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THE IRON ORES AND SYSTEM OF MINING AT SUNRISE MINE, WYOMING.

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The Sunrise Iron Mine is situated about 125 miles north of Cheyenne, in Laramie County, Wyoming. It is connected by the Colorado & Wyoming Railway with the Colorado & Southern at Hartville Junction, fourteen miles west, and at Guernsey with the Burlington six miles west of the mine. The district is generally known as the "Hartville Iron Range." The property is owned and operated by the Colorado Fuel & Iron Company.

The iron ores present characteristics which are seldom met with in the ore deposits of the better known iron districts of the United States. They consist of two distinct varieties of high grade hematite; the soft red variety of greasy texture, and the hard blue hematite, intermixed, affording an ideal character of ore for working in the blast furnaces.

The occurrence of the two varieties of ore in the same body I believe is easily explained by the fact that the soft hematite is a secondary alteration of the hard due to the action of surface waters. This theory seems to be well demonstrated by the fact that at the surface of the ore-body the soft ore is in excess; at the two hundred foot level the hard ore is more in evidence; at 300 feet the hard ore is in excess, in fact with very little showing of the soft ore, which, in the diamond drill holes below this point, cuts out and gives way entirely to the hard blue ore. By experiment we have found that the two

varieties of hematite differ to quite an extent in the phosphorus and silica content, the hard ore containing the lower phosphorus and the higher silica, while the soft ore holds the higher phosphorus and the lower silica, a combination which makes it a difficult matter for the mine chemist to get a correct sample and analysis of the car shipments. Unless the sampler gets the proper proportion of the soft and hard ore in the car it is misleading, as it is impossible to check up at the steel works. For this same reason it is impossible to take any drift or pit samples ahead of the mining which will be of any value for close checking, as two samples taken in the space of one foot of ground will vary to quite an extent. This variation, however, applies only to the ore near the surface, where the alteration is most marked. As depth is attained the ore becomes very uniform with a low phosphorus and silica content.

The ore-body which we now have opened up occurs in irregular masses or lenses with no well defined walls as yet proven. The lenses of ore are surrounded by schist, which undoubtedly must be considered a part of the iron formation, as we will endeavor to show. Next to the schist lies a hard dolomitic limestone of an impervious character, which in all probability will prove to be the wall rock of the iron formation as our explorations and development progress. However, up to the present time we have not done enough in the lime formations to show what relation they actually bear to the iron. In exploring ahead of our producing ore bodies, we have as yet found nothing to guide us in looking for new ones, especially on surface, which, in the immediate vicinity of the mine, is capped by limestone. The ore is where we find it, and the diamond drill is the only reliable expert we have yet employed. The schist areas are badly folded and twisted, dipping at all angles from surface down to a depth of 300 feet, and having no well defined strike, so that it is impossible to follow them out with any degree of certainty.

As to the derivation of the ore, it is reasonable to assume that it is a product of the schists, having originally occurred in the schist in the form of pyrite and perhaps some magnetite.

The hematite then is no doubt a replacement of the schist, probably being responsible for the greasy character of the ore. The explorations up to date I think demonstrate this theory. On the east side of the main ore body, and deeper than we have yet explored in the mine, we find a dark gray biotite schist impregnated with pyrite. This I believe to be the original form of the iron bearing schist, the schist itself probably resulting from some igneous rock. As we approach the orebody, we find a more altered phase of the same rock with a heavy iron stain, and the pyrite missing, and finally next to the ore the very much altered light gray to greenish schist, looking very much as if it had gone through the leaching process, as illustrated by the specimens at hand.

Besides these three forms, we have been fortunate enough to obtain some good examples of the replacement of the schist by the hematite. The specimens showing this will run about high enough in iron to make a low grade ore while the schistose structure is still well preserved.

System of Working.

In taking up the system of working the mine, which is very simple, it might be well to take up its history and follow through the interesting development.

The first mining, at what is now the Sunrise Mine, was done in the early nineties for copper. The copper deposit proved to be a pocket, which was finally worked out and the shaft with some small drifts bottomed in iron. This, together with a small showing of iron on a side hill below the copper, called attention to the possibility of the value of the immediate territory for iron.

In 1900 the Colorado Fuel & Iron Company first entered the field, leased a group of seventy-two claims, covering quite an extensive part of the district, and later purchased the same.

In the same year operations were begun on a small scale with a steam shovel in the ore which was exposed on the side hill. Up to the spring of 1901 about 81,000 tons of ore had

been shipped and nothing was as yet known about the existence of any more other than that actually in sight, which at this time was a very small quantity ahead of the steam shovel. At this stage Mr. J. D. Gilchrist, now manager of the Iron Mines Department, was summoned from the Mesaba Iron District of Minnesota to take hold of the property. He started immediately by introducing vigorous Lake Superior methods in the endeavor to locate and open up some available ore in the quickest possible manner, and at the same time with a view to the most economical future mining operations. Guided only by the fact that the old copper shaft was bottomed in iron, as above mentioned, and the trend of the ore already being worked, stripping operations on the overlying surface were started with a second steam shovel. The work was well rewarded by the uncovering of a good body of ore which was available for mining with the steam shovel, which is without doubt the cheapest method of mining where conditions are suitable. While this was under way, dimond drills were put to work and constantly kept busy proving up the ore. It was soon found that an ore body of large proportions was awaiting development.

As the ore had been located to several hundred feet in depth by the drills, the end of economical mining with the steam shovel was anticipated several years ahead, it being necessarily limited to the maximum grades on which the railroad locomotives could haul the loaded cars out of the ore pit. (It might be well to state here that the standard gauge tracks were laid direct to the steam shovel in the pit and the ore loaded into the cars for immediate shipment). To prepare for another system of mining then a vertical shaft was started in December, 1902, and sunk in rock to a depth of two hundred feet, where a level was started off into the ore body, as shown on the accompanying plat and sectional views. Later, sinking was continued to a depth of three hundred and forty feet. Another level was started off at three hundred feet, the remaining forty feet being for a skip sump and loading chutes. (The shaft is 6′x18′ in the clear, with three compartments

consisting of two skip ways each 5′x6′ and a ladder way and pipe compartment 6′x6′8″). Drifts were rapidly pushed out into the ore and under the first steam shovel pit (a second steam shovel pit having been opened up just north of the original one). This was in preparation for the milling system, which ranks next only to the steam shovel work in cheap mining operations. Raises were put up from the underlying second level drifts to the open pit above, as shown on the map. These formed the mills through which the ore is picked down to loading chutes on the second level, where it is loaded into cars, hauled out to the shaft and hoisted to surface, dumped into shaft pockets by self-dumping skips, and thence into railroad cars. The system is very common in the Lake Superior iron districts, especially on the Mesaba Iron Range.

The prompt development of the ore-body under-ground not only brought the milling system into operation at the proper time, but also served to drain the ore with which more or less water is always associated, so that when the milling was started the ore was quite dry.

Drifting on the underground levels has gone on steadily until the mine has reached the stage of development best shown by the map. All drifts are in ore except where we have met with small talcose horses or seams of schist, which have been few for such a large area. The diamond drill is here in constant use. No drifting is done in waste rock until it is known that there is ore beyond. This is determined by not only putting a drill hole in on the course of the drift, but also fanning out with at least two angle holes on either side of the first one, especially where there is no knowledge of the ground in the immediate vicinity. We find this much more economical than drifting ahead blindly with the possibility of getting into undesirable ground. To give an idea of the extent of our diamond drill operations it might be interesting to state that the total number of feet of drilling done by the company in this district amounts to 50,648 feet, or 9·6 miles, of which 12,222 feet was done underground in the mine.

Since the summer of 1903, the development in drifting amounts to 18,815 feet, or about three and one-half miles. From the year 1901, with 97,000 tons, the production has increased rapidly, the last fiscal year showing 571,000 long tons of ore.

The underground levels are equipped with electric haulage, the trolley system being used, operating three five-ton Jeffrey electric locomotives. This makes it possible to handle the ore very rapidly in connection with the milling system. The main haulage drifts are electric lighted and arc lights are used around the open pit on the surface so that the milling work can be carried on at night.

The surface plant consists of two 125 k. w. direct current Westinghouse generators, belt driven by two enclosed high-speed compound Westinghouse driving engines; two cross-compound two-stage Rand air compressors of twenty drills capacity each, and one 20"x42" first motion hoist of the Corliss type, operating two five-ton skips in the shaft. The boiler plant consists of a battery of six 150 h. p. return tubular boilers. You will notice that the electric and also the air power is installed in two units each, rather than installing the same capacity in one large unit for each. The feature of this being the one unit in reserve in case of a break down in the other. At this time we are using but one generator and one compressor, having one unit of each always in reserve, but even though they were all working at once to get the desired capacity, half the power is better than none in case of an accident to one of the units.

One of the features in the equipment, which should not be passed over, is the new dry or change house recently built for the comfort of the men. It consists of a one-story brick building 40'x115', divided into a changing room 38x54', a wash room 38'x46', the mining captain and shift bosses' room, and an emergency hospital in the remaining space. The two large change and wash rooms are laid with cement floors on concrete base and sloping to a central drainage system. The whole floor space can thus be flushed out with a hose and kept

remarkably clean and sanitary with very little work. The change room is fitted with several hundred expanded metal individual lockers equipped with Yale locks, so that every man has a private and safe place to keep his clean clothes and valuables. On either side, and running lengthwise of the change room between the rows of lockers, are long hanging racks for the working clothes, fitted with steam coils underneath and large ventilating hoods overhead, which converge into stacks projecting out through the roof. This makes an ideal arrangement, as the steam coils below the racks (which, by the way, are for this particular purpose, the heating system for the building being installed in steam coils around the walls), dry out and air the clothes by creating a steady draft up through the ventilating hoods and thus disposing of the resulting foul air at once without having it distributed through the building. The wash room is connected with the change room by doorways, and is fitted with twelve shower-baths on one side, while on the other there are two long steel wash troughs, equipped with thirteen pairs of faucets each, and individual wash basins for as many men as are employed. The troughs each have a capacity for fifty-two basins. Both the showers and wash troughs are equipped with hot and cold water. I believe this is the most modern and best equipped change house at any mining location in this western country and goes a long way toward keeping good miners.