

ART. X. NOTES ON THE ECONOMIC MINERALOGY OF NOVA SCOTIA. (PART I.) BY PROF. HOW, D.C.L., UNIVERSITY OF KING'S COLLEGE, WINDSOR.

[*Read April 4, 1864.*]

It is unquestionably desirable, that as complete an account of the Minerals of Nova Scotia as can be obtained should exist in the Province, and that the Institute of Natural Science should possess in its archives all the information that can be laid before those seeking to know the mineral resources of the country. In the absence of a Provincial geological survey, the reports of which would, of course, contain everything of importance relating to the subject, and would, in all probability, be found upon the shelves of such an Institute as ours, the labours of individual members must be looked to for the acquisition of all that can be expected from private sources.

The latest book treating of the Mineralogy of the Province, is *Dawson's Acadian Geology* (1855), of which a supplementary chapter was issued in 1860. Since the publication of the body of this work, various additions have been made to the number of minerals known to exist in the Province, while new localities have been found for those previously recognized here, and in some of these commercial operations have been undertaken. Since the issue of the supplementary chapter gold has become an object of extensive enterprise, and a tolerably complete collection of the minerals of Nova Scotia has been exhibited to the world, in the International Exhibition of 1862, a catalogue of them being at the same time distributed, containing their names and localities, and the briefest possible statement of some of the most important facts relating to a few of them. As regards gold, the reports of the Chief Gold Commissioner give the statistics of this branch of industry, and with respect to the quantities of other useful minerals raised, there are also official sources of information in the Provincial records. It is very obvious, however, that there are facts relating to minerals, the knowledge of which is desirable for scientific purposes and interesting to the general public, not mentioned in catalogues or in statistical statements, and these it is an object of our Institute to

acquire. Many such facts have been given in original papers, by myself and others, published almost exclusively out of the Province, during the last few years, and are scattered through the pages of various periodicals, Dawson's supplementary chapter touching on a few of them only: various others I have become acquainted with by my own researches, and by communications from gentlemen engaged in mining or in operations connected with mining, some being collected when I was preparing the minerals for the Exhibition of 1862; and I propose, now that an Institute of Science exists in the Province which has a prospect of permanence, and an established system of publication of its transactions, to offer for the consideration of its members from time to time, such notes on the Minerals of Nova Scotia, as I hope will be acceptable and useful. And, in the first place speaking only of the useful minerals, these being most generally interesting, I offer the following as my first contribution to the Economic Mineralogy of this Province.

Iron Ores and Iron Manufacture.—There is an excellent description of the iron ores of the Province in *Dawson's Acadian Geology*, where particular attention is paid to those which were being worked at the time of writing. No large deposit of ordinary ores has been, I think, found since this account was published; but titaniferous iron ores have been met with, and these I intend describing in the present notes.

In the International Exhibition of 1862, a fine representation was made of these ores, and of iron manufactured from some of them in the Province, viz. at the Acadia Iron Works at Londonderry. Ores were exhibited from sixteen localities: the majority of the specimens were valuable hematites, and a large proportion consisted of massive samples which remain distributed through museums in Britain, as evidence of the nature of this portion of Nova Scotian Mineralogy. The most important contribution was made by E. JONES, Esq., Manager of the Acadia Iron works, who furnished nine large remarkably fine samples of hematite ores, with four specimens of pig iron, and some bars of iron produced at the works from such ores. Having had the pleasure of visiting this establishment in 1861, in company with R. G. HALIBURTON, Esq. Secretary to the Exhibition Commissioners, and of observing the

admirable arrangements under which a large amount of work was being done in mining the ores, smelting them and converting the metal produced into bars, I requested Mr. JONES to favour me with a description of the works, and a statement of the amount and quality of iron made, feeling confident that if published these would be found very interesting to numbers of persons in the Province. This gentleman having been kind enough to comply with my request, and to supplement his first account with a few additional details last month, I am sure I do the members of the Institute an acceptable service, in laying before them the brief statistics of an industry so interesting, and happily so important and flourishing as it proves to be:—

“The Acadia Iron Works were commenced in 1849, and the first iron was made by the Catalan forge in 1850. In 1852-3 a blast furnace was erected for the manufacture of pig iron, the Catalan forge being then abandoned. Up to the time of my arriving in the Province, in the summer of 1857, there had been manufactured altogether about 1000 tons of iron, from about 4000 tons of ore. Since that time to the present (1861) we have made about 4000 tons of iron, using about 9000 tons of ore. Our present make of bar iron is at the rate of 1200 tons, of an economical value of about £24,000 per annum. The ores we use are a hematite, yielding about forty-eight, and a brown and red oxide yielding about forty per cent. of iron. The ores are somewhat refractory: this arises mainly from the presence of a stone mechanically mixed through the ore, and which is very difficult to act upon in the blast furnace. It requires about a hundred and sixty bushels imperial of charcoal, and two hundred bushels of limestone (this is found in the neighbourhood) used as a flux, to smelt one ton of pig iron, and about three cords and a half of wood to convert the pig iron into bars. The wood used is required to be perfectly dry; for drying it we use artificial means, and also house a large quantity in sheds for winter use—as much this year as a thousand cords. We have one blast furnace, and three puddling furnaces, with one re-heating furnace; the pressure of blast used is about four ounces to the square inch, and the quantity of air about two thousand cubic feet in a minute. We employ now about two hundred and thirty men, and

our expenditure for wages, &c., at the works will average about £1200 per month.” The blast, I may insert here, is obtained by the improved noiseless fan, which, with the heavy hammer used in the puddling process, and the rolling mills for making the bars, is worked by a powerful steam-engine.

“The iron made,” Mr. JONES told me, “compares very favourably with the best metal brought to market from any part of the world for the same purpose, which is the manufacture of steel. Thus the Swedish iron, of which there are many varieties, varies in price from £12 to £25 sterling, one brand bringing as much as £30 to £34 per ton in the Sheffield market. The Acadia iron is worth about £16 sterling per ton, so that it compares with the average of the Swedish metal. It should be added that at Londonderry a less expensive mode of manufacture is adopted, than that usually pursued in Sweden, on account of the high price of labour in this country.”

Writing on 25th January, 1864, in answer to some additional questions of mine, Mr. JONES further states, “I have little to add to the account I gave you some time ago of our works, and excepting in the increased production there is no change; we shipped in 1863, 900 tons of bars and 402 tons of pig iron, of the aggregate value of \$85,000. We are now driving an adit into the mountain at the head of the river, which will enable us to ascertain the nature of the deposit of ore at about one hundred yards under the surface.

“The value of our iron as compared with English of the best quality, is best estimated from the selling price :

English Pig Iron (Staffordshire) average.....	£4	0	0	stg.	per	ton.
Acadian “	“	.....	7	0	0	“ “ “
English Bar Iron (Staffordshire)	“	.....	9	0	0	“ “ “
Acadian “	“	.....	15	10	0	“ “ “

“As compared with Swedish iron, our bars rank with the best qualities, there being *but one* iron which is considered superior for *steel*; our bars are all used for this purpose, and the demand is steadily increasing. The pig iron is used principally for the manufacture of railway wheel tires, for which purpose it is well suited, being, when converted into malleable iron, very compact, and not liable to wear by attrition.

“This year we have for the first time shipped to the United States, where the bars are coming into demand for making steel.

“Dr. Percy has found titanium in our iron in considerable quantities.

“I may add that we have purchased a neighbouring property on the same mineral range, with a view to extending our manufacture.”

It would appear that the Silurian rocks at Londonderry abound in iron to their very base, for a specimen of ore coming from the intersection of the lower carboniferous with the slates on the south side of the Cobequids, put into my hands by Mr. JONES for examination, proved to be amorphous carbonate of iron converted externally into hematite; as Mr. JONES thought the deposit might possibly prove of economic value, there must have been indications of its being extensive. I find it stated that, since the Exhibition of 1851, this amorphous carbonate of iron has become one of the most valuable ores of Great Britain. It is scarcely fifteen years since it was first proved to be worth smelting, and yet, in 1860 one district produced 248,665 tons of pig iron. (*C. News*, VI. 88.)

The iron formerly made at Nictaux was inferior to the Londonderry metal, one reason being that it contained phosphorus; the character of that produced at Clementsport, where operations were recommenced two or three years ago, I am not acquainted with.

Titaniferous Iron Ores.—These exist at three localities in the Province; of which one is Sable Island, where there occurs a magnetic iron-sand, in which I found titanium; according to Dr. Percy, the ferruginous portion (the rest being quartz sand) is chiefly magnetic iron with a little titanium and a trace of chromium. This information was obtained from G. HANDLEY, Esq. of Halifax, who exhibited the ore. The other localities are in western counties, and one affords an ore containing a considerable quantity of titanium. A sample of this ore was procured by R. G. HALIBURTON, Esq., and exhibited by him as of average quality; the deposit was said to be large. It was, like that of Sable Island, in the form of sand; it consisted of grains of quartz sand and small crystals of two distinct minerals, one strongly magnetic (Iserine), the other not affected by the magnet (Ilmenite). The relative proportions of these three ingredients I found to be, in round numbers, in the hundred parts:—

Magnetic Iserine Sand	30
Non-magnetic Ilmenite Sand.....	56
Quartz Sand.....	14
	100

I found titanium in both the forms of ferruginous sand, and contented myself with proving its presence in large quantities in the whole mixture, without making a complete separation of it from the iron and magnesia. The published analyses of these ores show a very great difference in their relative richness in titanium; thus, iserine contains :*

Oxide of iron.....	91
Oxide of titanium	9
	100

While ilmenite is represented† as consisting of, exclusive of unessential matters :

Oxide of iron from	91.5 to 46.4
Oxide of titanium from.....	8.5 to 53.6
	100.0
	100.0

This latter ore, it will be observed, I find to form about fifty-six per cent of the Digby deposit as exhibited.

The third locality of titaniferous ore is at Sable River, Shelburne County, where a vein has been found on the Atlantic coast. This information I obtained from Mr. HALIBURTON in 1861; no specimen of the deposit was shown me.‡

The value of titaniferous iron ore for steel making, has been of late years much insisted on in England. It was mentioned in Mr. JONES' last letter above quoted, that Dr. PERCY had found titanium in considerable quantity in the Acadia iron; this fact was brought out by a question of mine directly on this point, my object being to ascertain how far this excellent steel-making iron agreed in this respect with Swedish and other irons noted for the same application. With regard to some of these, Mr. Mushet states in a long and most interesting letter to the *Engineer*, quoted in part in the *Chemi-*

* Dana's Mineralogy, 4th Ed., p. 102.

† Loc. cit. p. 116.

‡ I have learned since this paper was read, that titaniferous iron sand is also found in Cape Breton.

cal News of April 21, 1860,* that, “If any chemist will be at the pains of analyzing the steel irons used in Sheffield, and seek especially for their per centage of titanium, he will find that their market value is in exact proportion to the per centage of titanium they respectively contain;” also, “that the magnetic iron ore from which the Dannemora iron is prepared contains a larger per centage of titanitic acid than any other ores from which the inferior brands of Swedish iron are obtained, and the bar iron is therefore more largely alloyed with titanium,” and “the celebrated Damascus blades are made from iron reduced from a highly titaniferous iron ore. The Wootz ore of India is more titaniferous than that of Dannemora. The Elba iron ore is moderately titaniferous. Iron alloyed with titanium possesses a degree of body and durability unknown in ordinary bar iron of good quality. First rate steel can only be made from iron containing titanium.”

The durability of Acadia iron railway wheel tires, was especially mentioned by Mr. JONES. Further, Mr. Mushet says, even one half per cent of titanium may possibly constitute the excellence of steel, and that as all magnetic ores contain titanium, the most impure ores of this class yield superior iron. This should be of interest to the owners of magnetic iron ores in Annapolis County, where I have been shown, on the North Mountain, the outcrop of a bed of this ore.

That faith is placed by Mr. Mushet in considerable proportions of titanium constituting generally the excellence of irons, is shown by another statement of his,† viz., that “whoever wishes to make the best iron must add the largest proportion of titanium ore to the burden of his blast furnace, being careful, however, to introduce nothing which tends to counteract the effect of the titanium alloy, such as materials containing phosphorus, sulphur, and an excess of lime.” He is not singular in this opinion, for Mr. Struson, another English ironmaster, after describing the difficulties met with in working titaniferous ores, says,‡ “the remedy was obvious, and by adding more carbonate of lime and other reducing fluxes, success was so far obtained that iron of various qualities could be produced at will, a soft malleable iron resulting from one assay, and from another

* Vol. I. p. 231.

† Quoted in *Chemical News*. I. 276.‡ *C. News* I. 274.

a fine grained silvery steel, which when made into a chisel could cut any other steel in our possession. “These experiments, and some of Mr. Mushet’s, were made on titaniferous iron sand from Taranaki in New Zealand, an ore which, from the accounts given of it, appears to resemble the Digby mineral described in these notes: it is found in enormous quantities: it is said that more than 185 millions of tons are ascertained to exist, enough to supply all the furnaces in England for twenty-five years.

The publication of the letters from which I have quoted drew from Dr. Sterry Hunt, of Canada, a communication* on the titaniferous ores of that country, which he shewed to be numerous and of vast extent; the supply of them in fact was stated to be inexhaustible.

In 1861 Mr. Mushet secured two patents for improvements in the manufacture of iron alloys by the addition of ores of titanium to other ores of iron, (*C. News*, VII. 35,) and was no doubt convinced that the metals really contained the titanium existing in the ores from which they were made. It is remarkable, however, that, while no difference of opinion seems to exist about the titaniferous ores producing excellent iron and steel, the titanium does not always pass into these products. In a paper read at the last meeting of the British Association, and given in the *Chemical News* for Nov. 7 and 14, 1863, Mr. Riley states that up to the end of 1862 he could find no distinct evidence of titanium except in occasional traces, either in pig iron or in Mr. Mushet’s steel, and that Dr. Perry also said he could never find it. It will be remembered that this chemist is this year mentioned by Mr. JONES as having found it in the Acadia iron in considerable quantities. Mr. Riley also afterward detected it in several pig irons, in one to the amount of more than one and a half per cent.; and he states in the paper referred to, that “it must be admitted that when titanitic acid is present in iron ores, it appears to impart a steely nature to the iron reduced from them, somewhat similar to that obtained by the use of manganese; and fluxes that have been used with advantage at Sheffield, have, on analysis, been proved to contain a high per centage of titanitic acid. The pig iron made with seven and a

* *C. News* II. 41.

half per cent of titaniferous iron ore, proved also to be an iron of very great strength and excellent quality both for castings and for the Bessemer process.”

It follows that if the deposits of titaniferous iron ores in this Province should prove to be extensive, the discovery ought to be of great service. As there is abundance of such ores in Norway, whence they can be taken to England for about £10 a ton, the only apparent market for export would be the United States; in proximity to which Nova Scotia would have the advantage of Canada. The obvious use of them, however, would be the improvement and developement of the home manufacture of iron and steel.

As it is already shown that the Acadia iron, so excellent in the respects described, contains titanium, and as it is admitted on all sides that titaniferous ores are very beneficial additions to other ores of iron, though the reason of their being so is not clearly made out, it becomes important to enquire fully into the extent of such deposits in the Province, where there are so many other iron ores (some of which, those of Nictaux certainly, do not afford iron equal in quality to that of Londonderry), upon which to try the effect of the addition of such ores as the Digby titaniferous sand, in making them yield irons equal to those of first repute abroad.

ART. XI. ON THE PEARL. BY J. HUNTER DUVAR.

[*Read May 2, 1864.*]

[MR. HUNTER DUVAR read a preliminary paper on North American Pearls. The author promises to pursue the subject.]

Attention was first drawn to an abundance of Pearls in the rivers of Nova Scotia, in 1861. Upwards of fifteen hundred specimens were sent from King's county to the London Exhibition of 1863. None of these were of large size,—none larger than one submitted on this occasion to the Institute, and which weighed three and a half carats. The colour of most of those yet found in Nova Scotia is a silvery white or opaline, and generally pellucid,