptical, the longer axis trending about 25 degrees west of north. The northwest end of the mass is thus nearer the granodiorite than the southeast end. The dip is variable, but the mass as a whole dips to the east at an angle of about 45 degrees, so that the ore is nearer the granodiorite on the 275-foot than on the 100-foot level. There is no sharp separation between ore and limestone, although on the foot-wall side of the ore body there is a persistent seam or fissure which in places serves practically as a wall. The ore, however, does not everywhere extend as far west as the seam, and the limestone beyond this fissure, which shows no evidence of important movement, contains the same minerals as the ore. A similar, but less persistent fissure serves in some places as a hanging wall for the ore body, which at its ends passes gradually into mineralized but unprofitable limestone. Similar gradations from ore to limestone may be observed at many places within the mass of the ore body. The ore maintains its general character down to the 275-foot level, but the 300-foot sublevel at the time of visit showed only mineralized country rock. Mr. C. A. Weck, superintendent of the mine, has estimated on the basis of careful sampling that the quantity of ore blocked out is between 2,000,000 and 3,000,000 tons, with an average tenor of 3 per cent. of copper.

The ore consists essentially of chalcopyrite disseminated as grains and small irregular masses through limestone, that has been altered to an aggregate consisting chiefly of a yellowish-gray epidote with subordinate calcite and quartz. The ore proper is almost free from pyrite, but the chalcopyrite gives place to this sulphide as the ore grades into country rock.

Oxidation is not extensive and scarcely penetrates to the 100-foot level, while chalcopyrite is present in the croppings. A little chalcocite occurs above the 100-foot level, but there has been no important enrichment through the secondary formation of this mineral. It is evident that the ore body as a whole is too solid to have been penetrable to any considerable depth

by oxidizing solutions, and that erosion has kept pace with the process of weathering.

At the time of the writer's visit, experiments were in progress to determine the best method of concentrating the ore. The scheme devised is to crush the ore and pass it through a 10-mesh screen. The material is then given a slight roasting, which renders the chalcopyrite magnetic, and is passed through Wetherill magnetic separators. The experimental extraction ranges from 92 to 95 per cent., but the concentrates still contain considerable epidote.

Mason Valley Mine.—The Mason Valley Mine is three-quarters of a mile southeast of the Bluestone and at nearly the same elevation. The ore body outcrops at about 5,500 feet above sea level, and has been cut by tunnels running southwestward into the ridge at elevations of 5,385, 5,325, and 5,200 feet. A new tunnel, known as No. 4, is being driven at 5,080 feet, and is expected to enter the ore at about 1,100 feet from the portal. There are also some abandoned workings, which attained a depth of nearly 200 feet, and which, like the Bluestone Mine, supplied copper sulphate to the mills on the Comstock lode. The recent work is of an exploratory character, and is mainly on the No. 3 level.

The country rock of the ore is limestone, which shows much local alteration. The Mason Valley Mine is at least half a mile east of the fault contact of the limestone with the granodiorite.

As exposed at the surface the copper-bearing zone in the limestone trends nearly north and south but is curved and irregular. Its greatest width is about 150 feet. Its total length, without measurement of sinuosities, is nearly 2,000 feet. Probably beneath a small part only of the copper-stained croppings is ore present in commercial quantity. The workings of the Mason Valley Mine show that the ore bodies are irregular and indefinitely bounded masses which, as a rule, grade into garnetized limestone, although in some places, particularly on the west side, there is a close fissure, or joint, separating ore from country rock. The development at present is insufficient to reveal the sizes or shapes of the ore shoots, but apparently they do not extend continuously from the surface down. The No. 2 tunnel, for example, is in barren ground, with ore above and below it.

The sulphide ore is composed essentially of pyrite and chalcopyrite, with garnet, pyroxene, and a little calcite. The most abundant and characteristic gangue mineral is a pale-brown or amber-tinted garnet, which in crystals is almost transparent, and where massive is not unlike the epidote rock of the Bluestone Mine in general appearance.

The primary ore of the Mason Valley Mine contains more pyrite with the chalcopyrite than that of the Bluestone Mine, and appears to be generally of lower grade. Oxidation, however, has penetrated deeper and has effected some local concentration down to the No. 3 tunnel, although some sulphides occur at the surface. On the No. 3 level there is a considerable body of rich ore, consisting of impure earthy cuprite with much disseminated native copper. The shape and extent of this body, which contains up to 20 per cent. of copper, have not been fully ascertained. Chalcocite in a soft sooty condition occurs sparingly, but there has been no important enrichment through the formation of this sulphide.

As in the Bluestone Mine, the original ore of the Mason Valley Mine forms irregular metasomatic masses in limestone and is without definite boundaries. Its character suggests contact-metamorphic action, although the ore is not at present close to the granodiorite.

These two mines above described are evidently the largest and best developed properties of the district. From a geological standpoint they may be taken as typical of their class of deposits. From lack of space the descriptions of the Malachite, McConnell, Western Nevada, and Nevada-Douglas mines are passed over in order to devote attention to the Ludwig Mine, which is typical of the second class of ore deposits in the district.

REPLACEMENT VEIN DEPOSITS

The Ludwig Mine.—The Ludwig Mine lies on the west side of Singatse Ridge at the edge of Smith's Valley. It is worked through a vertical shaft 400 feet deep with a steeply inclined winze 200 feet deep, below the 400-foot level. The 400-foot, 500-foot, 550-foot, and 600-foot levels were the only ones examined, the levels above the 400-foot having been stoped out and abandoned. The drifts vary in direction from north to N 35° E. The most extensive level is about 400 feet long.

Unlike the deposits on the east side of the main ridge, the Ludwig ore body is of lodelike form with a steep dip to the east. The ore zone is from 50 to 60 feet wide on the upper levels, but in the deeper workings the number of cross-cuts is too small to show fully the limits of the pay shoots. No walls are known, for example, on the 400-foot level. The general country rock is limestone. That in the foot-wall is an ordinary gray massive limestone which for a depth of 50 feet has been extensively altered to solid alabastine gypsum by acid solutions from the oxidizing sulphides. The hanging-wall limestone is generally thin bedded and contains garnet with other metamorphic silicates. The beds dip to the east at about 65 degrees, but are intruded and disturbed by dikes of granodiorite porphyry, one of which, just north of the shaft, forms the hanging wall of the lode. Within the ground explored, the fissuring that permitted the ore deposition appears to have coincided with the plane bedding between the massive limestone, which is probably over 100 feet thick, and the thinner, more metamorphosed beds now forming the hanging wall.

The ore from the surface to the 500-foot level is mainly oxidized. It consists on the 400-foot level of a large mass of shattered limestone, whose interstices and fissures are filled with coarsely crystalline calcite.

The ore on the 550-foot level consists chiefly of sulphides and carries from 2 to 3 per cent. of copper. There is, however, some rich oxidized ore even at this depth, one soft, earthy face exposed at the time of visit affording assays up to 40 per cent. of copper. Ore enriched by the deposition of chalcocite on pyrite is also present, but the quantity of such rich sulphides is apparently not great. The 600-foot level showed no ore at the time of visit; the vein filling then exposed consisted of coarsely crystalline white calcite with some quartz and a little pyrite.

The Ludwig deposit differs from those on the east side of the ridge in the fact that it fills a fissure. The original filling contains some garnet and quartz, but is predominantly calcite, with enough pyrite and chalcopyrite to make an ore of very low grade.

Summary.—In the first class of deposits the original sulphides of the ores are pyrite and chalcopyrite, in various proportions, whose tenor is generally low; probably no masses of large size average over 3 per cent. copper. The largest and richest body of such ore that has been at all satisfactorily blocked out is that of the Bluestone Mine, which is about 300 feet long and of approximately the same width and depth. The oxidation of these ore bodies has not been extensive, and there has been no important enrichment through the deposition of chalcocite or other secondary sulphides, though some of the oxidized ore is of high grade.

The only important deposit of the second class is the Ludwig ore body, in which the vein is composed mainly of coarsely crystalline calcite carrying some garnet with pyrite and chalcopyrite. Oxidation has here extended to a depth of about 500 feet and has produced ore of shipping grade.

The economic importance of the third-class deposits has yet to be proved.

The total quantity of oxidized ore exposed in the district is small and there is no indication of any extensive sulphide enrichment. The quantity of gold or silver in the ores is

practically negligible. The future of the mines depends on the working of low-grade primary deposits. The conditions are in some respects favorable for cheap mining and concentrating; a railroad could be constructed from Wabuska along Walke River with very little difficulty; water is more plentiful than i most other parts of Nevada, and many agricultural product can be grown in Mason Valley. On the other hand, water tailings, and smelter fumes are subjects concerning whic miners and farmers usually find agreement difficult.