

PAPER III.—COPPER MINING IN CANADA EAST.

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(Read before the Society, 15th March, 1865.)

The discovery of copper ores in the Eastern Townships may reasonably be within the memory of most persons present, as dating within the last fifteen or twenty years, whilst actual operations for their development only commenced within the last seven years.

The first discovery appears to have been made on lot No. 4, in the second range of the Township of Inverness; and although some very fine samples were exhibited in the City of Quebec, it was some time before any notice was taken of the circumstance. I believe it was not until some samples were shewn to one of your most enterprising citizens, Dr. James Douglas, whose characteristic shrewdness induced him to enquire into the matter, that a move was made, the result of which was the formation of the Megantic Mining Company.

The second discovery was that now known as "The Harvey Hill Mine," situated on lot 17, in the fifteenth range of the Township of Leeds, which was also secured by the same gentleman and his associates, who organized a company under the name of "The Quebec and St. Francis Mining Company."

This second discovery seems to have created some excitement at the time, as several other companies appear to have been organized for working copper mines in the Eastern Townships about this period, and beyond the purchasing of large tracts of land and the procuring of charters of incorporation, little appears to have been done by any of the Companies, excepting the Quebec and St.

Francis Mining Company, who made such explorations on Harvey Hill as enabled them, in the spring of 1858, to bring it under the notice of some English capitalists, who organized themselves under the Imperial Statutes, with "limited liability," as "The English and Canadian Mining Company." Under the auspices of this company, systematic mining operations were commenced, and have been uninterruptedly continued up to the present time, with the results to be hereafter detailed.

In the autumn of the same year (1858), operations were commenced by Mr. Sleeper, on that most extraordinary deposit, known as the Acton Copper Mine. Although the discovery of copper ore of very rich quality had been made some few years previously, so incredulous appeared the public mind on the subject, that the property was purchased by Mr. Davis, of Montreal, for a very insignificant sum and a royalty; but that gentleman had so little faith in his purchase, that he at once let it to Mr. Sleeper on "tribute," at two-thirds of all the ore that he could obtain from it for a period of three years.

The enormous results obtained by Mr. Sleeper, almost immediately on commencing his operations, induced more extensive researches, leading to the discovery of copper (as reported in May, 1859, by our eminent Provincial Geologist) in sixty-seven different localities in various parts of the Eastern Townships, since which period I may fearlessly state that copper ores have been found in thousands of places.

My own occupations in connection with the development of copper mines in the Eastern Townships commenced in the year 1858. The observations and examinations that I have made since then extend over a large area of the country, the minute details of which cannot be comprised within the limits of a short review on the copper mines of the Eastern Townships, such as I purpose submitting to you on the present occasion; but to those who may desire to form a better acquaintance with the geology of the Eastern Townships, for the purpose of rendering its mineral resources commercially available, I would strongly recommend a

careful study of the report of our eminent and deservedly popular Provincial Geologist, Sir W. E. Logan, published in 1863, by Messrs. Dawson of Montreal.

The amount of valuable information to be obtained from a careful and patient perusal of that most valuable compendium of the labors of the geological staff of this Province, cannot, I fear, be fully appreciated in the present stage of mining operations; but its importance will appear in the future development of the immense mineral resources of this country, by enabling the miner to trace, with some degree of certainty, the limits within which he may reasonably expect to find copper ores in the rocks of the Quebec group, which is regarded as the equivalent of the upper copper-bearing strata of Lake Superior.

The structure of this important mineral region, in which numerous deposits of copper ore occur, is described in that work as follows :*—" The strata of this region, which include both the Quebec group and some dark-colored slates supposed to underlie it, are, from the effect of undulation, arranged in long parallel synclinal and anticlinal forms, with many overturn dips. The latter circumstance renders it difficult to determine which of these folds are synclinal and which anticlinal, inasmuch as the outcrops, in both cases, present a similar arrangement. The weight of evidence, however, at present goes to show that the strata dip towards the centre of the areas about to be described, and they will therefore be designated as synclinals. These in the part of the region which has been most examined (extending from the boundary line of Vermont to the Chaudière River), are three in number," the first of which is briefly defined as " The synclinal extending from the Township of Farnham, near Missisquoi Bay, to the Seigniory of Lauzon, on the St. Lawrence. This, where it is traversed by the St. Francis, is nearly or quite separated into two parts by the appearance of the underlying slates. The south-western portion appears to be divided by an undulation into at least two subordinate troughs,

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“ thus giving in Roxton and Ely an additional breadth to the exposure of these rocks. The copper deposits of Upton, Acton, Wickham, Roxton, and Durham, occur in this synclinal, while in its north-eastern extension are those of Wendover, Somerset, Nelson, and St. Flavien.”

In the long extent of this synclinal, although copper ore has been found in a great number of localities, the Acton mine necessarily claims precedence of all others, as having yielded by far the greatest quantity of copper. The celebrity which this mine attained during the first few years of its working, will, I doubt not, be fresh in the recollection of most persons present. Several valuable papers have been published on the subject, both in the records of the Geological Survey and in the *Canadian Naturalist*. One, in particular, published in the latter, in December, 1862, by Mr. Thomas Macfarlane, is well worthy the perusal of every student and miner in the province, as affording a very large amount of detail with regard to the actual working of the mine from 1st September, 1861, to 30th September, 1862. The total amount of ore taken out during that period appears to have been 2,336 tons, averaging about twelve per cent. of fine copper, or at the rate of about 179 tons per month.

By the Directors' Report to the shareholders, up to the end of September, 1863, the total amount of ore taken out for the year appears to be 3,695 tons, nearly 308 tons per month, the same averaging 12.46th per cent. Although this exhibits a fair increase in the produce of the mine, the balance-sheet for the same period does not exhibit an equivalent increase in financial results to the stockholders; neither did the mine present, at the end of that year, the same promising appearance that it did the year previous, as no sinking appears to have been done with a view to the discovery of more ore, and the creating of further reserves.

The ores at Acton and other places along the course of this synclinal are composed of the vitreous, variegated and yellow sulphurets, with occasional traces of green carbonate of copper, and are characterised as occurring associated, in most places, with

bands of greyish-white and reddish-grey compact sub-crystalline yellowish weathering dolomitic limestone. Explorations have been made upon outcrops of copper so associated, at Upton, Wickham, Durham, Somerset, Nelson, and St. Flavien, besides a great number of intermediate localities between these places, some of which have resulted in the production of a few tons of good quality ore; but, being prosecuted by American capitalists, the high rate of gold as compared to the value of the present American currency has necessitated the suspension of operations in most of them for some months past, and has even curtailed operations in the great Acton Mine.

The second synclinal is described as "extending from St. Armand to the Seigniorship of St. Mary, on the Chaudière. In it are the copper deposits of Sutton, Shefford, Stukely, Melbourne, Cleveland, Shipton, Chester, Halifax, Leeds, Inverness, and St. Mary. In its southern extremity, this synclinal is divided into two by Sutton Mountain, and while one part occupies Sutton Valley, the other extends southward into Potton."

The Harvey Hill Mines, in the development of which I have been chiefly engaged, lie within the limits of this synclinal. Active operations were commenced here in the spring of 1858, by developing some quartz courses found cropping out at surface, and carrying chiefly the vitreous and variegated sulphurets of copper. These courses were found to be lenticular in form, cutting the strata of the country in their strike and dip; and although the ores discovered in them were of the very richest quality, the actual result, commercially, was by no means as satisfactory as could be desired, arising mainly from their very limited extent, both longitudinally and vertically, and the great cost necessary for their extraction and the subsequent preparation of the ores contained in them for transport to market. These courses, though bearing some resemblance to lodes occurring in dislocations of stratification, did not present the usual indications to the eye of the miner by which similar discoveries are made in Europe, viz., by their gossan outcrop; they nevertheless presented highly favor-

able indications of the existence of copper ore in depth, and such as induced more extensive explorations with a view to ascertain whether they were not connected with regular lodes beneath the surface. These explorations, though not meeting with any lodes in depth, made other discoveries that may eventually prove of much greater importance to the country than old European theorists on the formation of copper will probably admit for some time to come, viz., the existence of copper ores imbedded in the slates of the country, in quantities sufficient to render their extraction highly remunerative, with careful management and economy in laying out the works.* These slates present in section an undulating appearance, and the copper is disseminated through them in lenticular masses, varying from one-sixth of an inch to two and three inches in thickness, and in length exhibiting lines varying from three inches to eighteen inches, and at times over two feet.

These masses may, for the most part, be considered as overlapping one another, with variable distances between them; whilst the ore is disseminated throughout the whole thickness of the bed, which varies between five and six feet.

The existence of this bed has been proved, at intermediate distances, for a length of over two hundred fathoms; the breadth has also been proved for an average of between seventy and eighty fathoms. Therefore the area, as far as it has been proved, may be assumed to contain about sixteen thousand superficial fathoms of ground.

By careful trials, the average yield of the richest portion of the bed is computed at a little over twelve and a half tons of three and a half per cent. ore to the superficial fathom of ground, or about 190,000 tons in that portion of the bed which has been proved, the extraction of which, supposing it to be worked at the rate of one hundred tons per day, will occupy between six and seven years. It must not, however, be supposed that the foregoing limits

* Three such deposits have been met with at Harvey Hill, the upper one of which is now being wrought.

comprise the entire extent of the copper-bearing slates ; for works are now in progress, proving their existence over a very much greater area. In speaking of this bed, I may observe that two other mines have been started on its run in other properties, one of which has already a shaft sunk over thirty fathoms in depth ; and from the general nature of the ground now in the bottom of the shaft, there is every prospect of meeting the ore-bearing slates equally rich as they are at Harvey Hill.

In estimating the probable value of the ores that may be regarded as in sight at Harvey Hill, we may take the average of the Swansea sales, showing the unit of copper to be worth \$4.50. Hence, the ton of rough ore, at the mouth of the mine, may be regarded as representing \$15.75, and the 190,000 tons contained within the area above described will therefore be worth \$2,992,500.

The long land carriage, however, of these ores to market, renders their concentration on the premises necessary, with a view to effect a saving in that item of expenditure. This is done by a system of washing, by which the average percentage of the ore is raised to about eighteen or twenty per cent.

This operation, unfortunately, entails a loss of some of the copper in the mass, which may be estimated at about one-fifth, leaving for transport to the smelting furnaces a money value of ore copper of about \$2,394,000.

In stoping the slates, some lenticular quartz courses, similar to those discovered at surface, are met with ; but in no instance, up to the present time, have they been found to pass through the ore-bearing strata, but they appear to take their rise from them.

One of these, which seems to have taken its rise beneath the bed, yielded nearly two hundred tons of ore, averaging over thirty per cent. of pure copper, and has not yet been exhausted. This, however, seems to have interfered with the general yield of the bed in its immediate vicinity, as the average yield of copper in the slates is considerably diminished for some distance. This fact goes far to strengthen the theory suggested by Sir W. E. Logan,

“ that the quartz courses derive their copper from the interstratified beds.”

Some quartz courses have recently been discovered above the bed, apparently carrying a fair amount of ore, but no explorations have as yet been made upon them ; so their extent or productiveness has not been ascertained. I may, however, here remark, that the productiveness of the bed itself does not appear to have been affected in the same manner in the vicinity of those quartz courses taking their rise above the bed, as it is by those taking their rise from beneath the bed, for I have not as yet been able to perceive any diminution in the quantity of copper in the slates in the former case.

With reference to the bed, therefore, as I believe will be the case in several other localities along the course of this synclinal, when the country is more thoroughly explored and its resources developed, it will not be the question of the quantity of ore, there being no doubt now about the weight of ore that can be taken out monthly at Harvey Hill, within the limits already proved, but everything will depend upon the judicious laying out of the explorations, and the amount of working capital employed.

The difficulty at Harvey Hill, as I shall endeavor to show, is not now the one we, at the commencement of our operations, had to contend with, or the usual one met with in mining—a want of ore. There is at present, and for some time to come, a certain guarantee, without the usual mining chances to contend with. The difficulties to overcome at the present time are quite of another order. First, we have that of working up, on the spot, a very large mass of ore, rendered difficult by a want of water for its manipulation and ultimate separation from a considerable portion of gangue or the matrix with which it is associated ; and, secondly, a want of roads, and consequently a want of an easy transport to a foreign market. We have paid as high as \$10 per ton for the carriage of our ores to Quebec ; we now pay about \$7 per ton. When that cost shall be reduced by the introduction of a tram road to the Grand Trunk Railway, to the construction of which I

look forward with some amount of certainty within the next few years, larger profits will be made on the working of the mine by the saving alone between the present price of carriage and the reduced price, even supposing it should be greater than that of other countries.

In treating the subject of our copper mines and their ultimate importance in the great future of the province, a comparison with some of the European mines may not be uninteresting. "The Devon Great Consols Copper Mine" of England, produces monthly about 1,800 to 2,000 tons of dressed ore, averaging about six per cent., and to produce which some 25,000 to 30,000 tons of lode will be broken, containing perhaps, on an average, a half or three-quarters per cent. of copper. Now, 30,000 tons of bed stuff broken at the Harvey Hill Mines would produce about 4,200 tons of twenty per cent. ore, worth at present prices about \$387,000, whilst the same amount of lode, in the other case, does not produce more than about 2,000 tons of six per cent. ore, worth at the same rate about \$54,000; so that in point of value as regards quality, our Canadian mines present no mean contrast with the greatest mine at the present day wrought in Great Britain. And at no distant day, I trust to see the other beds already discovered more extensively developed and opened out, and the monthly yield of rough ore equal even to that of the Devon Great Consols.

The works at Harvey Hill, from their commencement in the spring of 1858 to the autumn of 1864, were almost entirely of an exploratory character, notwithstanding which the following weights of ore have been sent to market:—

	Tons.	Cwt.	Qrs.	lbs.		
In 1858.....	9	15	0	2	} Averaging about 30 per cent.	
" 1859.....	43	7	0	21		
" 1860.....	104	5	3	0		
" 1861.....	70	4	1	6		
" 1862.....	94	17	2	21		
" 1863.....	113	20	3	14	do	26 do
And " 1864.....	225	12	3	3	do	20 do

Making a total of 671 20 2 11

The mining ton being 21 cwt., or 2,352 lbs.

It will therefore be perceived by the foregoing figures that there has been a very perceptible falling off in the average quality of the ores sent to market in the two years 1863 and 1864, as compared with the five previous years; this arises from the fact that during the two past years but small quantities of ore were obtained from the quartz courses, the chief portion having been obtained from exploratory drivages on the interstratified bed.

In following the course of this synclinal in a south-westerly direction, the copper-bearing slates present themselves in several places. There is no difficulty in tracing them, notwithstanding the absence of gossan. There are other characteristics observable by which their existence is identified, one of which is the association of chloritoid with the slates.

The metamorphic action of the copper on the slate is characterised by some peculiar alterations in that rock whenever the copper is in contact with it. A more minute study of the phenomena as presented to view would be in the highest degree interesting to geological science, and most valuable to the practical miner.

These phenomena are observable over extensive areas in the Township of Leeds, as also in the Townships of Ireland, Inverness, Halifax, Wolfestown, Chester and Ham.

Copper ore is also found in these several townships associated with a yellowish-brown weathering dolomitic limestone, and the discovery of its existence in quantities sufficient to render its extraction highly remunerative may be reasonably expected after careful exploration.

Up to the present time, although explorations in the townships above enumerated have been on a very limited scale, there are several exposures of copper well worthy the attention of capitalists.

The Township of Chester seems to have drawn the particular attention of explorers. Some of the discoveries in that township may be regarded as presenting the most promising indications; particularly the Viger Mine, situated on lot No. 8, in the sixth range.

On the adjoining lot, No. 9, in the same range, some very pro-

missing indications are also exposed by the partial explorations which have been made on the property.

On lot No. 11, in the tenth range, some very fine samples of variegated copper were broken on the side of the Nicolet River, where it passes through that property, and on lot No. 11, in the eleventh range, a band of copper-bearing slates, several feet in thickness, was exposed during the past summer.

Along the continuance of the second synclinal, from Chester to St. Armand, there have been numerous explorations made, and copper discovered in nearly the whole of the intervening townships. I have not yet had an opportunity of examining them, therefore I cannot speak more particularly as to their promise of productiveness.

The third synclinal is described as "extending from the Owl's Head Mountain on Lake Memphremagog, to Ham, and includes the Stoke Mountains. An extension of this is traced north-eastward to Vaudreuil and St. Joseph, on the Chaudière and beyond it, into Buckland. Between the south-western portion of this synclinal and the second one, is a large area occupied by newer rocks, of the same age as those which limit the belt to the south-east. They include the slates and limestones which occupy the northern part of Lake Memphremagog; and, extending through parts of Oxford and Brompton, cover a considerable area in the contiguous parts of the Townships of Windsor, Wotton, Ham, and Stoke. These unconformable rocks overlie and conceal a large portion of the strata of the third synclinal; but along the eastern limit of this are exposed the copper deposits of Ascot, Ham, and Garthby."

The Ascot Mine was discovered about the year 1859, and was leased by the late Thomas McCaw, Esq., of Montreal. The copper-bearing bed in this mine differs very considerably from that at Harvey Hill, both in its composition, extent, and regularity, the ore being the yellow sulphuret (copper pyrites), associated with a little iron pyrites; the matrix is composed of an impure limestone associated with chloritic schist; the average thickness of the bed varying between five and six feet.

The limited means of the proprietor in this case for carrying on works, the very nature of which necessarily required a large amount of capital to open them up, with a view to the more profitable extraction of the ore, only enabled him to carry on such works as yielded ore in quantities sufficient to pay for the labor as he went on. In this he was tolerably successful, some of the ore yielding in the rough state as broken in the mine, and without any dressing, as much as eight per cent. of copper; whilst the poorer portion, from the nature of its matrix, could at small cost be dressed to an average of twelve or fourteen per cent., with but small loss of its copper contents.

The ore from this mine was discovered, at the smelting works at Boston, to contain within itself all the elements necessary for its reduction and liquefaction in the furnace, without requiring the aid of any foreign flux or admixture of other ores for the purpose of smelting it. In addition to which it was ascertained that this ore answered admirably as a flux for such ores as those from the Acton and Harvey Hill Mines, which are deficient in sulphur, and those from the Clark and other mines, containing silicious matters, requiring lime as a flux in their metallurgical treatment.

The ore from this mine therefore may be regarded as of some importance, should smelting works be established on a large scale in the province, as may be inferred from the fact that this mine was, in the fall of 1863, purchased by an American Company who erected furnaces at Lennoxville for the smelting of the ores from this and other mines in the province; and operations were carried on by them for some time successfully and profitably; but the lamentable difficulties of our neighbors for the past few years, and the great difference between the value of their currency and ours, compelled, a few months ago (like many other enterprises in this province carried on with American capital), the temporary suspension, at least for the present, of their smelting as well as mining operations.

About a mile to the north-east of the Ascot Mine is the Clark Mine, also possessed by an American Company. Here a bed of

copper-bearing slates of considerable thickness was discovered, and operations have been vigorously carried on for the last year, and large quantities of ore have been taken out and sent to market. Of the approximate quantity of ore extracted or its copper contents, I am not aware. There are several other localities in the neighborhood of Lennoxville where copper ores in promising quantities have been met with.

In the Township of Ham, on lot No. 28, in the fourth range, near to the line of Wolfestown, some considerable work has been done within the last two or three years, on a mass of dolomitic limestone averaging over one hundred feet thick. On the upper strata of this limestone, to a depth of twenty or thirty feet, the variegated and yellow sulphurets of copper have been found in nodules, and lenticular masses of no mean promise. The band of copper-bearing rock has been traced for some distance. When I visited this mine about two years ago, a large pile of very promising ore had then been taken out. Some machinery has since been erected for crushing and dressing the ore, and this mine may, I think, be reasonably regarded as one likely to become permanent.

On lot No. 26, in the second range of the Township of South Ham, several veins have been discovered subordinate to the stratification, varying in thickness from two to ten feet, and presenting at surface promising indications, by exposures of copper pyrites and green carbonate of copper in costeens made on the lot.

In the Township of Garthby, on lot No. 22, on the first range north, there appears a large mass of iron and copper pyrites subordinate to the stratification, which consists of calcareous serpentine.

The entire thickness in which the sulphurets are mingled with the rock is over twenty feet. Samples of copper have been broken from the mass, yielding by assay as much as twenty-two per cent., whilst samples of sulphuret of iron have also been broken, which on being submitted to assay, were found almost entirely free from copper.

An opening was made on this a couple of years ago, and sunk to a depth of about ten feet, and the sulphurets were found to

continue for that depth with some regularity. A shaft was then commenced a little distance to the south-east of the outcrop of the mass, the object being to prove its nature at a depth of about ten fathoms from surface. This reached a depth of between seven and eight fathoms, when the quantity of water met with was such as required the aid of pumping machinery to enable the work to be proceeded with, and the same was in consequence suspended.

From the foregoing remarks, the existence of copper ore over a large area of the Eastern Townships, along the divisions laid down in the able Geological Report of Sir W. E. Logan, as described in the three synclinals, may be regarded as fully established.

That copper mines in the Eastern Townships present features of future promise, and inducements for the investment of capital for their more perfect and permanent development, will, I have the fullest belief, become patent within the next few years to capitalists seeking legitimate enterprise.

I must not, however, forget to lay great stress on the economical expenditure of labor, as well as capital, in all mining operations; as much injury might be done to the mining industry of the country by injudicious management of labor or disadvantageous expenditure of capital.

In conclusion, it must not be supposed that the mere discovery of copper ore constitutes a mine, as was the case at Acton, which may be truly regarded as one of the most extraordinary occurrences ever met with in the history of mining. On the contrary, it will be found in Canada, as in other countries, that it most frequently requires a large expenditure of capital, and the patient and persevering prosecution of works of an exploratory nature, for several years, before the long hoped-for return finds its way into the treasury of a company.