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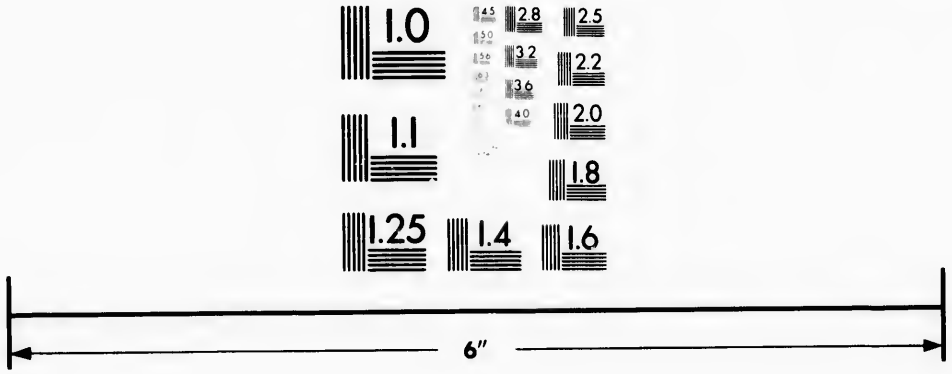

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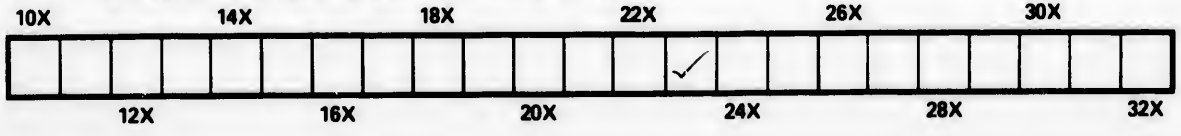

NOTES

ON THE POSSIBILITIES OF

IRON AND STEEL PRODUCTION

IN ONTARIO.

BY

WM. HAMILTON MERRITT, F.G.S.

Member Iron and Steel Institute, England; Associate Royal School of Mines; late Commissioner Royal Commission on the Mineral Resources of Ontario, &c.

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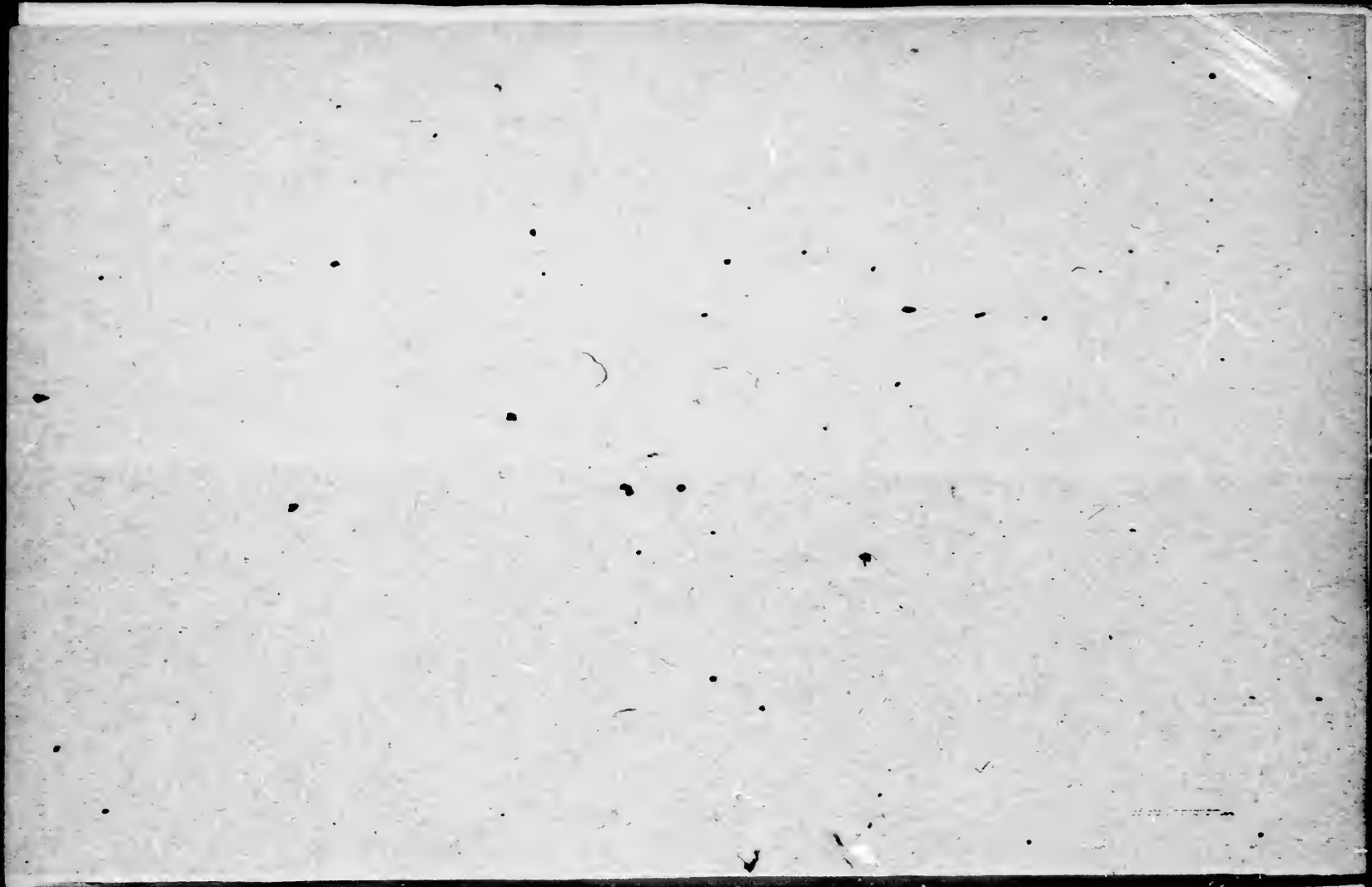

[*Extract from Transactions of the Canadian Institute, 1890-91.*]

NOTES ON THE POSSIBILITIES OF IRON AND STEEL PRODUCTION IN ONTARIO.

By Wm. Hamilton Merritt, F.G.S.

Member Iron and Steel Institute, England; Associate Royal School of Mines; late Commissioner Royal Commission on the Mineral Resources of Ontario, &c.

This paper is a condensation of three papers, read at different times before the Geological and Mining Section of the Institute, none of which have appeared in the "Transactions." The first paper was on the "Laurentian Iron Ores of New Jersey," and the second paper was on the "Iron Ores of Lake Superior."

These two papers were written on the fields developed in the United States because geologically they continue into the Province of Ontario, where they exhibit identical features to those found in the United States.

As will be pointed out later on, the assured abundance of Iron ore, and the magnitude of the mining operations, in the United States, on the same belts as we have in Ontario, have a particularly important and gratifying bearing on the possibilities of permanent Iron and Steel production in our Province, so far as the supply of ore is concerned.

In my third paper, "A few Notes on the Production of Iron and Steel in Ontario," I gave a short comparison between the production of Iron and Steel in Canada and in the United States, and touched on the possibilities of inaugurating an extensive production of Iron and Steel in the Province of Ontario.

THE NEW JERSEY IRON ORE DEPOSITS.

The examination of a geological map of the United States and Canada, such as one compiled by Mr. C. H. Hitchcock for the American Institute of Mining Engineers, shows very clearly the passage of the Laurentian iron carrying rocks from the State of New Jersey through the northern part of New York State across the St. Lawrence, where the Thousand Islands occur, into the north-eastern portion of Ontario.

I have had opportunities of studying these Iron deposits in New Jersey and in Ontario at a number of places. There is a complete geological similarity in the rocks, both consisting chiefly of Gneiss, (Felspathic and Hornblendic or Syenite-Gneiss), Granite, Syenite, Chrystalline Limestone and Magnetite.

In New Jersey the formations are locally divided into: 1. Massive Group. 2. Iron Bearing Group. 3. Gneissic and Schistose Group.

It is suggested that the Iron Bearing Group is the same as the Canadian "Grenville Series." It is also considered in New Jersey that the Iron occurs in true beds, though generally more local than the rock strata. As an example, the "Hibernia" and adjacent mines might be quoted, all of which work an ore bed along a length of two and a-half miles, the ore and the rock walls pitching together. The ore has been worked in the "Hibernia" mine down to six hundred feet, and at that depth there is no sign of it giving out. The width of the ore varies from 4 feet to 25 feet, and the associated rock is chiefly Grey Gneiss.

As a rule in this district Chrystalline Limestones appear generally slightly above the horizon of the beds of Magnetite, near its contact with the underlying Granulites; a few mines have been opened in the Chrystalline Limestone.

The ore is often associated with Hornblendic and Micaceous Gneisses on the hanging wall side, while the foot wall is composed of Grey Gneiss or darker coloured Hornblendic and Micaceous Gneiss, and it occurs in beds conformable to the wall rocks, consisting of pure Magnetite, or mixed with Felspars, Quartz, Hornblend, Augite, Mica, Garnet, Calcite, Pyrite, Apatite, and more rarely with other minerals.

The usual strike is to the north-east, the "pitch" of the ore shoots generally north-east, and the dip of the ore bed is generally to the south-east, but sometimes and less frequently, the dip is found in the contrary direction.

It has been found that as a rule the analyses of the new Jersey magnetic iron ores give a greater amount of phosphorus than usually occurs in the Magnetites of north-eastern Ontario, therefore, in many cases the New Jersey ores are not suitable as Bessemer ores. For example while some of the New Jersey ores give from 60 to 65% of iron some of them give from 44 to 50% iron with from ·06 to ·5 and even to 1% of phosphorus and from ·06 up to 3·5% sulphur. The following, taken from the New Jersey Geological Reports, might serve as examples:

	Iron.	*Phosphorus.*	*Sulphur.*
1.	48·00	·47	1·5
2.	59·91	·066	3·5
3.	64·00	——	——
4.	50·00	——	——
5.	62 00	·44	·06
6.	58	1·5	——

The feature in connection with these deposits, which was peculiarly gratifying, was their permanency. The result of many years working in this State has enabled the local geological survey to place on record the fact that "their permanent withdrawal and final abandonment has come not so much from the lack of ore or the exhaustion of the veins, but from the heavy expenses attendant on mining operations at a greater depth, etc."

As an example of this I might quote the fact that the "Hurd Mine" has reached two thousand feet in depth, the "Byron Mine" eleven hundred feet, the "Mount Pleasant Mine" eight hundred feet, the "Dickenson Mine" seven hundred feet, the "Orchard" and "Hibernia Mines" six hundred feet, etc.

The yield in New Jersey has reached as high as nearly a million tons in one year. In 1889 it produced 415,510 tons while in the same year New York State produced 1,247,537 tons from her Laurentian Series.

The above mentioned facts are full of significance to us, for the great bug-bear held before our prospectors or investors is that there is no certainty as to the persistency of the magnetite deposits of north-eastern Ontario, as has been shown by many of them playing out in the small development which we have attempted in the past. There is no doubt that many small deposits may prove disappointing in the future, as they have done in the past, but when we fully realize that the continuation of the same series has yielded such results as I have above indicated, we may rest satisfied that under the stimulation of a permanent demand, and of systematic mining development, there can be no question whatever, geologically speaking, about the ultimate permanent supply to be derived from the magnetite deposits of north-eastern Ontario; that is to say a supply adequate to meet a demand within any reasonable bounds.

IRON ORE DEPOSITS OF THE SOUTH AND NORTH-WEST SHORES OF LAKE SUPERIOR.

The ores on the north-west shores of the lake occur in geological series running uninterruptedly into the Province of Ontario, and the ores on the south shore of the lake we find in similar, if not entirely identical, geological series to those occuring in Ontario, on the eastern shores of the lake, and where it is not impossible that somewhat similar developments may be made.

Therefore, for these reasons I have thought a short description of the Iron ranges in the Lake Superior section of the United States would not be without interest to us, as having a direct bearing on the possibilities of

our own territory, for the Vermillion and Messaba ranges of Northern Minnesota have been followed north-easterly into Ontario, and apparently large Iron deposits have been located on our side of the International line, where, it is a well known fact, that our neighbors in the United States are rapidly acquiring the largest proportion of these discoveries.

These deposits are all in the Huronian formation, and I think it can be unquestionably stated that the Iron ore deposits of the Lake Superior Ranges, as developed in the United States, are the most remarkable for richness and extent at present known anywhere in the world.

The best known Iron ranges to the south of the lake and in the States of Michigan and Wisconsin, are the "Marquette," the "Gogebic," and the "Menominee" ranges, while the "Vermillion" and "Messaba" ranges are on the north-west shores of the lake.

The production of ore from these ranges reached in 1890 nearly six million of tons, the estimated amount being placed at 5,900,000 tons.

It might be of interest to quote from Mr. Berkinbine's figures for 1887 to show the ratio of the consumption of the various iron ores used in the United States in the production of pig iron. Since 1887 the amount of the Lake Superior production has however increased over a million tons but at the same time the production of pig iron in the United States has increased nearly three million tons, largely owing to the immense development in the southern States.

RATIO OF CONSUMPTION IN 1887.

From Lake Superior Ores	44.4	per cent.
" Foreign Ores (largely Spanish)	10.5	"
" Lake Champlain Ores	6.5	"
" Cornwall Ore hills–Pennsylvania	5.0	"
" Alabama Ores	5.0	"
" New Jersey Ores	4.4	"
" Tennessee Ores	4.1	"
" Missouri Ores	3.5	"
" Virginia Ores	3.2	"
" Ohio Ores	2.4	"
" Salisbury Ores	.8	"
" Georgia Ores	.7	"

Many of the iron mines of the Lake Superior region are comparatively new discoveries, yet it is astonishing the manner in which Railroads have pushed into every part of these iron ranges, and, as may be judged from

the figures above mentioned of the ore output, the traffic done by the railroads is something prodigious. The railroads take the ore for the most part to the Lake-board where it is run out of hopper cars into ore pockets in docks especially built for the purpose, whence again it is run into the vessels, without handling.

The ore from the Vermillion Range is chiefly shipped from Two Harbors, that from the Gogebic Range from Ashland, that from the Marquette Range from Marquette and Escanaba, and the ore from the Menominee Range also from Escanaba.

The mode of occurrence of the Iron ore in these ranges may be said in a general way to be somewhat similar. As a rule it is found in a certain bed (or beds) in the Iron bearing formation connected with the occurrence of Jasper, and often with Chloritic or Hydro-mica Schists. The ore occurs in the bed or beds in lens like masses of varying size, and in the ranges alluded to, some immense lenses of solid ore have been opened up. The rocks in the immediate vicinity are generally schists, as above mentioned, and Diorite and Quartzite ridges.

It might be of interest to mention that the manner in which the Cupriferous and Nickeliferous Pyrrhotite occurs in the vicinity of Sudbury, also in the Huronian formation, is extremely similar to the manner in which the Iron ore lenses are found as above mentioned, except that there is no Jasper at Sudbury.

I shall now allude shortly in detail to each of the ranges which I have mentioned.

MARQUETTE IRON RANGE.

The Marquette Range in Michigan, comprises a main range chiefly in Marquette County, striking east and west, 8 to 12 miles wide, and 60 miles long, the ores occur with Jasper and Chloritic Schists, between Diorite and Quartzite ridges. A second smaller range some 10 miles to the south, comprising the Republic Group, also belongs to the Marquette Range, and in which the ores occur similarly.

The ores are fine Hematites and Magnetites. As a sample of the composition of the ore from the main range, the following analyses can be given :

Non-Bessemer Ores.

	Red Specular Ore.	Black Magnetic and Slate Ores.	Soft Hematites.	Flag Ore.
Metallic Iron	62·900	62·90	52·640	49·330
Phosphorus	·111	·08	·078	·053
Sulphur	·050	·13	·110	·030

Bessemer Ores.

	"Lake Superior."	"Champion."	"Republic."
Metallic Iron	64·80	67·00	65 to 71
Phosphorus	·06	·03 to ·054	trace to ·07
Silica		3·00	0 to 4·6

The Mining commenced in 1854 in this district and some of the mines are from 500 to 700 ft. deep. Since mining started to the end of 1888 about 27,011,998 tons were mined from this range.

The only mine I went down in this range was the Barnum Mine at Ishpeming. This mine yields a hard ore, from a close grained to a semi-crystalline hard specular ore. The ore lies between a Jasper, on the foot wall, and a hard compact grey, and probably silicious Hydro-mica Schist on the hanging wall. The ore varies in thickness from 4 to 40 ft. and as the ore is hard, pillars are left and there is no filling or timbering.

There are three styles of working on the "South Shore." 1. The hard ore, with pillars as above mentioned, and the soft ore; by 2. Nevada timbering; and 3. Filling in earth and debris in the space left where the ore is taken from.

Perhaps the most wonderful of these many rich iron ores is the "Republic" micaceous hematite. The mine is worked by 8 shafts, one of which is 1000 feet deep. The ore body generally strikes east and west, but at the east end it twists round and strikes north-west. Hanging wall is quartzite and footwall jasper; but between both walls and the ore there is a lining of soapstone (hydro-mica schist) which in places surrounds the ore. The Jasper and ore are 100 ft. thick.

THE MENOMINEE IRON RANGE.

The Menominee Range only commenced shipment as short a time ago as 1877 when 10,405 tons were shipped. This range is south and a little east of the Marquette Range. It is 8 to 12 miles wide and about 45 miles long (from Iron River to Waeedah). The ores in this district are generally red hematites and partake of the same general characteristics as similar ores in the Marquette district, except that they are as a rule softer. They are found in large deposits. The largest producing mine in the district—The Chapin—is a soft blue hematite.

The following analysis shows the grade of ore produced from this range.

	"Chapin."	"Vulcan."	"Cyclops."	"Norway."	"Quinnesec."
Metallic Iron ..	63·00	63·900	60·400	58·900	67·00
Silica		6·800	3·300	12·200	4·80
Phosphorus	·07	·013	·009	·016	·01

Total output of range to 1888 was 8,547,126 tons.

Three mines in this district, the "Chapin," the "Norway" and the "Vulcan" have produced nearly four million tons of ore since opened. The former mine has averaged nearly 200,000 tons a year since it was opened and in 1887 exceeded an output of 300,000 tons. I visited this mine and was much struck with the magnificent machinery. The hoisting engines for example have 30" and 60" double cylinders acting direct on two conical wrought iron drums of an average diameter of 12½ feet. The chief feature, however, about the machinery in connection with this mine, and other smaller mines operating at Iron Mountain, is the fact that all under-ground power, for pumps, motive power, drills, etc., is supplied by compressed air from three miles off. The largest compressing plant ever built is situated at Quinnesec Falls on the Menominee River, 3 miles from Iron Mountain, driven by water power. This plant consists of three pairs of 32" x 60" compressors, driven by three independent vertical 48" inward flow turbines, and one pair 36" x 60" compressors driven by a 54" turbine. The delivery of air through a 2 feet wrought iron pipe is stated to be 1,827,350 cubic feet of 60 lbs pressure and 60° temperature per 24 hours.

Full details of the mode of working adopted in the "Chapin" mine (where a filling in process is adopted by waste or earth brought from the surface to fill the space left in mining the ore) is to be found in a paper by Mr. Per. Larsson, read before the American Institute of Mining Engineers, and much other information of value is also given in the paper.

The ore occurs in lenses, of which three have been worked in this mine. The main lens is 60 feet to 75 feet wide, and has a length of some 2,500 feet. The strike is with the strata N. 70 degrees W. About 800 tons a day are mined, and 600 men employed.

THE GOGEBIC IRON RANGE.

The Gogebic Iron Range runs nearly parallel with the southern shore of Lake Superior, and about 15 miles distant from it. It is about ¾ to

1 mile wide, and 30 miles long. The Montreal River (which is the boundary between the State of Wisconsin and the upper Peninsula of Michigan) flowing northward into the lake, cuts through the range nearly midway between the extremes of the present exploitations, about one half of the ore strike, as now believed to be determined, lying in Ontonagon County, Michigan, and the other half in Ashland County, Wisconsin.

There seems good reason to believe that the ores lie in lenses of greater or less width and depth, throughout an ore bearing stratum, confined by quartzite, which is very regular, and diorite, which in places is decomposed into so-called "soap rock." In places small quantities of Kaolin is found formed from the decomposed felspar in the diorite. The dip of the ore bearing rocks is 65° to 70°. Most of the analyses of the Iron ores show that they are rich in metallic Iron, from 50 to 66 per cent., very low in Phosphorus, variable in Silica and free from sulphur. The Colby mine as an example shows metallic Iron from 48 to 65%; Phosphorus .04 to .08%; Silica, 2 to 8%; and Mn. 1 to 11%; analyses from a number of other mines show, Fe. 51 to 65%; P. .02 to .08%; Si. 3 to 5%; and a little Mn. in some ores.

This range was only opened in 1885, and the results have been simply prodigious. From a wilderness a very few years ago, it has by means of railroad communication, been opened into a thriving populous district. Several railroad systems now run into this range, which has outstripped the older ranges.

As an example of the ore deposits I might mention the "Ashland Mine" which I visited. The strike is N. 80° E. Dip of foot wall 65° N. On the property there are 4 lenses of ore dipping to the North and pitching to the East. The width of ore is 220 to 240 feet in widest part. The usual manner of working in this district, as I saw it in this mine, is by running a slope down the quartzite foot wall and running levels from it.

The footwall is quartzite, into which they ran 68 feet, below that is bluish argillite, and below that to the south is granite. Diorite, varying to crystaline hornblendic rock, is seen on the hanging wall; and next to that come mixed ore and quartzite, then alternating bands of diorite mixed ore and quartzite.

Nevada style of timbering is used and there are 3 million of feet of timbering in this mine. As an example, the first room is 140 feet wide by 60 feet high and 70 feet long, and this space is all built up with timber.

The ore is an open hematite in layers with cavities, looking very much as if it was for the most part the result of a secondary formation; some of it is hard steel blue ore. At the "Germania Mine" in the same range,

where the ore body is said to be 20 to 30 feet wide, I examined the ore on the stock heaps. As a rule it is a soft red hematite, in small pieces like coarse sand, but all angular; much of the ore is also harder and shews a lamination in flat open texture with ochreous stains, there is also hydrated and brown ore in places, and as an exception it occurs as a solid steel blue ore very close grained and called "blue ore."

VERMILLION AND MESSABA IRON RANGES.

In Northern Minnesota, near Vermillion Lake, there is an Iron range of great richness, containing hard hematite ore deposits of very large size. This was opened up in 1884, by the Iron Range and Duluth R. R. The shipments from this range have been:

In 1884	62,124	tons.
" 1885	225,484	"
" 1886	304,396	"
" 1887	394,252	"
" 1888	450,075	"
" 1889	864,508	"
" 1890	875,000	"
" 1891	900,000	"
Total	4,075,839	"

At "Tower" there are a number of openings or mines, namely:

North Ridge.

"Tower No. 1."—Ore body 20 to 60 feet wide as an average, and at one point 155 feet wide.

"Tower No. 2."—Ore body 100 feet wide.

"Ely Mine."—Ore body from 20 feet to 120 feet wide.

"Stone Mine."—Ore body from 6 feet to 120 feet wide.

"Stuntz Mine."—Ore body from 20 feet to 60 feet wide.

"Breitung Mine."—Ore body from 10 feet to 40 feet wide.

South Ridge.

"North Lee."—Ore body from 30 to 40 feet wide.

"South Lee."—Ore body about 20 feet wide.

The quality is shown from result of 150 analyses by F. Prince, in 1887, which gave an average content of Iron 67·7%; P. 0·06%; Si. 1·5%. The ores are generally separated into three grades, namely: "Red Lake" 57%; "Minnesota" 62%; "Vermillion" 67% Iron. All the

mines are large open cuts, but arrangements for deep mining are being made.

There are two ore ranges near Tower, the "Vermillion," which is hematite, and further to the S.E. the "Messaba Range," which yields chiefly magnetic ores. This latter range yields ore running from 50 to 60% metallic Iron, and ·01 to ·16 in Phosphorus.

The Vermillion Range has been followed in a N.E. direction for 25 miles to Ely, where the "Chandler Mine" has been opened up. Of this deposit Mr. H. S. Pickands says: "The vein has been proved for a length of over 100 feet, and a depth of 90 feet, showing at every point of test high quality Bessemer Ore." The analysis of the ore is Fe. 69 to 66; P. ·01 to ·03; Si. ·8 to 4 . The deposit has been tested by drill to 306 feet in depth. Between "Tower" and the "Chandler" Mine, in about a straight line, the formation of country rock and Jasper is nearly continuous; but although much exploration work has been done, no other remarkably valuable deposit of ore has thus far been found. To the east of the Chandler the same may also probably be said. The formation extends almost unbroken, in a north-easterly direction, to the Canadian border, and shows ore at various points. A lean black ore outcrops for miles in length and of great width, but as yet determined, its Metallic Iron is not over 50° ,, and Silica from 20 to 30 .

CONTINUATION OF THE VERMILLION RANGE IN ONTARIO.

In the vicinity of "Gun Flint" Lake and "North" Lake, on the Canadian side, undoubtedly good magnetic ore has been found, analysing Metallic Iron 68 , Phosphorus ·028 .

At other places on "Hunters' Island" and near "Knife" and "Basswood" Lakes, good ore is also reported to have been found. There is every reason to believe that this Iron bearing formation runs N.E. up as far as the Kaministiquia River. To the west, at Attikokan Lake, there is also said to be a very large deposit of a high grade Magnetic Iron ore.

I have, I think, proved conclusively from the foregoing that, in order to supply any reasonable demand for iron ore in the Province, it is merely a question of exploration and mining development. I shall conclude by making a few statements; Firstly, on the alleged necessity of our iron ore to the United States; and, Secondly, on the advisability of smelting our own iron in Canada, and particularly in Ontario.

SUPPLY IN THE UNITED STATES.

In the first place we have constantly been told that the iron ores of the United States are becoming exhausted and that, therefore, they must

in the immediate future have our ores. This is quite erroneous as I can testify from personal observation and also from the reports of correspondents in the annual statistical number of the *Engineering and Mining Journal* of this present year.

Though the increased consumption in the United States during this past year has been enormous, yet the development of new deposits has been so much greater that the supply is more than enough to meet the demand.

Take the report on the "Lake Superior Iron Ore market in 1891," as an example and we find it stated: "Large deposits of soft ore have been discovered in the Gogebic and Western Menominee district, which owing to their great size and in many cases proximity to the surface, have been worked at a cost much less than was necessary to produce a ton of ore from the old hard ore mines of the Marquette County district; it can be readily seen that the prices which ore brought on cars at the mine ranged from $1.00, for the lowest grades, to $3.50 per gross ton for the higher grades. Now no mine produces only the higher grades. The production of most of them consists of a variety of grades, ranging from the lowest to the highest. . . . . Some companies only produce the lower grades, etc."

Also in the case of the Southern States, Tennessee, Alabama and Virginia, the reports are unsatisfactory, it being stated: "It has been evident to all unprejudiced observers that much unwise haste has been made in the South in the production of pig iron, for which there was no local demand. It is obvious that while 80% of the pig iron produced in the Southern States has to be sent away from home to find a market, competition must be exceedingly severe, and only those plants which are well located and possess every advantage can hope to survive. Numerous furnace companies have already fallen by the way and others are now sick unto death."

With the above facts before us we must once and for all accept as final the fact that our iron ores will not be essential to the United States for many many years to come, and that our best policy is to develop them and use them ourselves.

SMELTING IN ONTARIO.

I now come to the advisability of smelting our own iron in Canada and particularly in Ontario.

So far as available statistics go to show we are practically standing still, if not actually receding, in our manufacture of pig iron, while in

the United States, under a more vigorous iron policy, they are advancing with marvellous strides, and to-day are the greatest iron and steel producing country in the world, having at last outstripped Great Britain.

The following figures speak for themselves. Those of Canada have only been available for the last few years.

PRODUCTION OF PIG IRON IN THE UNITED STATES.

	Net Tons.
1860	919,770.
1873	2,868,278.
1882	5,178,122.
1890	10,307,028.

PRODUCTION OF PIG IRON IN CANADA.

	Net Tons.
1887	24,827.
1888	21,700.
1889	23,921.

In the United States they produce ·104 of a ton of pig iron per capita of the population. In Canada we produce ·003 of a ton of pig iron per capita of our population.

In the United States they produce 100 times as much pig iron as we produce in Canada, and yet their population is only twelve times that of the Dominion. Or *in the United States each person has 54 times as much pig iron manufactured for him in his own country as he would have if he lived in Canada.*

This comparison is drawn not for the purpose of belittling the efforts of those among us who are striving to build up our metallurgical industries, but to invite attention to the disparity which is exhibited in the working results and which no one can believe legitimately exists in the possibilities of the two countries.

I boldly make the assertion that Canada's greatest deficiency lies in not producing her own iron and steel.

We have built magnificient railroad systems, have created splendid steamship lines and are constantly projecting others. These may be said to be our greatest works, but what are they but *Iron* and *Steel?*

What if we had produced it all in Canada, and were now manufacturing that which will be used in all the newly projected railroads and steamships lines, to say nothing of all the multitudinous require-

ments of everyday consumption of the king of metals? We can say at least that there would be a million more people in Canada to-day.

We cannot point to any nation in the world that amounts to anything which does not manufacture its own iron and steel.

One who has never visited a "black country" cannot conceive the stupendous scale of each member of the family of industries that goes to make up the creation of iron and steel. First the underground world teeming with miners to produce the ore and coal, or the busy neighbourhoods where the forests supply charcoal, the great traffic of these products to the railroads to some central point for smelting, the men day and night round the blast furnaces, the swarm of workmen at puddling and rolling the product, if iron, or converting the pig into steel and then rolling it. In all of these the consumption of nearly every other product is so prodigious that a thousand other trades are permanently benefited, from the farmer, who produces food for the workman, to the cloth maker who turns out his Sunday clothes.

A Royal Commission reported last year on the mineral resources of Ontario, and in connection therewith some information was given about this question of Iron and Steel Smelting. The report states on page 21: "The industry is of first class importance and every proper means should be taken to secure its establishment in Ontario;" also on the same page: "It is unquestionably in a country's interest not only to smelt its own ores, but to refine and manufacture the metals, providing always that the various operations can be carried on economically and without taxing other interests indefinitely for their maintenance."

With regard to fuel, I may state the above mentioned Mining Commission reported that there is no more favourably situated district for charcoal iron smelting in North America than Eastern Ontario. In this connection I would add that the Rathbun Company, of Deseronto, is shipping large quantities of charcoal to the United States, and it is a known fact that for a long time charcoal has been shipped from Essex to Detroit chiefly for iron smelting purposes.

With regard to coke let me briefly remark that the Illinois Steel Company at Chicago produced in 1890 the largest output of steel rails of any firm in the United States—nearly a million tons (exact amount 925,000 tons), and we should not have to bring our coke or ore so far to the works—say at Toronto.

A new and great factor in steel making, as you all know, has recently appeared. Mr. James Riley, of Glasgow, and others showed that structural steel could be improved in quality by alloying it with from one

to five per cent. of nickel; and carrying out the tests on a larger scale, recent experiments at Annapolis proved that armour plate made of steel containing nickel was superior to any other plate.

These facts and the statements in the New York *Mining Journal* in connection with the Sudbury deposits (and which my observations lead me to believe are correct) "that the Canadian mines alone could supply the whole demand in the world even if the other sources did not produce anything" give to us a new interest in this question of manufacturing steel, as well as gratifying information as to the supply of this new element which, without doubt, will enter into its composition in the future.

THE AVAILABLE MARKET FOR HOME PRODUCTION.

I shall, lastly, briefly touch on the question of market. I merely allude to home market, for what foreign demand might spring up for a superior grade of nickel steel, did we make it, I shall not attempt to predict.

The fact that I previously pointed out that a man living south of the 40th parallel has produced for him in his own country 54 times as much pig iron as if he were located to the north of the said line, seems to prove to me one of two things, namely, that there is a great deficiency that can be legitimately made up by smelting and manufacture, or that the average Canadian is lower in the scale of civilization than I believe him to be.

I think if the matter were thoroughly investigated that a Canadian uses per capita as much iron and steel as an inhabitant of the United States.

As to the amount of the consumption I do not think I could quote anything more disinterested as authority than the geological survey of Canada. In the report for the year 1887-88, page 37 of part S, we find that "during the years 1886 and 1887 there were imported for consumption into Canada 345,000 tons of pig iron and 283,000 tons of steel. If to this is added the amount of pig iron consumed as such, it will be seen that, excluding all the iron and steel entering into such highly manufactured articles as cutlery, surgical instruments, edge tools, machinery of all kinds, engines and many other hardwares and manufactures, there was a total consumption equivalent in pig iron in 1886 and 1887, respectively, to about 415,000 tons and 356,000 tons. If made in the country, this quantity of pig iron would represent to our makers at actual prices a value of about $5,000,000; it would necessitate a yearly supply from Canadian iron mines of 1,000,000 tons of ore, and, before

this ore could be melted into pig iron and further made into the different mercantile articles of iron and steel, which are now imported, it would also require about 3,000,000 tons of coal."

Taking this amount, say 400,000 tons (which we must believe is constantly increasing from year to year), *we have the product of 27 to 28 blast furnaces being used per annum in Canada*, instead of what we often hear—that one blast furnace would glut our market. I take the basis of furnace output, the standard adopted by Mr. Bartlett, alluded to in his evidence before the Mining Commission.

If however, we take the wonderful yields of the latest Edgar Thompson furnaces, the market would be supplied by a smaller number of furnaces, but even on the liberal standard of the Lucy furnace (No. 2), yielding 91 tons per diem, we should need some 20 blast furnaces to supply our demand, when we make allowance for an average number being out of blast.

In 1879, after I had been for some time at smelting works in North Staffordshire, I wrote an article, "A Few Words About Iron," in the *Canadian Monthly*. In it I pointed out that iron of the finest quality was being produced at that time in North Staffordshire for $5 a ton, while it was costing $20 a ton at Pittsburg to smelt a bessemer grade, prices in both cases not including management, interest, etc. I then stated that I was at a loss to know how we in Canada were to build up our iron and steel industries under a smaller protection than the United States.

I have yet to be enlightened on that point, and the existing state of affairs seems to indicate that no satisfactory basis has yet been arrived at. It would surely be better to have no protection than a half-hearted one, which is a tax on the consumer and yet one which will not build up a national industry.

The expenses in connection with the establishing of smelting works are so enormous that without a policy which says "*We* ARE *going to smelt our own iron and steel*," little can be hoped for.

But once that policy is adopted, whether by protection or by bonus, and the gigantic industries can be launched and set running, we shall have taken a greater step in the commercial development of our country, even than by building the Canadian Pacific Railroad.

A very practical, and I believe satisfactory solution, so far as Ontario is concerned, would be for the Local Government to offer a bonus, similar to that of the Dominion Government, on iron and steel smelted in the

Province during a term of years, and the Dominion Government should encourage the manufacture of steel rails in Canada.

This question is one of immense, nay, of vital importance to us who are citizens of the Province of Ontario. There ought to be no point more favourably situated. Iron ore can be brought from the north-east nickel from the north-west, and coke from across the lake. The magnitude of the operations can be realized when I say that, from my personal knowledge, one private works in England paid in wages alone $40,000 a week.

And not only Ontario, but the whole Dominion would be benefitted if we smelted our own iron and steel. Iron ore occurs in so many places that it is difficult to say what part of the Province might not be directly benefitted by mining, besides the general renewed prosperity it would give to the whole country.