

COPPER MINING IN LAKE SUPERIOR

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Copper Mining in Lake Superior by Thomas Egleston

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COPPER MINING ON LAKE SUPERIOR.

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THE copper-bearing rocks of Lake Superior are composed of a series of metamorphic rocks, comprised under the names of amygdaloid and conglomerate, in which the copper and silver found with them are pseudomorphs. These rocks, generally, have well-defined walls which cause them to separate easily. Generally, the country rock is sterile, but it occasionally rises into the copper-bearing rock, and then carries copper. Usually, the amygdaloids carry copper, and the greenstones or melaphyres which encase them do not.

There is a very generally received opinion that the copper in these beds occurs in shoots. This does not appear to be proved, though the opinion seems to have some foundation from the experience of the Calumet & Hecla Mine, where a body of poor rock has been left, which, on the mine map, shows a general direction. The theory may be true of that individual mine, but too little work has been done in the other mines to draw any decided conclusion. The copper is very unequally disseminated in the rock, if any given piece be taken as an example, but, if the whole copper-bearing series be considered, its distribution is uniform. It may prove that there are certain directions in which the copper has been deposited more abundantly than in others, and these may be found to correspond with certain geological causes, but up to the present time the knowledge gained is not sufficient to warrant any general conclusion.

These rocks are supplemented by a series of true fissure veins, of which there are several systems, making the amount of native copper very large. Unfortunately, except in the fissure veins, known as "mass-mines," the copper is so scattered through the rock, and is in such a fine state of division, that, although it is not always difficult to mine, it is always difficult to dress it sufficiently to make it pay.

The metal is so uniformly distributed through these copper-bearing rocks that detached pieces, called "float," are found in digging on almost any land in the country. These pieces vary from very small fragments, weighing not more than a few ounces, up to many pounds. In one instance, in making an excavation for a cellar of a

house, a piece weighing 1500 pounds was found. This copper is from 90 to 95 per cent., and, in detached pieces, even purer, and has evidently been deposited by electro-chemical action, having replaced parts of the rock, atom by atom. This phenomenon has taken place in all the different characters of deposits. I have had sections made of "barrel-work," from both the amygdaloid and conglomerate mines, which show the rock in all stages of impregnation. One from the Franklyn mine shows the copper in a leafy state, replacing the chlorite, so that when the chlorite not transformed is picked out the rock is nothing but a succession of hollow shells of copper. Not more than 40 per cent. of this mass was copper, and the rest was the more or less altered iron chlorite, known as dellesseite. Another, from the Calumet & Hecla Mine showed the paste of the rock completely transformed into copper, leaving the crystals of quartz and feldspar intact. This piece was almost pure copper.

This condition of things characterizes the amygdaloid and conglomerate beds, and is in them in every possible stage of development, and gives rise, in both classes of rock, to very thin leaves which float on the water and are carried off in the process of dressing. The change of the rock into pure copper has not taken place to any great extent in these two kinds of veins.

The amount of copper in the rock varies from less than 1 per cent., as in the Atlantic, to 4 and 5 per cent., as in the Calumet & Hecla, which is the richest of all the mines; the yield of this mine for the year 1876 was $4\frac{1}{2}$ per cent. mineral.

The strike and dip of the strata is very nearly uniform. At Portage Lake they have a strike of 35° , and a dip which is about 55° , which in the rest of the district rarely falls below 30° .

The amygdaloids vary but little in their constitution. They have been carefully studied by Professor Pumpelly,* and all the changes given in minute detail.

The conglomerates are found in every possible condition, from a type porphyry of large grain, with pebbles of from two to three inches in diameter, to a very fine-grained one, which is frequently transformed entirely into metallic copper. This rock, called the "sandship," is from three inches to twelve inches thick in the Calumet & Hecla and the Alouez mines. At other times the whole rock is entirely decomposed into a hard clay, sufficiently plastic to be with difficulty compressed by the hand, but easily cut with a knife, retain-

* Proceedings of the American Academy of Arts and Sciences, vol. xiii.

ing exactly the colors of the rock, and the shape and colors of the crystals of quartz and feldspar. In the vicinity of Portage Lake the conglomerates are entirely feldspathic, but from the Calumet & Hecla on they are highly quartziferous.

There is a theory that the conglomerates, when they are of fine grain, will be rich, which is not entirely to be depended upon. It is true that the finer the grain of the rock the more copper there will be likely to be in it, since the deposit seems to be more readily made in the paste of the rock, and for that reason a given cubic foot will contain more copper, since the larger pebbles are usually barren. Occasionally, the "sandlip," which is the conglomerate in the condition of very fine grains, is completely transformed into metallic copper, but this is an exception, as is also the transformation of the pebbles into copper. The fineness of the grain may be said to be a favorable indication, but the pillars of poor rock left in the mine are not usually of any coarser grain than those extracted.

There are fifteen different conglomerate beds, which are recognized by their position in the general geological section of the country, all but four of which have been found by explorations to continue through the whole of the copper region of the promontory of Lake Superior. All but five of these have had workings upon them, but the only paying mine on them is the Calumet & Hecla. They were formerly considered as barren of copper, and for a long time received no attention from mining men. At the Nonsuch Mine the copper is found in very thin flakes, scattered through a bed which is $14\frac{1}{2}$ feet thick. This is divided into three sections: the upper one is $6\frac{1}{2}$ feet, and is said to contain $1\frac{1}{2}$ to 3 per cent. of copper; the middle one is slate, 5 feet thick, but poorer in copper; the lower one, 3 feet thick, contains 2 per cent. of copper, and carries pockets rich in silver. The mine has only just been opened, and although extensive preparations had been made to work it, they were brought to a standstill by the death of the president of the company.

The amount of copper contained in these rocks is very variable, but as the amygdaloid is easily crushed the selection is not very carefully made. An exceedingly poor rock, as at the Atlantic Mine, which yields only $\frac{1}{4}$ per cent., can be worked. This is not true of the conglomerates which, on the contrary, are very hard. The rock must be richer, and the pieces have therefore to be carefully picked. The exceedingly favorable showing of the Atlantic, which is an amygdaloid mine, is owing partly to the fact that the ore is much

more easily mined than in the conglomerate beds, but is also in part due to its excellent management.

All of these mines produce more or less copper in lumps, which, when of sufficient size to be handled, is called "barrel-work," to distinguish it from that produced by the stamps, which is called "stamp-work." These masses of copper vary from the size of a pea up. Masses weighing as high as one ton have been found in the conglomerate mines, but this is unusual. When slips have taken place in the hanging wall of these mines, the copper is deposited between the layers of the slips in thin sheets, which look as if they were rolled out. Many of them have been taken out from the Calumet & Hecla two feet square. They could probably have been taken out much larger but for the difficulty of handling them, for as it is not possible to separate all the rock, the sheet breaks or tears with its weight. It requires great judgment in the mine to determine what rock shall be brought to the surface and what left in the mine. The eye frequently fails to detect anything in the poor rocks, but by running the fingers gently over their surface, the miner soon learns to detect the slightly projecting pointed pieces of copper from the inequalities of the rock, and even to form an approximate judgment of how much it contains.

The methods of mining which will be described are, those of the ancients, which will be passed over with only a notice; those used in the fissure veins, or "mass mines," and those used on the amygdaloid and conglomerate beds.

The disposition of the copper in the mines causes several kinds of material to be sent to the smelting works: "mass copper" is the large pieces, from fifty pounds and upwards; "barrel-work" comprises the pieces less than about fifty pounds, which can be easily packed in barrels; "stamp-work," or "mineral," is that which comes from the dressing works. All the mines produce mineral and barrel-work. Mass copper comes, except occasionally, from the mass mines. The conglomerates produce but a small amount of barrel-work, while the mass mines produce a great deal. As all the mines produce mineral, it is by far the largest part of the copper treated in the smelting works.

The organization of the mines is generally the same throughout the district. It is usually arranged so as to separate the surface work from the mining proper, and differs only in non-essentials from one district to the other, in different mines. The chief man is the agent, who is responsible directly to the board of directors. Under him

are three officers, the head mining captain, the surface superintendent, or "surface boss," as he is generally called, and a physician. In a few exceptional cases, the head captain is, to some extent, independent of the agent, but this is not generally so. The agent makes all the contracts for supplies, and purchases all the materials for the mine. He conducts all the business of the office, having under him a force of clerks, more or less large, according to the business of the mine. Sometimes the surface contracts are made by the superintendent, but always with the approval of the agent. In the office the mining and surface work are always kept separate. The mine clerk has charge of all the books relating to the mine proper, keeps all the accounts of the mine contracts and a personal ledger account with each miner. These accounts, less the store charges, are settled once a month in drafts, which the men negotiate. Generally, very little money is kept at the mine, both on account of want of security, and because it is quite as easy for the men to negotiate their drafts as for the company to get the ready money. A miner desirous of leaving before the end of the month sells his verified account easily. In mines with full credit such an account will bring very nearly its face. They are, however, sometimes sold at a great reduction, when the credit is not good or a panic takes possession of the men.

The surface superintendent has under him a master mechanic or machinist, a head blacksmith, and a head carpenter, who have charge of the machinery, tools, buildings, and all the work of the mine, not immediately connected with mining. They take charge of all the ordinary repairs to the machinery and tools, cut and saw the timber, build and repair the houses, take care of the surface railroad, etc.

In some mines, in addition to these men, there is a farmer, who raises produce on the company's lands; but generally it costs more to raise crops than to purchase them in the open market. The store at which the men purchase their supplies is either kept by the company or let out by contract, with the agreement that the store accounts shall always be secured by the company to the store, and have preference over all other debts owed by the men.

The prices charged are reasonable, and are generally as low or lower than the men could obtain elsewhere. The men are not obliged to go to the store, though most of them do.

The companies generally own houses, which they let to the men with families at a low rent; some of these families take boarders, but most of the single men prefer to live in boarding-houses, which at some of the mines are kept by persons licensed by the company.