OS_166

1/14

(1)

REPORT ON THE BLYTHE RIVER IRON ORE DEPOSIT.

Government Geologist's Office,
Launceston, 30th January, 1901.

SIR,

I have the honour to report that, according to your instructions, I visited the Blythe River property, near Burnie, on the 15th June last, and again on the 9th and 10th of this month. There is a large deposit of hematite iron ore here, proposed to be worked by the Blythe River Iron Mines, Limited. In the interval between my two visits, the property had been inspected by Mr. John H. Darby, an iron expert from England, and the more particular object of my last visit was to see the result of the test tunnels, which he had recommended to be driven.

At about 6½ miles from the mouth of the Blythe River, the stream cuts through a huge outcrop of hematite iron ore, which runs N. 27° E., and S. 27° W. for an observed distance of over a mile. To the north of the river it extends 65 chains, traversing Quiggin's 78 and 73-acre sections, O'Keefe's 50-acre section, and Quiggin's 40 acres. South of the river it passes through Quiggin's 78 acres, Jones' 20 acres, the company's 12 acres into Atkinson's land. It is said to be traceable still further south. I noticed it strong and good at this end of the line.

It will be convenient to divide my remarks into :—1. The occurrence of the deposit. 2. The quality of the ore. 3. Its probable quantity. 4. Its extraction.

1. GEOLOGICAL AND PHYSICAL OCCURRENCE.

The outcrop runs up the hillside on either side in a series of huge crags. At about 21 chains north of the the river, and at the height of 600 feet above the stream, it passes below a sheet of basalt, which caps the hill. It emerges from below this cap about 26 chains further north. The outcrop is nearly perpendicular, dipping at a high angle to the S.E. It is conformable, both in strike and dip, with sedimentary rocks of the Cambro-Silurian system. Its strike is slightly sinuous, following the direction of the edges of the enclosing beds. These beds are fissile sandstones, with intercalated slates.

The upper crag on the north side appears to be east of the main line of outcrop, and is probably part of a paralled ore-bed, which has been trenched upon lower down, and crosses the river 40 or 50 feet east of the main outcrop.

I should not be surprised if this eastern outcrop is not the continuation of the line upon which the upper eastern siliceous crag is situate on the south side of the river, unless the latter line is a separate one still further east. At any, rate, there seems to be more than one deposit of ore, separated by intervening country. As we are dealing with a sedimentary deposit, and not a lode, the intervening country cannot properly be described as a horse.

The thickness of the bed, as shown by the width of the outcrop, varies in different parts, but it is greater on the south side of the river than on the north. At about 120 feet above the stream, at the base of the lowest crag, 4½ chains S.W. of river, the ore-bed measures 147 feet across. The ore here is good hard hematite, but in the crag there is a considerable quantity of siliceous matter. At the top of the crag, 2½ chains to the S. and 200 feet above the river, the ore has been exposed in a trench to a width of 4 chains. For half this distance there is good ore, the rest is seamy, and, towards the west, is more siliceous. Higher up is what is called "the purple crag," an immense projecting mass of solid ore. Here the ore measures 114 feet in width, as far as I could measure, but it evidently continues to the west, concealed below overburden, getting siliceous also in that direction. The crag itself is dense and crystalline, and the ore equal to the best on the property, This is 9 chains S.W. of river. The ore has a peculiar lumpy structure, the origin of which is rather doubtful, but I am inclined to think the most likely cause is that of meteoritic waters percolating through the ore, and dissolving away the softer parts, leaving the hard ore in lumps. This explanation is preferable to the supposition that shattering has taken place.

Greater widths have been ascribed to the outcrop of the ore-bed on this side of the river, but I think these must have included the interval of iron-stained country between the main outcrop and the paralled eastern line mentioned above. It is difficult to measure the exact width in the absence of more and deeper trenches, and I shall not be surprised if future work shows that my measurements can be extended considerably.

At 8½ chains N. of the river, and 280 feet above river level, is the central tunnel, a crosscut tunnel which has been driven right through the ore-bed 50 feet below its outcrop. The latter is stony to soft, and is rather a poor-looking part of the line, between two large crags of ore, which project from the surface of this side of the hill. The place for the tunnel has been badly chosen. The ground is too shallow, and if the crosscut had been begun further north, increased backs would have been obtained. To get these backs now, the north drive in the tunnel would have to be continued a couple of hundred feet, and crosscuts then put in to prove the ore. The ore deposit in this tunnel measures 54 feet across, and is bounded by sandstone strata on both sides. A drive N. has been put in along the W. side of the deposit for 34 feet, and was then stopped. The ore cut through in the tunnel is of inferior grade. Perhaps, 10 per cent. is good ore, the rest is earthy and siliceous. Going southwards from here the outcrop strengthens, and at a point on surface about 6 chains N. of the river it measures 81 feet wide.

As for the cap of basalt, the exact point where the iron disappears beneath its edge is concealed by the chocolate soil which has tended to fall down the slope; but, as far as I could see, the basalt rock comes in between 20 and 21 chains N. of the river, and continues northward, covering the ore outcrop for a distance of 26 chains, and attaining a maximum thickness above the ore of 120 feet thick. It is a Tertiary basalt, rich in olivine.

At 47 chains N. of the river, and 650 feet above river level, a few chains within the N. boundary of O'Keefe's 50 acres, is an old quarry, which has exposed hard iron ore of splendid grade.

Six chains N. of this is the upper tunnel outcrop, a fine mass of dense hematite. Trenches have been put in on each side of this, defining the solid ore as 94 feet across.

A few chains further north, the outcrop has been trenched upon, showing good dense iron ore, associated with infiltrated silica. It measured here 108 feet across, and appeared to be bearing down the hill still further north.

Mr. Darby's Tunnels.—To test the behaviour of the ore-body in two important parts of its course, Mr. Darby recently recommended two tunnels to be driven, one near the bridge over the Blythe River, and the other 79 feet below one of the northern outcrops on Quiggin's 40 acres. These points are situate 53 chains from one another along the strike, and the vertical difference between the two is 650 feet. They are, consequently, fair tests of the continuity and uniformity of the ore.

At the face on the northern bank of the river, the ore-body is 30 feet wide, bounded on the E. by 40 feet of decomposed sandstone and slate country. Further E. is a jaspery ridge, and 80 feet of siliceous and brecciated iron ore. Much of the latter ore is earthy and stony, though some of it is of fair quality. This I take to be the eastern deposit.

Stacked at this face is a large pile of good hematite, free from visible silica. This ore has been broken from the outcrop. At this place, opposite to and N. of the bridge, a low adit tunnel has been driven into the hill. The result of the work has been to confirm the opinion which I expressed on my first visit, that this is not the oxidised capping of a lode, and, consequently, there is no reason to fear that it will make into sulphide in depth. The ore-body is holding down with undiminished strength and quality. The level has been driven 225 feet into the hill on the western or footwall side of the ore-deposit, which latter has been tapped at frequent intervals by crosscuts. The first crosscut E.

was driven at 30 feet from mouth of tunnel for a distance of 12 feet, the last 6 feet of which are in dense solid ore, free from visible silica. The second crosscut, at 45 feet, was driven E. 6 feet to the ore, and then stopped. The third crosscut, at 66 feet, was driven E. 10 feet, 6 feet of which has been in ore of a somewhat jaspery nature. The fourth crosscut, at 77 feet, has been driven E. for 17 feet, all in ore, hard and solid, the best in the level. This ore is of splendid grade. The fifth crosscut, at 142 feet, has cut into good ore for 6 feet, though not quite so good as in the 77 feet crosscut. At 167 feet, the sixth crosscut has been driven E. 25 feet 6 inches in ore, some of which is good and solid, though rather patchy in places, and in the end of crosscut having a hackly fracture, which points to the development of silica. At 189 feet the ore has been cut into for a foot on the E. side of the level, and is of excellent grade, hard and solid. At 199 feet the ore has also been exposed by a cut into the side of level. Its grade is first-class, though it is slightly siliceous on the western wall. Just behind the end of tunnel, at 225 feet, the seventh crosscut was being driven E. wholly in ore (for 13 feet). The ore is good, pure-looking stuff, mostly lumpy, and with a short fracture. Some of it is rather fine, and would have to be cautiously mixed with the harder ores.

The crosscuts from this tunnel have disclosed good payable ore, though here and there not without siliceous matter. The assays of the samples which I took from the several crosscuts are given lower down. In no instance has a crosscut been driven right across the ore-body, and, therefore, absolute evidence as to the thickness of the ore at that depth is wanting, but I see no reason for questioning that the outcrop thickness is maintained down to the level of the bottom tunnel. At 6 chains north of river the outcrop measures 81 feet across. It contracts to 30 feet at the river. The vertical depth of the crosscut at 30 feet is 36 feet; at 45 feet, 42 feet; at 66 feet, 52 feet; at 77 feet, 57 feet; at 142 feet, 96 feet; at 167 feet, 111 feet; and at the 225-feet, 140 feet. The tunnel works show that the ore is unchanged at these depths, and I do not anticipate that any change takes place below river level. Moreover, any possible deterioration below this level is unimportant, as there is enough ore above river level to occupy the owners for a generation to come.

The second tunnel initiated by Mr. Darby is the upper one, near the northern end of the outcrop, 600 feet above the lower one. It is a crosscut tunnel, being driven E., cutting the ore-body at 79 feet from surface. It has been driven E. through country for 182 feet, and then 84 feet into the ore, which measures 94 feet across at surface. The ore in tunnel is good grade all through, barring a few siliceous and earthy patches. The country strata at the entrance dip W., then E., further in W. again, and are nearly vertical where the ore-bed comes down. Some softer ore is beginning to show at the face.

This tunnel, too, has shown that the promising surface outcrop is not a mere cap, but part of an ore-body, which descends with the enclosing strata. The results of both tunnels are highly satisfactory.

The Silurian or Cambro-Silurian series of strata, which enclose the ore-body, are of undetermined thickness. They have been folded, and the folding has taken place on a large scale. The iron ore was, in all probability, originally deposited as limonite, and may be expected to go down to a depth limited only by the fold of the strata. Although the ore bears a close physical resemblance to the celebrated Cumberland hematite, the geological occurrence differs, as the Cumberland ore fills cavities in carboniferous limestone, and the dissolved iron from superincumbent strata has probably been brought down and substituted for the limestone *in sitû*. The Cleveland iron ore is mostly carbonate in lias shales; and the Staffordshire ironstone belongs to the coal measures, so that the English sources of the metal offer no parallel. The Spanish hematites are largely associated with limestone, but there seems to be no sign of any limestone connected with the Blythe deposit. The explanation of the formation of the iron ores, which are so common in limestone, is that ferruginous carbonate ($Fe\ CO_3$) originally replaced a calcareous sediment, and was afterwards converted into iron oxide by surface water, which brought carbonic acid and oxygen.

As the laminations of the sedimentary beds may be interpreted to be parts of huge folds, it is natural to expect that all along this coast, as far as the same geological series extends, there will be exposures at various points of similar beds of iron ore. Perhaps few deposits of this magnitude may be found, but where the conditions of sedimentation were similar, and the sedimentation was contemporaneous, it is likely enough that other occurrences will be met with.

2. Quality of the Ore.

The Blythe deposit has long been recognised as ore of very superior quality. Mr. J. R. M. Robertson, in 1891, reported :—

"I know of no deposits of iron ore so pure, and, consequently, so admirably fitted for producing the highest and best brands of iron and steel."

Mr. W. F. Ward, Tasmanian Government Analysis, in 1894, reported :—

"This ore is of excellent quality, being practically free from all impurities, with the exception of the silica. It resembles the well-known Cumberland red hematite, so long used for the production of steel by the Bessemer process."

Mr. A. Montgomery, referring to Mr. Ward's analysis, reports :—

"According to this analysis, the Blythe River hematite is one of the finest and purest in the world, ranking with the famous Spanish, Algerian, and Cuban ores, which are now exported in very large quantities to the United Kingdom, United States, France, and Germany, for the manufacture of Bessemer steel."

Mr. Ward's analysis referred to above is as follows :—

Iron peroxide, Fe_2O_3 (=66·4 iron)	95·2 %
Silica	4·8 %
Phosphoric acid	traces

On my recent visit, I took samples from different points, so as to be sure that the deposit is fairly uniform, and does not carry deleterious ingredients at any of the horizons accessible. I believe, too, the samples are fairly representative of the bulk.

The only instance in which I think I may have included too high a proportion of siliceous matter is the stone from the upper tunnel. Siliceous ore is only met with locally in that adit, and has, I think, augmented the average silica contents unduly. The samples have been assayed by Mr. Ward, Government Analyst, with the following results :—

	Iron.	Silica.	Phosphorus.	Copper.	Sulphur.
From Mr. Darby's low tunnel—	°/o	°/o	°/o		
Crosscut at 66 feet ...	46·0	34·2	...	Nil	...
" 77 feet ...	65·0	7·0	...	Nil	...
" 142 feet ...	67·2	3·8	...	Nil	...
" 167 feet ...	68·1	2·4	...	Nil	...
" 199 feet ...	68·5	2·0	...	Nil	...
" 225 feet ...	68·7	1·6	0·04	Nil	Traces
From Mr. Darby's upper tunnel	59·8	14·4	...	...	...
Upper quarry	68·4	2·2	0·04	...	Traces
Central tunnel...............	56·7	18·8	...	...	...
Lower South Crag	61·5	12·0	...	...	...
Purple Cliff...................	68·6	1·8	0·09	...	Traces

The metallic contents are extremely satisfactory, the average iron percentage being 63·9 in the lower tunnel and 64·1 in the upper tunnel and quarry. The silica percentage of the ore in the lower tunnel is 8·5, and for the whole of such ore as would be selected for export, (including the inferior grade ore of the central tunnel), 9 per cent. The high proportion of silica in the samples from the upper tunnel has diminished the iron percentage, which from appearance I should judge to be equal to the average of the whole mine.

From these analyses it is apparent that the ore will suit the smelter. There is no carbonic acid to be expelled, no iron protoxide to be raised to peroxide, hardly any sulphur; consequently, no calcining is necessary. The ore is suited to the acid Bessemer process for steel making, being low in phosphorus and high in silica. The Bessemer process, it will be remembered, consists in blowing compressed air through moulten pig iron, and the air being thus brought into close contact with all the particles of the metal, rapidly causes the combustion and elimination of some of its impurities—carbon, silicon, and manganese. Phosphorous is one of the undesirable elements not eliminated, and, as 0·001 to 0·002 per cent. retained in the steel makes it brittle and cold-short, ores to be treated by the acid process should have as little phosphorus as possible. Copper, too, is not wanted. Only an infinitesimal proportion of phosphorus is removed during the conversion. The Cumberland hematite iron most suitable for the process should not contain more than 0·2 per cent. of phosphorus. Smelters, however, have grown more exacting of late years. In the United States, the presence of 0·01 per cent. phosphorus to 1 unit of iron used to be allowable, but now iron ores there are not accepted as Bessemer if they carry over 0·0075 of phosphorus to the unit of Fe. The phosphorus in the Blythe ore is in about the same proportion as in the Cumberland red hematites, which average 57 per cent. and 58 per cent. iron. The Bilbao ores average from 55 per cent. to 60 per cent. iron, and a few of the ores of the south of Spain go up to 65 per cent. The Lake Superior ores carry mostly about 60 per cent. metallic iron. Few of them contain more, and few are sold leaner, unless they command a sale owing to special qualities, such as manganese contents, freedom from phosphorus, or fluxing properties.

I believe the shipments of the Blythe ore could easily be made to bulk over 60 per cent. iron. This ore, owing to its high per cent. of iron and its easy smelting qualities, will, without doubt, be acceptable to the smelter.

Sometimes, in a bed of iron ore, the phosphorus contents are far from uniform. The water-level often brings a change, or the marginal parts will merge into non-Bessemer ore. At the Blythe, the ore at the river-level and that at the upper quarry show no difference in phosphorus. The only increase shown is at the Purple Cliff, on the south side of the river, and I should recommend further samples to be taken from there, to see whether the variation is only accidental.

Quantity.

An estimate of the quantities available above river-level can only be made very approximately indeed. If I give figures, it must be understood that they are only intended to furnish a rough idea of the extent of the deposit. I have taken, as carefully as possible, the average width of the ore-body and height above river-level for separate lengths, and base my calculation of the tonnage on a mean specific gravity of 4·75, that being the average of determinations of lean and rich ore.

In order to be well within the mark, I have deducted 50 per cent. for waste rock, taking credit only for the remaining half. The resulting net weight is 17,291,000 tons marketable ore. This, I confidently believe to be an irreducible minimum. As I have taken only unquestionably defined widths of solid outcrop, I think it highly probable that a deduction of only 33 per cent. for waste rock could be safely made, and upon this basis the total tonnage of iron ore from surface down to the level of the river, and for a horizontal length of 5940 feet, would be about 23,000,000 tons.

Extraction.

The quantity and quality of the material being all that can be desired, the cost of extraction has to be considered. Fortunately, unusual facilities exist for breaking the ore. The open cut system can be everywhere followed, which saves timber, lighting and ventilation expenses, reduces surveillance costs, and is best adapted for large outputs. The working cost of quarrying this ore will be about 5*s.* cubic yard; the cost per ton should be within 3*s.* The transport by rail from the mine to Burnie cannot well exceed 1*s.* per ton, and can probably be effected for 9*d.* At any rate, I do not see why the ore could not be put on board ship at Burnie at 4*s.* per ton, which will leave a fair margin for delivery to a New South Wales port.

The daily quantity broken in iron mines depends always on the conditions of ore occurrence. Where much waste stuff has to be excavated, as in some parts of England, a miner does not raise more than 1¼ ton a day. But in some of the Lake Superior mines, with underground workings, ore is raised at the rate of 4 or 5 tons per day per man employed, while in others 2 to 4 tons per day per man are broken. At the Blythe Mine, with open works, 6 tons of stuff per man would be possible--3 tons of ore at about 2*s*. 8*d*. per ton—so that I think 3*s*. is a safe estimate; for the series of benches by which the outcrop can be attacked will enable the deposit to be worked very economically. Immense quantities can be brought down by blasting, and these will be easily reduced to suitable sizes by hammers, wedges, and picks.

The basaltic overburden lying on a portion of the deposit will not need to be removed for many years to come, unless it is found that exceptionally pure ore passes beneath the basalt capping. If the ore at the northern end of the outcrop is worked, a short horizontal tramway of a few chains will have to be made, and an inclined line or aerial tram will take that ore down to the river.

A line is being surveyed for a 3 feet 6 inches railway from the mine to the mouth of the Blythe River, about 6½ miles, where it will join the Government line to Burnie, other 5 miles.

There is good reason to believe that the company can undertake profitably the manufacture of steel from this ore by erecting smelting works in New South Wales. They are contracting with the New South Wales Government for the delivery of 100,000 tons steel rails during the next four years at British rates, *plus* freight and import charges. The smelting works will be in New South Wales, and the bulk of the ore will be from the Blythe, as this ore is exceptionally pure, and the New South Wales ore possesses impurities which exclude it from any other use than blending. A suggestion has been made to build works at Burnie for the reduction of part of these ores, bringing coke from New South Wales as back freight for the vessels which carry the ore away. These could only treat moderate quantities. If we look round the world, we shall find the largest iron-making centres are near the sources of fuel, and not near the mines, notwithstanding that the ore is the item which weighs the heaviest. At first sight, we might suppose, and many do urge this, that the works should be close to the mine, even if distant from the fuel, because the ore is heavier than the coke or wood. But it is forgotten that by the time the pig iron is converted into manufactured steel wares, the weight of the fuel has overtaken that of the ore smelted.

If works are erected at Burnie, a supply of limestone for fluxing will have to be sought. That at Gunn's Plains, near Ulverstone, seems to be the nearest deposit, but I cannot speak as to its quantity or purity.

Probably a little less than half a ton of 90 per cent. limestone would be required per ton of pig iron produced. If charcoal fuel were adopted, the consumption of limestone would be less. Charcoal fuel gives high-class pig on account of its freedom from sulphur and other detrimental substances, but owing to the enormous supply of timber required for its constant production, charcoal iron-making cannot result in a large permanent industry. Even if indulged in as a beginning, it could only be on a very small scale. The making of charcoal pig is everywhere diminishing, and is destined to decrease still further. Such iron makes high-class steel for tools, etc., but the first aim of the company should be the manufacture of steel rails, as these can be turned out easily in large quantities, and are not dependent upon minor industries.

I have said enough to show that the deposit is one of immense proportions. Much of it is very pure, and the quality is unsurpassed anywhere. If iron-smelting in New South Wales can be carried on profitably, there is every reason for believing that this mine can supply suitable ore in sufficient quantities. It is not difficult to work out the cost of mining and delivery to a close figure, and if the enterprise is judiciously planned and managed, I anticipate the inauguration of an industry fraught with benefit to all concerned. The iron and steel industry will eventually be in these States what it is in other countries of the civilised world. It must even finally overshadow the other products of our mines, if we are to attain solid and permanent commercial prosperity. I cannot refrain from expressing my conviction that these large iron ore deposits on our N.W. Coast are destined to lay the foundation of this industry.

West Lode.—I looked at an iron outcrop on the 40-acre section, No. 3285-93M, called the west lode. Some surface trenching has been done on it, showing it to have a north and south bearing. Hematite, ferro-manganese ore, and silicate of iron are the minerals of the outcrop. 41 feet below this, a tunnel has been driven west across the Silurian slates for about a chain. It has passed through an 11-foot lode of hematite, with a soft dig on each wall. It is reported as assaying 2½ dwts. gold, 3 ozs. silver, and a trace of copper. 64 feet below this, an adit is being driven N.W. across black slate, dipping S.E. This hematite has different geological relations from those of the large deposit at the river, and partakes of the nature of a lode. I am afraid, however, that the lower tunnel is not deep enough to be below the zone of oxidation. At a greater depth there is likely to be copper sulphide ore.

I beg to return my thanks to Mr. Whitsitt (the Resident Secretary), Mr. Chaplin (the Manager), and to Mr. W. R. Bell, for information and assistance rendered during my examination.

I have the honour to be,
Sir,
Your obedient Servant,

W. H. TWELVETREES,
Government Geologist.

W. H. WALLACE, *Esq.*,
Secretary for Mines, Hobart.

JOHN VAIL,
GOVERNMENT PRINTER, TASMANIA.

PLAN OF IRON-ORE DEPOSIT
BLYTHE RIVER