MICHIGAN IRON MINING INDUSTRY.

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The iron mines of Michigan are appraised annually by the State Tax Department, formerly known as the Board of State Tax Commissioners. For the purpose of this valuation the mining companies furnish the Appraiser of Mines a detailed financial report for each individual mine covering the operations of the five year period preceding, together with maps, drill records and ore estimates. This information furnishes a means of obtaining a complete and authoritative picture of the main economic factors operative in the Michigan iron mining industry. The purpose of this article is to present details of certain of these factors, particularly the average cost and profit, the ore reserves and the present productive capacity of the various districts and to discuss the economic tendencies in the mining industry suggested by the compiled data.

Michigan iron ore production comes from four principal districts and the data on cost and ore reserves is in general segregated in the tables in like manner. These districts are as follows:

1. Marquette Range (Marquette and Baraga Counties).
2. Gogebic County.
3. Iron County.
4. Dickinson County.

The production from Iron and Dickinson counties is commonly grouped under the heading, Menominee range, but there is a natural geological division into two
districts which is reflected in the grade of ore produced. Iron County ores are all non-bessemer and with two exceptions, high phosphorus, while Dickinson County produces bessemer and non-bessemer grades but no high phosphorus ores.

The iron ores occur in the Upper and Middle Huronian divisions of the major group of ancient rocks known geologically as the Pre-Cambrian. The high phosphorus ores of Iron County and the ore from one mine on the Marquette range are derived from Upper Huronian iron formation. The remaining ores of the State are of Middle Huronian age.

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**AVERAGE COSTS, RECEIPTS AND PROFITS PER TON 1920 TO 1925.**

The bulk of the Michigan iron ore production comes from underground sources the exception being the Plymouth and Wakefield pits on the Gogebic range and a small tonnage of low iron, high silica ores from Marquette and Dickinson counties. The detailed tables of average cost, receipts and profit for the past five years for the four major subdivisions are therefore limited to active underground mines alone. State averages are presented in Table 6 for active underground mines while Table 7 is an average of all mines including open pits.

The per ton figures in Tables 1 to 7 are weighted averages throughout. Cost of mining, taxes, overhead expense, interest and carrying cost of idle properties are based on production or tons mined and transportation, marketing expense, royalty, and receipts, from sale of ore on shipments. The computation of receipts from sale of ore exclude those deliveries made at cost to consuming interests, but is based upon approximately 85 per cent of the total shipments of the past five years and is believed to be representative of the average value of the entire output. The tables do not include depletion and federal taxes of which we have only incomplete records.

The average gross earnings on mine operation for the past five years was $1.1479 per ton. Fee owners share or royalty totals $.4883. Interest and carrying cost of idle mines* amount to $.1147, leaving a net operators profit exclusive of depletion and federal income tax of $.5449. For active underground mines alone gross earnings on mine operation amount to $1.0427. Royalty and interest were $.4874, leaving a net operators margin of $.5553.

The period included two good years, 1920 and 1923, two poor years 1921 and 1924, with 1922 slightly below the average of the five. The leading county in earnings on mine operation was Gogebic with a profit of $1.2711, followed in order by Marquette, Iron and Dickinson, but the greatest net return to the operator is in Marquette County where a considerable portion of the mines are owned in fee. Gross receipts per ton for the period varied from $59597 in Gogebic County to $5.1637 in Iron County.
A comparison of the average cost of the past five years with the five years ending January 1, 1915, is shown in Table 8. Although there is only a $0.009 difference in the operator’s profit for the two periods it is quite significant that their margin alone shows a decrease while all other factors of cost and profit show an increase, the greatest percentage of advance being in the item of taxes and transportation and the smallest in cost of mining.
1915, this record is a tribute to the general operating efficiency of the engineers in charge of the Michigan mines.

Transportation expenses have been reduced during the past five years from an average of $1.88 in 1920 to $1.55 in 1924, the bulk of the saving being in lake freight. Rail freight rates were increased in 1921 and slightly decreased in 1922 and 1923. The only change in rates in 1924 was a reduction of three cents per ton on Western Marquette ores, effective May 26th. The variation in State average costs of rail transportation in 1923 and 1924 is due to proportionate differences in shipments from the various districts. Overhead expenses show little change during the five-year period and marketing expense is practically constant at five cents per ton. As this per ton cost is based on total shipments it is only about 50 per cent of the actual expense of that part of the ore which is sold.

**TAXES.**

The total taxes paid by iron mining companies during the five years has remained about the same and the yearly per ton cost varies inversely with the amount of ore mined. A better perspective of tax cost is obtained from Fig. 2, showing the per cent variation of total mine assessment and taxes paid on this valuation from 1914 to 1924, the assessed valuation and taxes paid in 1914 being plotted as 100 per cent and the curve showing the percentage of increase and decrease during succeeding years. The evidence is conclusive that the increase in mine taxes is not due to advance in valuation by the Board of State Tax Commissioners but to money raised by the various appropriating bodies.

By way of illustration of the distribution of the general property tax Fig. 3 shows graphically for the typical county of Gogebic the percentage of change in assessed valuation, state taxes and local expenditures for the years 1914 to 1924. The numerical values for 1914 are treated as 100 per cent. The increase of 250 per cent in local expenditures is in sharp contrast to the increase of 25 per cent in the county’s taxable wealth. It is noticeable that the only saving during the past fourteen years is in the county’s proportion of State expenditures which has shown a steady decline since 1919 and at the present time is only about 50 per cent in excess of the amount raised in 1914. The total taxes paid in Gogebic County in 1924 amounted to $2,839,036.80. Of this amount $162,398.61 was for State purposes and the balance of $2,676,638.19 was raised for local, city, township and county purposes. The State tax, therefore, amounted to only 5.7 cents out of every dollar raised. The local expenditures in Gogebic County are proportionately higher than the other iron counties of the State, but it is generally true that in all the districts the bulk of increase in mine taxation since 1914 comes from local expenditures and the principal saving in State taxes. The evidence seems conclusive that any great relief in the burden of iron mine taxation can be effected only through economy in township, city, village and county government.

**RANGE OF COSTS, RECEIPTS AND PROFITS DURING THE PAST NINETEEN YEARS.**

Fig. 4 is a chart showing the State average cost, receipts and profit per ton for the nineteen-year period from 1906 to 1924 inclusive. The curves indicate some interesting economic tendencies worth mentioning in detail.

For the period 1906 to 1916 profits in mining were proportionate to ore prices as the curve of total cost maintained a very straight line. From 1915 to 1920 both costs and receipts mounted rapidly. In 1921 prices took a sharp decline but costs still continued to mount, due largely to the radical curtailment of production and shipments during the depression of that year. In the following year costs were reduced nearly one dollar a ton or two-fifths of the distance back to the average of the years 1906 to 1916, and since 1922 total costs have shown little variation. It is my opinion that total ore costs are now generally stabilized. There will be small yearly fluctuations proportionate to tonnage produced and profit will be directly dependent on the price of ore as it was prior to 1917.

Peaks and depressions of ore prices and consequent profits followed a three year cycle in the pre-war years.
and the trend since 1919 seems to indicate that the industry will see a repetition of this experience. From 1907 to 1916 the curves in Fig. 3 clearly exhibit this condition and it is also noteworthy that in each succeeding three-year cycle the average receipts and profits were appreciably smaller than in the preceding three years. Thus the peak year of 1910 was less than 1907 and 1913 was still lower, and the drop in price for the years 1914 and 1915 was greater than in 1911 and 1912 while the latter exceeded 1908 and 1909. There has been insufficient time since 1920 to establish with certainty the return of this three-year cycle, but the record of the past five years is strongly suggestive that this condition of the pre-war period will repeat itself. If we start with the peak year 1920 it is followed by 1921 and 1922, years of falling prices. In 1923 receipts jumped to be followed by the reductions in 1924 and 1925. If this three-year cycle continues there should be an advance of ore prices in 1926 but probably not equal to the peak of 1923. Carrying the idea still farther into the future, 1927 and 1928 should witness a drop below the prices of 1926 and in 1929 there will be another upward turn of the market.

Fig. 4 also furnishes rather conclusive evidence that the war period which affected industry during the years 1916 to 1920 resulted in only a very moderate increase in profits for the iron miner. The curve of mounting profit kept pace with increased prices. Increased earnings during that time can be traced to the fact that unusual conditions prevailing eliminated the normal cycle of one good year and two bad ones and substituted two good years following the expected increase of 1916.

**MICHIGAN ORE RESERVES.**

On January 1st, 1925, the estimate of taxable-ore in the State amounted to 188,198,051 tons. Of this total 134,447,041 tons constitutes the reserves in the active mines, 40,569,428 tons is in the idle mines or undeveloped drilled reserves and 13,172,582 tons are classed as high sulphur reserves and are of doubtful merchantable value at the present time. These estimates include only high grade ores and do not include the tonnage tributary to the high silica pits.

In January 1913 the estimate of assured taxable reserves was 193,816,904 tons. From January 1st, 1913 to January 1st, 1925, 151,294,808 tons have been shipped, yet the estimate of this year is only 5,618,000 tons less than that of 1913 and 17,922,000 tons less than the peak estimate of 1915. It is therefore apparent that discoveries of ore have nearly kept pace with depletion of deposits. This condition clearly indicates that it is impossible to forecast the life of the Michigan iron districts from the sum total of an aggregate of estimates in individual mines. The yearly Tax Commission estimate should not be taken as a measure of the life or the production of Michigan iron mines.

Most of the iron ore deposits of Michigan occur in areas of complexly folded Huronian rocks and with a few notable exceptions it is impossible to make complete estimates of the ore even in individual properties. In most instances surface drilling supplemented by underground development fail to furnish the positive information required to measure the full possibilities of a mine. On the Mesabi range the nearly horizontal dip of the Biwabik iron formation and the flat lying, tabular shaped ore bodies permit a fairly close estimate of the full reserves in the property from surface drilling, but the geological structure in Michigan is in general too complex and the shape of the ore bodies is too irregular to permit such an accurate estimate of ultimate reserves in our mines. Under the conditions prevailing additions of probable or prospective ore to the tonnage blocked out or developed must necessarily be conservative, otherwise serious injustice might result to individual tax payers.

It is seldom that the future of a mining district can be gauged by the measure of the known high grade reserves alone. A factor of importance with succeeding years is the utilization of lower grades of ore so that depletion of reserves is partially offset by increasing use of tonnages not previously considered merchantable.

Mining of low grade ore in Michigan is at the present time limited to special purpose high silica grades and no efforts have been made to beneficiate Michigan ores comparable with those attempted and in operation on the Mesabi range. There is an immense bulk of iron formation within the state which will average from 30 to 33 per cent iron and estimates of several billion tons of such material are possible even if limited to a depth of only three hundred feet.

**FIG. V—YEARLY ESTIMATES OF MICHIGAN IRON ORE RESERVES BY DISTRICTS AND FOR THE STATE.**

Between the rock to which the term “iron formation” has been given and which will analyze below 35 per cent iron and the present merchantable grades there are undoubtedly considerable tonnage of material which will run from 40 to 50 per cent iron and which are not now merchantable. The Geological Survey Division of the Department of Conservation is at present engaged in an
investigation to attempt to ascertain just what additional tonnage can be expected by successive drops in grade of ore, but at the present time there are no figures available. Enough has been done, however, to warrant the statement that, should the grade of merchantable ore drop to 45 per cent iron it would result in a very considerable increase in known assured tonnage. All of the districts of Michigan have available large reserves of low grade material and it is undoubtedly true that their life will be prolonged by its ultimate utilization.

In a general way some idea of the possible ultimate production of present high grade ores may be obtained by the rate of decline of reserves. Fig 5 shows graphically for the State and for each of the four districts, variation in the yearly Tax Commission estimates. A study of these curves indicates a gradual but steady decline on the Marquette range and Dickinson County since 1913 and for the State and Gogebic County during the past five years. Iron County has apparently not yet reached its peak of known developed reserves. On a basis of the rate of decline indicated by these curves the life and ultimate production is as follows:

<table>
<thead>
<tr>
<th>District</th>
<th>Years</th>
<th>Reserves (in tons)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gogebic</td>
<td>20</td>
<td>103,000,000</td>
</tr>
<tr>
<td>Dickinson</td>
<td>17</td>
<td>22,000,000</td>
</tr>
<tr>
<td>Marquette</td>
<td>51</td>
<td>150,000,000</td>
</tr>
</tbody>
</table>

The State curve of decline during the past four years predicates a life of sixty years and an ultimate production of 740,000,000 tons. Subtracting the tonnage already accounted for by the three districts showing a decline, would leave 456,000,000 tons to come from Iron County and the unexplored ranges. This figure is undoubtedly too large a proportion for Iron County and in general I am of the opinion, that these curves are not reliable as a measure of actual life and ultimate production, but probably are close approximations of the relative output and duration of the four districts.

**PRODUCTIVE CAPACITY OF MICHIGAN AND LAKE SUPERIOR DISTRICT.**

The productive capacity of the Lake Superior district may be divided into two classes, active and potential. The active capacity, as the name implies, includes available stockpiles and the estimated possible output of equipped mines. Potential productive capacity is possible tonnage to come from proven drilled reserves or idle unequipped mines. Properties of this class ordinarily require from one to five years to place them on an operating basis. It is possible to estimate closely the capacity of the active group on the basis of past record, state of development and available reserves, but it is of course impossible to estimate the annual production that might come from the potential reserves. The market is however only interested in the amount of ore available from year to year and this is necessarily limited to the offerings of the developed and equipped mines.

Although it is impossible to measure potential productive capacity some idea of its possibilities may be obtained from the relative percentage of total reserves tributary to active mines and to undeveloped properties. The following table divides the Minnesota and Michigan ore reserves into active and reserve tonnages. No data is available for Wisconsin.

<table>
<thead>
<tr>
<th>State</th>
<th>Total Reserves</th>
<th>Active or Idle Equipped Mines</th>
<th>Reserve Tonnage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minnesota</td>
<td>1,314,659,160</td>
<td>134,647,041</td>
<td>508,748,285</td>
</tr>
<tr>
<td>Michigan</td>
<td>155,977,151</td>
<td>80,376,866</td>
<td>613,456,285</td>
</tr>
</tbody>
</table>

The division of the Minnesota reserves is based on individual records from the Mining Directory for 1925 published by the Minnesota School of Mines, and is dependent upon whether the individual reserve or mine has a recent record of shipment. The classification into active and undeveloped reserve tonnage for Minnesota is probably not entirely accurate but is nevertheless believed to be a sufficiently close approximation to serve the purpose intended. It is apparent that the present active productive capacity of the Lake Superior district is coming from properties having approximately 60 per cent of the total reserves and that nearly 40 per cent are not at the present time factors in the competitive situation.

In a recent report to the State Tax Department I estimated that the active productive capacity of the Lake Superior district was 87,700,000 tons per annum of which Michigan’s share was 19,900,000 tons and the balance for Minnesota and Wisconsin was 67,800,000 tons. The estimate for Minnesota was made at my request by W. L. Tinker of the Lake Superior Iron Ore Association. It is probably a fair assumption that consuming requirements for the next few years will average 57,000,000 tons per annum which leaves an excess productive capacity in the Lake Superior district of 30,000,000 tons. This condition has resulted in sharp competition and reduced prices for ore in accordance with well established economic laws.

It is of primary interest, therefore, to examine the factors tending to restore normal equilibrium between production and consumption. Three factors will operate to wipe out excess productive capacity, namely, increase in consumption, depletion of reserves, and closing down of high cost mines. The first two are effective only over extended periods and the third acts rapidly during periods of depressed prices. It is undoubtedly the most potent factor which will effect the immediate situation in the next few years and it is of considerable benefit to attempt to estimate the percentage of productive capacity which can compete at present prices.

Total productive capacity in Michigan may be divided into two classes as follows:

<table>
<thead>
<tr>
<th>Category</th>
<th>Tonnage (in tons)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excess ore in stock</td>
<td>2,697,000</td>
</tr>
<tr>
<td>Capacity of equipped mines</td>
<td>17,203,000</td>
</tr>
</tbody>
</table>

The excess ore in stock is an estimate of tonnage above ground on January 1st, 1925, in excess of the normal requirements proportionate to the productive capacity of the mines. It is obvious, of course, that excess stockpiles on hand will be sold but a careful examination of the cost records of the individual Michigan mines indicates that the capacity of those mines which can
break even or make money at present ore prices is only 9,500,000 tons, or a maximum capacity below the average Michigan shipments of the past five years.

There seems to be little chance of relief in general ore costs which have probably reached a level below which there is remote possibility for further decrease of any consequence, and while there will undoubtedly be a narrow margin of profit for the next few years the present ore price is clearly too low to insure the required production if Michigan experience can be taken as indicative of the situation through the Lake Superior district.

THE IRON RANGES OF NORTHWESTERN ONTARIO.

THEIR EXTENT, GRADES AND ADAPTABILITY FOR FURNACE PRACTICE, RAINY RIVER, THUNDER BAY, ALGOMA AND SUDBURY DISTRICTS.

BY J. E. MARKS, PORT ARTHUR, ONT.*

From west to east the following more important ranges occur tributary to the Head of Lake Superior in the Thunder Bay and Rainy River Districts. On the north, Steep Rock Lake, Atikokan, Matawin-Kaministikwi, Lake Nipigon, and Little Long Lake Iron Ranges. On the south, Hunter’s Island, and the Canadian Mesaba at North Lake, White Fish Lake and the Loon Lake areas, with the unknown extensions between these different points. Less explored, and further from transportation, are the Little Pine Lake and Onnaman Lake Ranges.

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AGE OF THE IRON RANGES.

Vermilion, or Old Range, Middle Huronian, Upper Huronian or Mesaba:

Hunter’s Island Iron Ranges, Rainy River District—The Hunter’s Island Iron Range is the extension of the Minnesota Tower and Ely Range (Vermilion), which here crosses the international boundary into Canadian territory and continues through the whole length of the island, thence up the Valley of the Crooked River to the Shebandowan Lake and Greenwater Lake areas, where it is known as the Western Extension of the Matawin-Kaministikwi Range. A small series of troughs of the Middle Huronian Iron Range is also found in Hunter’s Island, but no extensive system of exploration has been carried on in this area.

Canadian Mesaba (Upper Huronian), Thunder Bay District—The Canadian Mesaba is identical with the Minnesota Mesaba Range in which the ore occurs as a magnetite near the Minnesota boundary with Canadian territory. A short distance east from the international boundary, the magnetite disappears and is replaced by hematite ores, similar to the Minnesota-Mesaba hematites. Practically no work has been done in this section of the range, with the exception of an area about 45 miles from Lake Shipping near Sand Lake, on the Canadian National Railway, where the owners report having located huge tonnages of iron formation, containing layers of both lean and high grade ores with intervening layers of taconite. Sufficient work has not been done to demonstrate whether they have heavy tonnages of merchantable grades of ore or not. From this point on the Canadian Mesaba to the Loon Lake area, 25 miles east of Port Arthur, practically nothing has been done in the way of exploration. Loon Lake area has had a number of shallow drill tests, as well as shallow shafting and test-pitting, with the result that the owners claim a large tonnage in this section, a small percentage of which could be made suitable for shipping with a little hand-sorting. The greater tonnage would necessitate more expensive sorting or beneficiating by means of some other plan of raising the grade.

Atikokan-Steep Rock Lake Iron Ranges (Vermilion), Rainy River District—On the Canadian National Railway from 125 to 150 miles from Port Arthur (the old Canadian Northern Line), is the Atikokan Iron Range, which is a series of long narrow troughs, which reach to a very considerable depth and which have proven to be very prolific in ore (magnetite), running high in iron content; but, generally speaking, with sufficient sulphur content to make a process of roasting necessary to meet the requirements of common furnace practice. On this range is situated the Atikokan Iron Company’s mine, for which they claim reserves of 10,000,000 tons averaging 55 per cent iron, 2 to 5 per cent sulphur and .10 per cent phosphorus. All the Atikokan Iron Company’s ore which has been shipped up to date, 86,433 tons, averaging 59.85 per cent in iron, is a magnetite with the exception of a small tonnage of limonite, which was found during the exploration of the magnetites. West of Sebawa Lake on the same range, from mileage 132 to 136, a very considerable amount of diamond drill work was done by the United States Steel Corporation, and at the three points on the range drilled, total reserves are claimed of 15,000,000 tons of magnetite, averaging 55 per cent in iron, from 2 to 13 per cent sulphur, and .03 per cent in phosphorus. Approximately 50,000 feet of diamond drilling was done in this vicinity, which is really the only systematic exploration which has been done on the old ranges in the Thunder Bay or Rainy River Districts.

A shipment of 400 tons of ore for an extensive test was made by the United States Steel Corporation from the Atikokan Range, which gave after roasting in Wedge furnaces, a very attractive product.

The analysis of the ore before treatment:

<table>
<thead>
<tr>
<th>Component</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Iron</td>
<td>59.34</td>
</tr>
<tr>
<td>Phosphorus</td>
<td>0.02</td>
</tr>
<tr>
<td>Silica</td>
<td>2.05</td>
</tr>
<tr>
<td>Sulphur</td>
<td>21.44</td>
</tr>
</tbody>
</table>

The analysis after roasting:

<table>
<thead>
<tr>
<th>Component</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Iron</td>
<td>65.53</td>
</tr>
<tr>
<td>Phosphorus</td>
<td>0.02</td>
</tr>
<tr>
<td>Silica</td>
<td>3.44</td>
</tr>
<tr>
<td>Sulphur</td>
<td>0.59</td>
</tr>
</tbody>
</table>
This test was made from the ores carrying the highest sulphur content on the range, while there is a very considerable tonnage that will run 2 per cent in sulphur in the known reserves.

The Steep Rock Lake Range, which is the thickest and most extensive in that district, is essentially the same age as the Atikokan Iron Range (Vermilion), the only difference being that practically all the ores that have been found are hematite.

The Great Steep Rock Basin covers an area of 25 square miles and has at least 8 or 10 very extensive parallel troughs which must, as shown by the structure, go to a very great depth. The greatest single thickness found of this iron formation was over 1,000 feet, measured on the south side of a syncline which was three-quarters of a mile across.

The structural geology in the vicinity of the Straw Hat Lake trough in this basin, I have classified as follows:

1—The basement complex consisting of granite and gneiss with some Keewatin greenstones.

2—The Steep Rock series.

The Steep Rock series, I have divided as follows in ascending sequence:

1—Conglomerate (fragmentary).

2—Iron formation, including fossiliferous limestone.

3—Lower Huronian conglomerate (jasper pebbles), including heavy ash beds.

4—Green stones; green stone schists.

5—Agglomerates.

6—Dark grey clay slate.

And having in all a maximum thickness of about 3,000 feet, dipping at angles of about 80 to 85 degrees.

A small amount of drilling was done under option, on the Straw Hat Lake trough, by the United States Steel Corporation. No definite information was given as to the results, but it is commonly reported that a considerable amount of hematite ore was located.

Matawin-Kaministikwi Ranges (Vermilion), Thunder Bay District—The Matawin-Kaministikwi Iron Ranges are within a distance of from 25 to 50 miles, of lake shipping on the Canadian National Railway. This range has a great thickness of iron formation, chiefly hematite with bands of jasper and cherts, and should be considered as being of importance as offering a favorable field for exploration for ores of straight shipping grade, as well as having great tonnage of banded ores of good grade that might be easily and cheaply concentrated into a product that would meet the requirements of the modern blast furnace. A small amount of drill work, test-pitting, etc., has been done by various syndicates, but this without a careful survey of the ranges, to determine the most favorable places for concentration of ores that would be high in iron.

A concentration test of these banded ores of several hundred pounds was made for the writer several years ago by the Federal Mines Department, Ottawa, which gave the following results:

| Analysis of crude ore (iron) | 37.19 |
| Ratio of concentration | 1.2 |
| Analysis of product (iron) | 53.25 |

A number of hand tests gave an average of 52.96 iron; .09 phosphorus and .08 sulphur from crude ore averaging 33.61 iron. This was banded magnetite-hematite. This ore shows by analysis as follows:

| Total iron | 37.19 |
| Hematite | 17.19 |
| Magnetite | 33.97 |

This sample was broken to ¼ inch only, with jig and water separation.

Nipigon Iron Ranges (Vermilion), Thunder Bay District—The greatest exposures of iron formation found east of Lake Nipigon are in the Poplar Lodge trough, which has a maximum width of over 3,000 feet and length of about 3 miles. A small amount of drilling was done on this range, but the operators seem to have contented themselves with following up belts of low grade iron (35 to 40 Per cent), rather than make a careful survey of the range in an endeavor to locate merchantable grade of ore of which there were many indications. Some exploration was carried on east of the Poplar Lodge trough and a number of belts of iron formation located, which in common with the Poplar Lodge trough are banded hematites, and extend as far east as Little Long Lake, a total distance of about 40 miles.

Little Pine Lake and Onnoman River Iron Ranges (Vermilion), Thunder Bay District—A small amount of exploration was done on these ranges which carry both banded magnetites and hematites, but the transportation difficulties were the chief cause of exploration ceasing on these areas.

Michipicoten Iron Ranges (Vermilion) Helen, Magpie and Josephine Mines, Algoma District—The Helen mine shipped about 3,500,000 tons of hematite ore averaging about 55 per cent in iron content. This depleted their merchantable ores, but they claim reserves approximating 100,000,000 tons of siderite, running
about 35 per cent in iron content, which, when calcined, made a product of about 51½ per cent iron content, .02 phosphorus.

The Magpie had very considerable reserves of a siderite, similar in grade to the Helen mine, which have been largely mined, beneficiated and shipped, meeting with a reasonably ready sale as blending ore, as well as furnishing about 40 per cent of the raw material for the smelters of the Lake Superior Corporation at Sault Ste. Marie, Ontario.

The Josephine owners report drilled reserves of 1,225,000 tons of merchantable grade of hematite.

North of the Canadian Pacific Railway and east of the Michipicoten are the Ridout River, Woman River and the Biscotasing Ranges (Vermilion), Sudbury District. The two former are extensive and entirely unexplored, but some diamond drill work was done north of Bisco, on the Canadian Pacific Railway and heavy tonnages of magnetite, running 50 per cent or over in iron content, are reported to have been found; but carrying too much sulphur to admit of being placed in the open market. The Moose Mountain mine, in the Sudbury District, is credited with reserves of 100,000,000 tons of ore, running 35 per cent in iron, and this company has made extensive experiments in concentrating and are producing a high grade product.

**COMPARISON OF CANADIAN-LAKE SUPERIOR RANGES WITH UNITED STATES LAKE SUPERIOR RANGES.**

Following the above description, it will be necessary here to make a comparison between the structure of the Tower and Ely (Minnesota) Vermilion Range and the Rainy River and Thunder Bay District (Canadian Lake Superior), as well as the iron-bearing material making up the range. As the writer has not had an opportunity of examining the Tower and Ely Ranges, quotations only can be given from engineers who have visited both sections. These invariably pronounce an exact similarity between the Tower and Ely and the Matawin-Kaministikwia Ranges. The ore-bearing formation is composed of jaspers, banded with both magnetite and hematite, in some cases the iron bands being almost entirely magnetite and in other sections the hematite predominates. These are in long narrow troughs, paralleling each other, resting unconformably on the Keewatin basement and are folded very sharply with dips at high angles. A close examination of several of the troughs, which the writer examined in the Thunder Bay District, shows also a large amount of carbonate of iron, both massive and schistose and in some cases this grades almost imperceptibly into a limestone similar to the Steep Rock Lake limestones. The Lower Huronian conglomerate (jasper pebbles) is in evidence in several places in Conmee Township, south of the Matawin River, showing here the duplication of the Tower and Ely structure and material except in the case of the iron carbonates, which have never been described as being found in Minnesota.

The Atikokan Range shows little or none of the common red jasper but has considerable thicknesses of chert and much greater thicknesses of the iron carbonate, and siderite crystals have been found in the massive magnetites.

The Atikokan magnetites, I would consider to have been primarily a hematite ore, which after the folding had been cut by a large number of greenstone dikes, bringing in sulphur solutions, which permeated the porous hematites, the heating and crushing converting the hematite to a magnetite and the sulphur solutions added the percentage of pyrite now making up the mass. The Atikokan trough has been traced continuously both in structure and material into the Steep Rock basin, definitely proving the continuity.

The Steep Rock Lake horizons show only hematites, with the exceptions of one or two narrow belts of magnetite in the vicinity of the Atikokan River. The iron horizons are very great thicknesses of carbonates, grading off in places to large outcroppings of the Steep Rock limestone, which can only be considered part and parcel of the iron horizon. The ores found are both brown and red hematites and others have been described as limonite, which in some cases are banded with cherts and jasper and in others running off into irregular masses and seams of hematite in the carbonate mass. The concentration of iron, however, does not seem to have been confined to any particular part of the horizon, bands and small bodies of good grade hematite having been found underlying the limestone and carbonate, and in other sections the replacement seems to have been mainly in the upper levels of the horizon, consisting largely of cherts, altering to ores, as well as carbonate running reasonably high in iron but not showing any special banding.

*Nipigon Iron Range*—The Poplar Lodge trough shows the usual banded jaspers and hematite, also very considerable widths of hematite ore running between 30 and 40 per cent in iron content. The jaspers and iron are interbanded with a soft schist, which is evidently part and parcel of the horizon, but running very low in iron content. I would consider all the ores, showing in connection with the jaspers in upper levels of the horizon, were primary deposits. Underlying the jaspy material are beds of carbonate, resting on the Keewatin, the carbonate showing in places very considerable replacement to hematite of good grade, these replacements being irregular in outline, being bands from a fraction of an inch in width to bunches of a foot or more across. Soft red jaspers and cherty bands occur at intervals with the carbonates.

East of the Poplar Lodge trough very considerable thicknesses of the carbonate were found interbanded with lean hematite. These horizons are extensive and repeated by parallel folding’s with the Lower Huronian conglomerate (jasper pebbles) much in evidence in
irregular patches over the iron formation and in other parts in widths of a half mile or more across.

**Michipicoten and District Iron Ranges**—The Michipicoten, Rid-out River and Woman River Iron Ranges all have the thick extensive bodies of iron carbonate, banded ores and jaspers, with the addition of higher grade siderite in the Michipicoten from which the Helen mine ores were derived.

**Exploration on Canadian Lake Superior Ranges**—It must be admitted that in the past the results of exploration for merchantable grades of iron in Thunder Bay and Rainy River Districts have been disappointing, but it is very much open to question whether the operators had given the districts explored sufficient examination and study before starting exploratory work. Drilling in the Atikokan District was confined entirely to the known bodies of magnetite ore. In the Steep Rock section, drilling was confined entirely to one horizon and the properties under consideration had little or no detail carefully worked out. Diamond drilling in the Michipicoten (Helen and Josephine mine sections) was begun on actual outcroppings of hematite, but any results outside of those particular properties have not been given out. Diamond drilling work to the east and north of Michipicoten areas has been very limited and, as far as the writer has been able to judge, also without careful consideration of the field.

Any further exploration in these districts should have the most careful comparisons made between districts that had been partially worked out in detail and the area intended to be prospected. The structural relations, of course, would have the first consideration, and for the many areas that have a large amount of overburden as well as known outcroppings, the writer would have no hesitation in recommending the most careful detail magnetic survey, with dip needle and dial compass. This is necessarily slow, tedious and expensive work, and without the most careful and complete correlation, such a survey would be almost worthless. With careful practice, a great deal of information can be gained by this means.

For example, the writer recently had an opportunity of establishing a satisfactory correlation in magnetic survey data, in connection with work done several years ago in the Steep Rock Lake basin. The structural relations of the three horizons were as follows: The iron carbonate occupied the crest of an anticline with heavy ash beds on both sides, the latter as the overlying formation having been eroded from the crest.

The three horizons had approximately the same magnetic intensity and each of the horizons had an exposed area of about 200 feet in cross section. The maximum dip needle reading (positive) was 17 degrees at a point near the centre of each of the horizons. A number of readings taken exactly on both exposed contacts gave in each case dip needle readings (positive) of 7 degrees showing definitely that such contacts could be established on ground that had a heavy amount of overburden. The former survey which was made over what were conceded to be similar structures, showed a diminution in magnetic intensity for several miles along the approximate line of contact.

The application of such data with the most careful establishment of correlation would effect a tremendous saving in any exploratory drill work done in such sections and the importance of such data would easily compensate for any expenditure which the work involved.

The area east of Lake Nipigon would have the detail worked out in much the same manner, but in the Poplar Lodge trough, the western portion of the range, gave entirely positive readings, and the eastern part entirely negative reading, with, of course, a zero line near the middle of the trough. The writer placed the same construction on the negative readings as on the positive, as there was no difference in the material of the iron horizon. This theory was borne out by the result of a pilot drill hole, which cut through a strip of about 300 feet wide, that showed greater negative intensity than the area on each side. The iron bearing material content was from 10 to 15 per cent higher than on either side. On the other hand, in a different field, it might possibly be found that the magnetic intensity had increased without any particular variation of the iron content, but I am of the opinion that in the latter case the variations, shown in the survey would be much more irregular. Correlation is needed, but in some cases surface conditions would make such data unavailable. Much remains to be done in the study of the Canadian Ranges and it would seem to be well worth while doing.

The Federal Geological Survey of Canada now has a party of geologists in charge of Dr. T. L. Tanton making a detail survey of the Steep Rock Lake basin and the Atikokan District. When this is completed, there will be much more data available and the age relations will have been worked out. The writer wishes to express his appreciation for maps furnished by the Federal Geological Survey Department, namely Michipicoten District, by Dr. W. H. Collins; Nipigon District, by Dr. T. L. Tanton; Seine River Sheet, by the late W. McInnes and the late W. H. Smith; Thunder Bay Section, Provincial Mines Department.

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**THE MARQUETTE IRON ORE RANGE.**

**BY GEO. A. NEWETT, ISHPEMING, MICH.**

At the time of the Lake Superior Mining Institute meeting held on the Marquette Range, Mich., August 31, to September 3, 1914, I presented a paper on this district, giving its early history and the progress that had been made during the time that had elapsed since ore was first discovered in 1844. Concluding that paper I wrote: "Its general condition is excellent, and it will be an active shipper for many years at the present rate of production."
It mines both soft and hard and soft hematites, and limonite ores. Its mines are operated underground with few exceptions and it has the deepest iron ore mines in this region. Its development, area and general structure is well known to the members of this Institute. Being the oldest of the iron ore producing ranges in the Lake Superior region, it has long been prominent. It has been a great training school for men engaged in the iron ore mining industry, and its graduates are to be found in all portions of the world where mining is being carried on.”

*Editor and Publisher of Iron Ore.

**THE TOTAL TONNAGE PRODUCED.**

Up to and including the year 1924, the Marquette Range had mined and sent to market 150,240,192 gross tons, the great bulk of which was sent from: the lake ports at Escanaba and Marquette. Little of the product has been smelted in the field where the mining has been done. In the early days there were a number of charcoal furnaces, small stacks, but these have all ceased operation. It is of interest that the first iron made in the Lake Superior district was at the Jackson forge, located about three miles east from the City of Negaunee, the initial bloom being made on the 10th day of February, 1848. The spot is marked by a monument erected by the Cleveland-Cliffs Iron Company, and ruins of the old plant may still be seen there. At the present time the Pioneer furnace, located at Marquette, Mich., and the property of the Cleveland-Cliffs Iron Company, is the only one in blast on this range. The Jackson forge used ore from the Jackson mine, Negaunee, Mich., which was the first one opened in this range, this following the original discovery of iron ore at this location in 1844. It was also the first iron ore found in the Lake Superior country. A suitable monument marks the discovery point.

**PRESENT CONDITION OF THE RANGE.**

Beginning at the extreme western end of the iron ore-bearing formation, is the Taylor mine, located about seven miles west from the town of L'Anse, on Section 32, Town 48, Range 29. The property was closed in 1881, after mining about 31,000 tons of ore. Of late the Ford Motor Company has operated diamond drills there in the hope of finding an extension of the ore body in the old mine working’s. It has interest in that it marks the limits of iron ore mining at that end of the Marquette Range.

**THE MICHIGAMME GROUP.**

The Michigamme mine, located at the northwest end of Michigamme Lake, was opened in 1872, and for many years was an active producer, its ores being magnetic. Before the mine closed, in the early nineties, an attempt was made at concentrating some of the lean ores associated with banded jasper, this being the first attempt to treat ores of this character, so far as I know, in this field. The separation was magnetically done, the product was satisfactory, but the cost was too high because of the small output. Soon after this attempt the mine was closed and has since been idle. The property was recently purchased from the Michigamme Iron Company by the Cleveland-Cliffs Iron Company. Immediately west of the Michigamme, was the Spurr producing ores similar, but it was long ago shut down.

Still farther west a few miles was a group of mines producing limonite ores that would yield around 50 per cent iron. Among these were the Ohio, Beaufort, Titan, Dalilba, Webster and others idle now for many years.

**THE IMPERIAL MINE.**

This property was opened in 1882, is located about a mile west from the west end of Lake Michigamme, and was first known as the “Wetmore.” It was operated in a spasmodic way several years, when it was secured by the Cleveland-Cliffs Iron Company, was well equipped and mining work prosecuted vigorously for a number of years when this company surrendered the lease to the owners. After an idleness of ten years, the property was secured by the Ford Motor Company, it being embraced in a purchase by this organization of over 400,000 acres of land from the Michigan Land & Iron Company. The Ford Company unwatered the mine, and have equipped it with the necessary machinery to handle it properly. There is a main incline shaft and an air shaft, the latter having recently been added. Mining is being principally done on the 4th level, but the shaft has been sunk to the 6th, a vertical distance from surface of 350 feet. On the 5th level a main haulage drift is being run east and west on the strike of the ore deposit. Orders for 275,000 tons of ore have been received, the ore being used in the furnace of the Ford Motor Company, at Rouge River, near Detroit. The entire annual output of this mine, furnishes ore enough for the steel needs of the company for about 30 days. The mine has been producing about 200,000 tons annually since the present proprietors reopened it. At the present time they are mining more than 1,000 tons daily and shipping about 1,100 tons, this going from lake ports in the company’s own boats that hold approximately 12,000 tons each. Another shift has recently been added to the mine force, three of eight hours each. The usual Ford Company wage of $6 a day is paid, this to all labor engaged on surface and underground, with the exception of foremen and men in positions of more than ordinary responsibility, who receive more. The ore is hard and requires much drilling and blasting. The mine makes about 250 gallons of water per minute, and a sump in the hanging wall below the 6th level is being figured on, this to hold about 8,000 gallons of water and from which the pumps could lift it, thus requiring certain periods in which the work could be done, as only a small portion of the time would be needed to keep the mine free from water. All the ore is crushed, being sent to the top of the steel headframe for this purpose. The company has fine mine buildings, and has built 50 houses for employes. Alvin Richards is
superintendent; H. H. Holman, mining captain; Bert Hooper and George Beauprid, shift bosses; Chester Carkeet, master mechanic; August Plichas, surface foreman; J. H. Reigart, mining engineer and geologist, is in charge of all mining operations, in all fields, for the company. "Hog fuel" is used under the boilers, this being waste from the Ford Company’s saw mills at Iron Mountain, L’Anse and Pequaming. When the Iron Mountain mill was started all the waste was consumed by paper mills in Wisconsin, but with the addition of the L’Anse and Pequaming mills the paper mills could not consume all the waste wood, and it was arranged to send the surplus to the Imperial mine, where special burners, or ovens, were introduced to handle it. I am told that this hog material has effected a considerable saving in former fuel costs at the mine.

The Imperial employes punch a clock when entering and leaving the mine, after the manner of many manufacturing concerns, but we know of no other mine in this region that observes the plan.

The operation of the Imperial has been a boom to the commercial interests of its locality, and to the people in general. A fine school building and gymnasium has been constructed near the mine, there is good water, sewerage, electric lighting and other conveniences.

Whatever the Ford Company does is regarded with more than usual interest, and today, this organization is the only one of mining kind now busy in the Michigamme district. There are others producing ores like those of the Imperial, but none are now operated, their iron content being too low to attract attention in the market. None of them can be worked as open cuts so the mining cost is high compared with the quality of their outputs.

**THE CHAMPION MINE.**

The next mining location east from Michigamme, on the Marquette Range, is at Beacon, where is located the Champion mine, owned in fee by the Oliver Iron Mining Company, and idle since April 30, 1911. Its present principal shaft, located at the western end of the property is to a vertical depth of 2,097 feet, being 65 feet below the 34th level. Because the ore pitched so rapidly to the west, the shaft was changed in direction to follow it, and was sunk on a spiral, and has been known in this district as the spiral shaft, a very fine bit of engineering. On the incline this shaft measures 2,314 feet. The ores are of excellent grade and are hard slate specular and magnetic hematites, and the mine is still a good one. After its purchase from the Champion Iron Company, soon after the Oliver Iron Mining Company was formed, it was closed down, there being no minimum royalties to meet, and the cost of production is undoubtedly higher than that of the company’s big open-pit mines on the Mesaba Range. Eventually, it will be reopened, and its ores will keep. In years gone by there were several smaller properties in this immediate vicinity, the Keystone among them, but all are abandoned. The Champion is located near the eastern end of Lake Michigan and the little village is naturally a quiet one with its former chief support on the inactive list. Now the Champion Beach, a popular bathing and tourist resort, is the scene of the most life in this place.

**THE HUMBOLDT GROUP.**

Next in progress eastward on the range is the Humboldt list of properties. This location was the scene of some of the earliest mining operations on the Marquette Range, when the Edwards and Washington were active. Later the Humboldt was created from them, and still later the Humboldt took the name of “Barron.” The Humboldt was opened in 1868, and several men who later were prominent in mining and political circles were engaged here. The Barron was the last to quit in this field, closing down several years ago. The mine still has ore but it is low grade and there hasn’t been a market for it at which a profit could he made. In the immediate vicinity was the Foxdale, Sampson and other small prospects.

**HOW HENRY FORD MAINTAINS EXPLORING CAMPS.**

The Bessie mine, located on Section 35, Town 48, Range 29, has been idle since the Oliver Iron Mining Company gave up its lease after making a trial of the property. The ore was too low grade for their use. The Ford Motor Company owns the fee of the property and at this time has diamond drills at work testing the formations in that vicinity, an extensive drilling program having been planned. It might be illuminating to the members of the Institute if they visited this exploring camp, located near Clowry station. They would find buildings painted white inside and out, concrete walks between the various buildings, sheets and pillow slips on the bed and these changed daily, and many other things a bit different from the usual make-up of camps associated with such explorations the world over. It is as Henry Ford wants it. In a drilling operation in the Republic district of this range he caused to be constructed several miles of highway to reach the place that cost him $18,000. Usually temporary roads are prepared that suffice to carry the machinery and supplies while the work is in progress, anything permanent awaiting the result of the search for mineral. In this case the road is of permanent character, and a fine one. While generally there may be little new on the old Marquette Range, Henry Ford presents a few innovations.

The Ford Motor Company has just completed a deal to option a tract of land of about 2,000 acres located west from the old Diorite mine, about 7 miles west from the City of Ishpeming, and is preparing to diamond drill portions of it, following the work done by Ralph Archibald, of Negaunee, who did diamond drilling there recently for the Palms-Book Company, of Detroit, and who found a promising body of soft hematite. The Palms-Book Company leased the tract from the Barnes
Land Company and have optioned to the Ford Motor Company.

**THE AMERICAN MINE.**

The American mine, located nine miles west from Ishpeming, and last operated by the M. A. Hanna Company and James R. Thompson, was closed several years ago. It produced hard ore of fine quality, but the veins grew too small to yield a profit. A soft hematite ore, found in connection with the hard, was much mixed and a concentrating mill was constructed to treat it, was operated for several years, and after the mine closed, crushed marble from the wastes of the Michigan Verde Antique Marble Company for about a year, after which all work ceased, and the mill was dismantled. This mine and mill was the support of the Village of Diorite. The hope is expressed that the operations of Henry Ford, near by, may revive it.

**MINES OF THE CLEVELAND-CLIFFS IRON COMPANY.**

This organization, originally known as the Cleveland Iron Mining Company, was the second to begin mining operations in iron ore production in the Lake Superior region. Its first shipments were made in 1854, and consisted of 3,000 tons. The dates of organization of the original company, and of those now embraced in the Cleveland-Cliffs organization, are as follows: Jackson Iron Company, 1848; Cleveland Iron Mining Company, 1849; Pioneer Iron Company, 1855; Iron Cliffs Company, 1864.

The company has produced, up to and including the year 1924, 68,974,848 gross tons of iron ore and 2,017,604 tons of charcoal pig iron.

**THE NORTH LAKE GROUP.**

In the North Lake group of properties of this company, located a few miles west of Ishpeming, beginning at the western end, is the Barnes-Hecker mine.

**BARNES-HECKER MINE**—The Barnes-Hecker shaft was started in 1907 and is now 1,067 feet deep. A great quantity of water was encountered in opening this mine and for a time mining had to be discontinued. The ore is a soft hematite. The system of mining is what is known as sub-level caving by top slicing. In small areas other methods have been tried. This shaft was sunk in a swamp by a contracting company using the pneumatic Caisson method who made a seal at ledge to exclude all surface water. From this point on the shaft was sunk by the usual method. Explorations were started in 1907.

**Mechanical Equipment**—The hoisting equipment consists of two geared double reduction motor driven hoists. The motors are 400 h.p. 360 r.p.m. induction type. The hoisting speed of the cage is 500 feet per minute and of the skip 900 feet per minute.

Compressed air is supplied by three electrically driven variable capacity compressors having a combined capacity of 7,000 cu. ft. per minute at 80 pounds terminal pressure. The motors driving these compressors are 3,200 volts, 3-phase 60-cycle synchronous type.

The pumping equipment at this mine consists of two 1,000 G. P. M. 1,000-foot head plunger pumps, electrically driven by 350 horsepower induction motors. The mine at present makes approximately 400 gallons per minute.

The underground haulage equipment consists of 100 k.w. motor generator set furnishing direct current for 250 volts for six-ton locomotives.

The top tram stocking is done with two endless rope haulage sets driven at a rope speed of 1,000 feet per minute by 50 horsepower induction motors.

The ventilation is natural.

**LLOYD MINE**—This shaft was sunk in 1909 and 1910. It is now approximately 900 feet deep. The workings are connected with those of the Morris. The ore is a soft hematite and is mined on the sub-level caving by top slicing method. A small amount of ore was mined from this property about 50 years ago and hauled by sleighs to the Pioneer furnace at Negaunee. Explorations by diamond drill were started in 1908. A part of this deposit, which outcropped to surface, was mined by open pit method.

**Mechanical Equipment**—The hoisting equipment consists of two geared double reduction motor driven hoists. The diameter of the drum is 10 feet with a 7-foot head. The mine makes about 1,000 gallons of water per minute.

The underground haulage equipment consists of 100 k.w. head machinery set furnishing direct current for three underground six-ton mine locomotives.

The top tram plant consists of one electrically driven endless rope haulage set operated by a 50 horsepower induction motor developing a rope speed of 1,200 feet per minute.
face. Motors are induction type 400 h.p. 360 r.p.m. The hoisting speed of the cage hoist is 500 feet per minute and of the skip 900 feet per minute.

The top tram equipment consists of two endless rope electrically driven haulage sets operating at a rope speed of 1,000 feet per minute and driven by 40 h.p. induction motors running 600 r.p.m.

The pumping and air compressing equipment for this mine is located at the Morris mine adjoining.

No. 6 gyratory crusher driven by a 25 h.p. motor is located at this shaft for crushing the product.

THE ISHPEMING CITY PROPERTIES.

HOLMES MINE—The Holmes mine is operated through one shaft. There is a connection with the Oliver Iron Mining Company’s Section 16 shaft for ventilation and safety. The shaft was sunk in 1916 and has reached a depth of about 1,300 feet. The mine is operated on four levels. The deposits consist of both hard and soft ore. The method of mining is sub-level caving by the top slicing method. The hard ore is crushed at the shaft house.

Mechanical Equipment—The mine hoists are electrically driven by 400 horsepower induction motors. The skips which are in balance are handled by a hoist having a rope speed of 1,000 feet per minute. The cage which is counter-balance is handled by a hoist which has a rope speed of 600 feet per minute.

Air is supplied by a variable capacity two-stage compressor driven by a 340 h.p. synchronous motor running 180 r.p.m. and compressing a maximum of 2,300 cu. ft. per air per minute to 80 pounds.

Pumping equipment has a capacity of 1,600 G. P. M. for a head of 1,000 feet. Pumps are driven by induction motors. The mine water approximates 180 gallons per minute.

The underground haulage set consists of a 100 k.w. rotary converter furnishing direct current for 250 volts for four six-ton underground locomotives.

The ventilation is natural.

The product of the mine is crushed, screened and graded by equipment located in the steel head frame. This equipment consists of three electrically driven gyratory crushers, two No. 6 and one No. 8. The rotary screens are also electrically driven.

CLIFFS SHAFT MINE—The Cliffs Shaft mine is operated through shafts “A” and “B” which have attained a depth of approximately 1,000 feet. The ore is hard specular and has to be crushed. A crusher is situated midway between the shafts, with which it is connected with a trestle. The shaft houses are of concrete construction and were built in 1919 around the old original shaft houses. The only hoisting time lost during the construction was two days, during which time the sheaves were being changed from the wooden structure to the concrete. The method of mining is what is known as the room and pillar system. The exploration for this mine was started in 1878; “A” shaft was begun in 1880 and “B” shaft the next year. Except from 1893 to 1897, the mine has been in continuous operation.

Mechanical Equipment—The hoisting equipment consists of a double drum, single reduction geared hoist, driven by a 500 horsepower induction motor with a rope speed of 1,000 feet per minute. The skips are counter-balanced.

An electrically driven air compressor with a maximum capacity of 6,000 feet per minute at 85 pounds pressure furnishes compressed air.

The electric pumping equipment is driven by induction motors. There are three units having a combined capacity of 1,800 gallons per minute working against a 1,000-foot head.

The underground haulage equipment consists of a 100 k.w. 250-volt motor generator set serving five six-ton electric locomotives. In addition there are five storage battery locomotives which are used underground.

The mine product is carried from the two shafts over a steel trestle in self-dumping cars operated by an electrically driven endless rope haulage system to the mine crushing plant which is also electrically driven and equipped with three gyratory crushers, two No. 5 and one No. 8. Rotary and disc type of screens are used for grading the ore.

For stocking the ore the gravity type of trams are used, all driven by a common motor, the drums being engaged by means of a clutch to pull the cars back to the chutes at the crushing plant.

In addition one endless rope haulage set is used for stocking. It is electrically driven by a 50 horsepower motor and has a rope speed of 750 feet per minute.

The ventilation is natural.

This mine has the usual type equipment and in addition a very complete equipment for sharpening rock drills. Oil is used for fuel, for heating and tempering.

THE NEGAUNEE GROUP.

ATHENS MINE—The Athens shaft was started in 1913 and was finished in 1917 at a depth of 2,490 feet. The ore consists of a soft hematite and is mined on the sub-level caving method by top slicing. The ore at this mine is stocked during the winter months from a permanent steel trestle. Explorations leading to the discovery of this deposit were made by means of a diamond drill which started in 1905. This is the deepest mine on the Marquette Range.

Mechanical Equipment—The hoisting equipment comprises two hoists, one standard A. C. cage hoist driven by a 400 horsepower induction motor handling a counter-balance cage at a rope speed of approximately 900 feet per minute, to a depth of 2,600 feet. The skip...
hoist consists of an Ilgner system having a 900 h.p. 72 r.p.m. direct current motor, direct connected to the hoist. This motor is driven from a fly wheel set consisting of an 850 h.p. slip-ring motor, 30,000 lb. fly wheel, 700 k.w. 300-volt generator and a 15 k.w. exciter and slip-ring regulator. The loaded skips weigh 17,000 lbs. each and are in balance. They operate at a total depth of approximately 2,600 feet at a rope speed of 1,800 feet per minute.

The two electric driven air compressors operated by synchronous motors have a total capacity of 5,000 cu. ft. of free air at 80 lbs. terminal pressure.

The pumping equipment consists of two center crank, duplex, pot form mine pumps having a capacity of 500 g.p.m. against 2,400-foot head. At the time of installation in 1917 these pumps were the highest head single lift pumps in operation.

The underground haulage set consists of 100 k.w. rotary converter furnishing D. C. for operating four six-ton underground locomotives.

The two top tram units for stocking ore are of the 8-foot rubber lined sheave type driven by 50 h.p. induction motors through herring bone gears with a rope speed of 1,300 feet per minute.

The ventilating system consists of a motor driven fan having a capacity of 42,000 cu. ft. of air against a static head of 3 inches of water. The motor is 50 h.p. induction type. The air is passed down one compartment of the shaft through the underground workings and up the other compartment. The partition between the two shaft compartments was guited to make them air-tight.

Negaunee Mine—The present shaft, No. 3, used at this mine was started in 1908. It is cylindrical in shape, 17 feet in diameter and of concrete. The sets are of steel. The present depth is approximately 1,200 feet. The ore is a soft hematite. The mining method being used is sub-level caving by top slicing. At this mine is located the district crusher used for the various ores. The hoisting equipment

Mechanical Equipment—Both the skip and cage hoists at this mine are driven by direct current motors with Ward-Leonard control. The motor for the hoist is 500 h.p. 60 r.p.m. direct connected to the hoist. The motor for the cage hoist is 200 h.p. 250 r.p.m. geared.

The fly wheel set consists of a 450 h.p. 2,300 volt induction motor, 400 k.w. generator for the skips and 150 k.w. generator for the cage, 25 k.w. exciter and a 20,000-lb. fly wheel mounted on one shaft running at 720 r.p.m. full speed. Automatic slip-ring regulators are provided. At the time of installation 15 years ago, this was the largest ligner system in operation.

Two variable capacity synchronous motor driven air compressors having a total capacity of 4,500 cu. ft. of free air per minute, compressed to 80 lbs., furnish air for the mine.

Two mine pumps are 5x24-in. duplex synchronous motor driven, 1,000 gallons per minute each against 432 lbs. pressure, with a piston speed of 480 feet per minute. The synchronous motors are mounted on the shaft between the main bearings. In addition to the above pumps a 1,000 gallons per minute 1,000-foot head centrifugal pump is maintained for emergency. The total capacity of the pumps is 3,000 g.p.m. The mine is making about 850 g.p.m.

The underground haulage set consists of a motor generator set of 150 k.w. capacity furnishing 250 volts D. C. for six haulage locomotives.

Two endless rope electric driven top tram plants are used for stocking ore. They are driven by 50 h.p. induction motors at a rope speed of 1,300 feet per minute.

Ventilation is provided by a No. 12 reversible Sirroco fan having a maximum capacity of 100,000 cu. ft. of air a minute against static head of 4 inches of water gauge. The driving motor is 150 h.p. two speed. This fan also furnishes ventilation for the Maas mine, which adjoins.

Maas Mine—The Maas shaft was started in 1902 but it was not until 1906 that a depth of 1,136 feet was reached. This is one of the most difficult drop shafts ever completed on the Marquette Range. The shaft has reached a depth of approximately 1,400 feet. The ore consists of a soft hematite which is mined on the sub-level caving method by top slicing. At this mine is located the district crusher used for the various ores. The ore deposit was discovered by the late George Maas, who commenced operations and leased the property to the company in 1901.

Mechanical Equipment—The hoisting equipment consists of two hoists, one for the skips which are in balance and one for the cage. They have drums 10 feet in diameter with a 7-foot face and are single gear reduction driven by 400 h.p. induction motors. The skips are four ton and operated at a rope speed of 1,200 feet per minute.

Two variable capacity synchronous motor driven air compressors furnish air at 80 lb. pressure. The total capacity is 5,000 cu. ft. per minute.

The pumping equipment consists of three units, two plunger pumps and one centrifugal with a total capacity of 2,400 gallons per minute. Each unit is driven by an induction motor and has a capacity of 800 g.p.m. against a 1,150-foot head.

The underground haulage equipment consists of 150 k.w. motor generator set furnishing 250 volt D. C. for five six-ton haulage locomotives.

The ore is stocked with two endless rope 50 h.p. induction motor driven top tram plants with a rope speed of about 1,300 feet per minute.
Ventilation is furnished by a fan equipment which is installed in the Negaunee mine and described under that head.

OGDEN MINE—The Ogden mine is an open pit producing a siliceous ore which is mined by steam shovel. It was opened some 50 years ago but was inactive for many years. It has been recently opened. It is situated about two miles south of Negaunee, in the Cliffs Drive territory.

*Mechanical Equipment*—This mine is equipped with a small shop 1,000 c.p.m air compressor driven by 150 h.p. induction motor. The ore is loaded by an 80-ton steam shovel.

**THE GWINN GROUP.**

**Stephenson mine**—The Stephenson shaft was started in 1905 and the total depth is now approximately 600 feet. Last year a winze was sunk 160 feet from the 6th to the 8th level. In 1917 a large inflow of water occurred. The mine was completely flooded. Special mining equipment was secured and the mine was pumped out by the end of 1919. The ore is a soft red hematite and is mined on the sub-level caving by top slicing method. Explorations were begun in 1902.

*Mechanical Equipment*—The mechanical equipment consists of one cage and one skip hoist. The cage hoist is second motion, electrically driven by a 400 h.p. induction motor. The skip hoist is second motion, electrically driven by a 400 h.p. induction motor.

Compressed air is furnished from a central power plant.

The pumping capacity is 5,600 gallons per minute at a 500-foot head, the mine making approximately 2,300 gallons per minute.

The underground haulage set consists of a synchronous converter of 100 k.w. capacity which furnishes current at 250 volts D. C. to operate five six-ton haulage motors.

The ventilation is natural.

The trop tram plant consists of three endless rope haulage sets driven by 50 h.p. motors which develop a rope speed of about 1,200 feet per minute.

**Princeton mine**—The company acquired this property in 1905, having been operated since 1872. The present shaft is what is known as No. 2 and has reached a depth of approximately 560 feet. The ore is a soft reel hematite and the system of mining is what is known as the sub-level caving by top slicing. It was temporarily closed in 1921.

*Mechanical Equipment*—This mine has its cage and skip in balance. The hoist is second motion, driven by a 2,200 volt 200 h.p. induction motor running 450 r.p.m. with a rope speed of 720 feet per minute. The hoist for a small timber shaft is second motion, handling a counter-balanced cage. Its induction motor is 75 h.p. at 450 r.p.m. with a hoisting speed of 460 feet per minute.

The compressed air is furnished from the central power plant. The pumping capacity is 1,500 gallons per minute, consisting of one 1,000 g.p.m. plunger and one 500 g.p.m. centrifugal pump working at a head of 500 feet and driven by 2,200 volt induction motors. An average of from 300 to 400 gallons of water per minute is pumped. The mine is making from 150 to 300 gallons per minute.

Current for the underground haulage is supplied by a synchronous motor generator set of 250 h.p. supplying D. C. current at 250 volts. Three underground six-ton haulage locomotives are used for tramming the ore.

Ventilation is natural, there being three connected shafts.

The top tram equipment for stocking ore consists of three endless rope haulage sets operated at a speed of from 1,200 1,300 per minute and driven by 50 h.p. induction motors.

GWINV MINE—This was the first shaft on the Marquette Range to be sunk by the pneumatic Caisson method making a seal at ledge to exclude surface water. This work was begun in 1907 and completed in 1908. The shaft is now 1,375 feet deep. The ore is a soft red hematite and is mined on the sub-level caving by top slicing method. Explorations were begun in 1904. The mine was temporarily closed in 1921, although pumping continues.

*Mechanical Equipment*—The hoisting equipment for this mine consists of two hoists, one for the cage and one for the skips. The skips operate in balance and the cage is counter-balanced. The hoists are double reduction geared, electrically driven by 400 h.p. induction motors operating at 350 r.p.m.

Compressed air is supplied from the central power plant. The main pumping equipment has a total capacity of 2,600 g.p.m. at 1,000-foot head and consists of two pumps, one plunger of 1,600 g.p.m. capacity and another centrifugal pump of 1,000 g.p.m. capacity. Both are driven by 2,200 volt induction motors. The mine averages from 150 to 400 gallons of water per minute.

The underground haulage equipment consists of 100 k.w. motor generator set furnishing 250 volt D. C. to operate three six-ton underground locomotives.

The top tram equipment for stocking ore consists of an endless rope electrically driven set operated by 37½ h.p. induction motor, giving a rope speed, of 1,000 feet per minute.

The ventilation is supplied by an electrically driven fan of the Sirroco type and having a capacity of 40,600 cu. ft. of air per minute against 3 inches of static water gauge.

AUSTIN MINE—The Austin shaft was started in 1903 and is now approximately 360 feet deep. A second shaft was raised some years later. The ore is a soft red hematite and is mined on the sub-level caving by top slicing method.
Mechanical Equipment—The mechanical equipment consists of second motion electrically driven skip hoist operated by 200 h.p. induction motor running at 450 r.p.m., 2,200 volts.

Air is being furnished from a central power plant.

The water is being pumped by the Stephenson mine which adjoins.

The top tram equipment consists of an endless rope haulage driven by a 50 h.p. induction motor, running at 600 r.p.m. with a haulage speed of 1,300 feet a minute.

The ventilation is natural.

GARDNER-MACKINAW MINE—There are two shafts with concrete collars on this property sunk in 1911 and 1912 by the pneumatic Caisson method, making a seal at ledge to exclude surface water. The depths of the shafts are approximately 950 feet. The ore is a soft red hematite. The ore and the hanging wall are sufficiently hard to permit of the use of the shrinkage stope method of mining. Explorations were begun in 1906. The mine was closed in 1920.

Mechanical Equipment—The hoisting equipment at each of the shafts consists of one hoist handling a cage and skip in balance. Hoist is second motion geared, electrically driven by 400 h.p. induction motor running 350 r.p.m. and giving a rope speed of 900 feet per minute. Compressed air is supplied by a variable capacity two stage compressor driven by a direct connected synchronous motor operating at 120 r.p.m. The maximum capacity is 2,090 cu. ft. per minute.

The pumping equipment consists of two units having a maximum capacity of 2,000 g.p.m. Both are electrically driven by induction motors.

The underground haulage equipment consists of a 100 k.w. rotary converter set furnishing direct current for three six-ton underground locomotives.

The top tram equipment is of the loose drum gravity type, electrically operated. The cars are run out by gravity. The motors are 25 h.p. induction type.

The ventilation is natural.

REPUBLIC DISTRICT.

REPUBLIC MINE—The Republic mine is served by two shafts; No. 9, which is 2,218 feet deep and the Pascoe shaft, which is 2,840 feet deep. The ore from the Pascoe is hoisted to the 2,070-foot level and from that level transferred to No. 9 shaft. The ore is a hard blue specular, and is mined by the open stope method. The mine was opened by the Republic Iron Company in 1870 and mining operations were begun in the hillside and in open pits. It was acquired by this company in 1914.

Mechanical Equipment—The hoisting equipment consists of a 12x12-ft. hoist second motion, motor driven by two 500 h.p. induction motors at 450 r.p.m.

Two air compressors are rope driven by water wheels with a total capacity of 4,400 cu. ft. of air per minute at 75 lb. pressure. The air is passed through a synchronous motor driven booster and the pressure raised to no lbs. The pumping equipment is small, consisting of two units. Very little water is made at this mine.

The underground haulage equipment is composed of two four-ton storage battery locomotives.

The top tram plant consists of two rope haulage units driven by 50 h.p. motors.

The mine is equipped with a gyratory crushing and screening plant driven by 150 h.p. induction motor.

The ventilation is natural.

DISTRICT ORE CRUSHERS.

The Cleveland-Cliffs Iron Company maintains two district ore crushers, one located at the Maas mine, at Negaunee, and the other at Gwinn. The equipment for each consists of a No. 7½ gyratory crusher, an 8-in. steel pan conveyor and a 36-ft. rubber belt conveyor. All are driven by induction motors. The motor for the crushers is 100 h.p. and those of the conveyors are 50 h.p. each.

HYDRO-ELECTRIC DEVELOPMENT.

The Cleveland-Cliffs hydro-electric development at present consists of four hydro-electric generating stations with three intake dams and two storage dams, and two reserve steam plants. These are all connected into a common 30,-000-volt transmission system. The generating and distributing voltage from sub-stations is at 2,300 volts. There are 16 connected sub-stations having a total rated capacity of 35,900 k.v.a. The total length of 30,000 volt transmission circuit is 125 miles, and the total length of 2,300 volt distribution circuits is 44 miles. Total connected motor load is 36,354 h.p, and various lighting and heating applications of 500 k.w.

The Au Train plant, located on Au Train Falls, on the Au Train River, about 15 miles from Munising, has a rock fill crib dam without storage. Total head of 90, feet with a half mile of 5-foot steel intake. Two 450 k.w. generators connected to Pelton Water Wheels.

The Carp plant, located a mile from Marquette, on the Carp River, has two 2,800 k.v.a. generators connected to Allis-Chalmers horizontal wheels. These operate under a head of about 600 feet. The penstock is steel on the high pressure section and wood stave on the low pressure section. It is 66 inches in diameter and four miles long. Dam is concrete containing 17,000 cu. yds. of concrete. Storage here for daily fluctuations. Near Ishpeming, on the Carp River, a storage impounds 434,000,000 cu. ft. of water for use during low normal river flow.
The McClure plant has two 5,000 k.v.a. generators direct connected to S. Morgan Smith horizontal water wheels, and operate under a 400-foot head. Penstock is steel and wood stave 84 inches in diameter and about 2½ miles long. The concrete intake dam contains 17,000 cu. yds. of concrete and has storage for several days’ normal operation. This is located on the Dead River about four miles north of Negaunee. Two miles above this dam is the Storage Dam. This is located at a place called the Hoist, formerly a log hoist to carry the logs out above the falls. The present storage dam will impound about 2,000,000,000 cu. ft. of water under normal conditions and should be sufficient for the needs for one year. At this point a generating station having a 1,250 k.v.a. horizontal unit and a 1,500 k.v.a. vertical unit is located. These units utilize the stored water before it passes into the McClure Intake Basin. The head here averages 135 feet and a 72-inch steel penstock about 500 feet long carries the water down. This dam contains about 35,000 cu. yds. of concrete.

Two steam reserve plants each of 1,000 k.v.a. capacity are maintained at Negaunee and Princeton.

The yearly output of combined plants 50,000,000 to 75,000,000 k.w. hours.

Power is supplied for regular operations of the Cleveland-Cliffs Iron Company in their mining, railroad, furnace, lumber and other affiliated operations.

Break down service is given to all commercial local electric companies in the community, and at times of surplus or flood water, power is supplied for these interconnected systems.

**Charcoal Iron Furnace.**

The Pioneer furnace, at Negaunee, was the oldest in the district, dating from 1858. This was dismantled many years ago, and in its stead the largest charcoal furnace in the world, taking the same name, was constructed at Marquette, where it is now active. In connection is a chemical plant by-products being secured from smoke distillation. The company also has another charcoal iron furnace located at Gladstone, Mich., but this has been idle several years. The company uses rough wood from its extensive timber lands, sending the hemlock logs to paper-making mills and its hardwoods to veneer and other factories making shapes of wood. Timber for the mines is also cut from these lands. The land department is separate from the mining, etc., and in this the real estate affairs are looked after. This office is located in Negaunee, John M. Bush being at the head.

The company has its own fleet of ore carriers, has its own railway from the mines to Marquette, where it has a fine steel and concrete shipping dock, and it is also interested in coal lands in several states and is associated with steel-making organizations, these aiding in disposing of its iron ore product.

**Those in Charge.**

The representatives of the company on this range are: M. M. Duncan, vice president and general manager; S. R. Elliott, assistant general manager; George R. Jackson, superintendent Negaunee group of mines; Lucien Eaton, superintendent Ishpeming group; Charles Stakel, superintendent North Lake group; W. W. Graff, superintendent Gwinn group; W. R. Myers, superintendent Republic and Iron River properties. James H. Rough, head mining captain.

The general offices for the range are located in Ishpeming. James E. Jopling is chief mining engineer; Edwin L. Derby, Jr., chief geologist; O. D. McClure, chief mechanical engineer; A. J. Yungbluth, purchasing agent; C. J. Shaddick, assistant auditor; William Conibear, safety engineer; W. H. Moulton, head of welfare department; Fred Baker, chief chemist.

H. R. Harris, of Marquette, is the vice president and general manager of the railway department; Austin Farrell, of Marquette, the manager of the furnace department, and F. W. Hyde, of Marquette, superintendent of lumber operations.

The following mining captains are employed by the company on the Marquette Range: Alfred Collick, James Stephens, William Tamblyn, John Olds, William Tippett, William Nault, Peter Pascoe, Joseph Thomas, James Stephens, William Tamblyn, John Olds, William Tippett, William Nault, Peter Pascoe, Joseph Thomas, Fred Ware, John Tregonning, William Jory, August Fagerberg and Alfred Bone.

**The Oliver Iron Mining Company.**

This organization is at present operating only one mine on the Marquette Range, this being Section Sixteen of the Lake Superior group, at Ishpeming. The Lake Superior Company was the third to mine iron ore on this range, it beginning in 1857, its first shipment of 4,658 tons being made in 1858. For many years it was the heaviest shipper in the district.

The Section Sixteen mine is a producer of both hard and soft hematites of excellent grades. It is opened to the 17th level, 1,248 feet vertically below surface, and mining is being done from the nth to the 17th, with an occasional attack on old pillars on levels nearer surface. There is one main hoisting shaft, in addition to which there is an air shaft, and the mine is connected with the Holmes, of the Cleveland-Cliffs Iron Company, located immediately on the west. Incidentally, the Holmes takes the water. About 550 men are engaged here. It is a mine of stable character, good for many years. It is worked on the caving plan.

Two centrifugal pumps in the old “D” shaft of the Lake Angeline mine, with a combined capacity of 2,500 gallons a minute, will care for any excess flow of water. The water is also bulkheaded in the old Lake Angeline to hold 140 feet of water, which easily takes care of any stormwater flow had.
The No. 7 hard ore mine is idle. It still has ore and the future will undoubtedly witness active mining again being done. Here, again, the operators possess the fee.

The Section Twenty-One mines of the company, located two miles south of Ishpeming, have been idle since 1910. These are properties of commercial kind with large ore reserves, with the fee in the possession of the company.

On the Cascade member of this range, the Oliver Iron Mining Company own the Moore, Joyce, Richards and Richmond. The latter is being operated under lease by the M. A. Hanna Company and the lease has only a brief time to run. These properties are producers of ores high in silica and for which there is a limited market, but one that is gradually being increased. The total shipments from this range will average about 750,000 tons, and there will be a steady increase in the volume as mix for ores deficient in silica and to better treat some of the highly aluminous ores. The company is the owner of extensive tracts of land on this range, and undoubtedly will add to its present list of mines when the ore is wanted.

Captain F. E. Keese is general superintendent of the company for this range. J. D. Slone is chief clerk; H. T. Hulst, chief mining engineer; A. L. Johnson, chemist; Joseph Kennedy, master mechanic; Alfred Edwards, mining captain; William Hatch, assistant, and James Bryden, surface foreman.

**The Rolling Mill Mine.**

The Rolling Mill mine is one of the old ones in the City of Negaunee. It is being operated by Clement K. Quinn & Company under lease from the Rolling Mill Mining Company. There are three principal levels being given attention, the 785, 900 and 1,000-foot. The shaft was extended to the 1,000 last winter and the lowest level is now under process of development. About 100,000 tons of high-grade ore from this mine are shipped annually, and, in addition, about 50,000 tons of silicious ore is shipped from an open pit south from the main mine. Of the high-grade ore they are producing about 16,000 tons monthly.

Preparations are being made at this time for diamond drilling the west forty of the property, which has never been prospected. They are to look for high-grade ores at a depth equal to, or greater, than thus far reached in the old mine. The drilling will be done from surface. C. J. Miron is mining captain; J. K. Osborne, mining engineer, and Guy Neault, surface superintendent.

**The Mary Charlotte.**

This property, operated by the Marquette Ore Company, is at this time mining silicious ore from underground. The property has been worked rather spasmodically in recent years.

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**The Jones and Laughlin Holdings.**

This Pittsburgh organization, well known steel makers, have a considerable holding on the Marquette Range, but is doing nothing in the way of mining at this time. They have merchantable ore bodies on the range and lands that are well located for mineral and as yet practically unexplored. Harry Peterson is representative of the company for the Michigan Ranges.

**The Cambria Mine.**

The Cambria mine is located on the Teal Lake member of the Marquette Range, now being the most westerly of the properties operated on the strike of this. Years ago there were the Lilly, Cleveland Hematite, Detroit and others. This formation parallels the north shore of Teal Lake, a beautiful body of water in the City of Negaunee from which the city’s supply is drawn. The Cambria begun shipments in 1876 and has been consistently active since then. It has many men who have long been in the service of the company, for 35 years, or more, attesting to their loyalty and industry and the fact that they like their jobs. The Hartford, immediately east of the Cambria, is worked in connection with the latter, the operators being the Republic Iron & Steel Company.

The mines have a depth of 1,300 feet, and the ore is coming principally from the four bottom levels, the 4th, 5th and 6th. They are producing about 10,000 tons monthly, are shipping steadily from stockpile, are working about 90 men five days a week. The ore is of excellent grade.

A year ago they introduced the Larry system of stockpiling, one man only being employed to operate it, and it has given excellent service. The property is partly electrified. The pumps are by Aldrich and their motors are Westinghouse. The stockpiling apparatus is electrically driven. Recent improvements have been made to the mine dry that gives better service than formerly, and is quite modern and complete. The premises of the company are very neatly kept throughout. The company shipped 141,361 tons last year.

J. E. Nelson is in charge and is general superintendent for the Michigan Ranges for his company; A. C. Hansen is mine superintendent, and A. T. Dalston, mining captain.

**The Cascade District.**

The Cascade member of the Marquette Range began mining operations 55 years ago. The Palmer mine, later changed in name to the Volunteer, sent out its first ore in 1871. This mine has been idle several years but still possesses ore. The range is a producer of highly silicious ores for the greater part, ores that yield about 40 per cent iron and are high in phosphorus. There is a steadily-growing demand for them for mixture with ores needing higher silicon content.
THE ISABELLA MINE.

The Isabella, is an exception to the general rule in this particular district in that its ores are of better grade, they being shipped at about 58 per cent iron. Up to recently there had to be much sorting to keep the grades that were attempted up to the desired points, but now it all goes as one grade, which is a great comfort to Captain T. J. Nicholas, in charge here. The Youngstown Sheet & Tube Company are the proprietors of this property but the latter is operated by Pickands, Mather & Company. The mine has a depth of 1,080 feet and attention is being paid to the 2nd and 3rd levels, the lowest. The property is still undergoing development, and an extra shift, making three of eight hours each, has just been put on to hasten development operations which had been somewhat neglected during the days of financial trial of the former operators. As soon as development work has been pushed to the point desired, one shift will be discontinued, making two the standard. About 160 men are now employed here.

The mine has recently been electrified. A new office has been built and there are three new bungalows for the local administration.

This company is operating two diamond drills on land of the Volunteer Iron Company, on Section 25, Town 47, Range 27, this being in Tilden township.

Local representatives are Captain T. J. Nicholas, superintendent; Charles Nicholas, mining captain; R. E. Tuttle, mining engineer; Joseph Lemire and Clinton Grigg, foremen. The company shipped 179,498 tons in 1924.

And if you visit the property do not overlook Captain Nicholas’ flower and vegetable gardens, which are beauties.

THE RICHMOND MINE.

The Richmond mine is operated by the M. A. Hanna Company. It is a silicious ore property and is mined with steam shovel directly into railway cars, the ore being broken from the sides of the pit. The ores are hard and tough, needing much drilling and explosives. They are now mining and shipping about 1,500 tons daily, and shipped 271,492 tons last year. Their lease, which is from the Oliver Iron Mining Company, expires this year, and they told me it was not to be renewed. They are developing a property about a mile to the southeast, and adjoining the Moore, of the Oliver Company, where they will have an ore exposure about a half mile in length. There are four forties owned by the Cascade Iron Company, formerly Pittsburgh & Lake Superior Company.

In the operation of the Richmond, mining has been carried nearly to the west line of the property. John Huhtala is superintendent; Lawrence Collins, mining captain.

THE MAITLAND.

This property has been one of the most active on this range. It was owned by the late A. W. Maitland, of Negaunee, and his son, A. P., has been in charge of operations here for several years, making a fine success of his operation. Ore is broken from the side of a prominent hill, and is of the same stubborn character generally found throughout this field. The mine sent out 290,148 tons last year, in a dull season. The ore is crushed near the mine pit, going from this plant direct into railway cars. Smaller cars are used in taking the ore from the pit to the crusher.

THE EMPIRE.

The Empire mine is idle at this time. R. S. Archibald, of Negaunee, has an option on the lands and will diamond drill them,

The Cleveland-Cliffs Iron Company has also been drilling some of its lands in this district.

THE ADVANCE INDUSTRIAL SUPPLY COMPANY.

The production of rock grits for the covering of felt shingles, and for other commercial purposes, is a comparatively new industry for this range. A successful operator in this line is the Advance Industrial Supply Company, with headquarters in Chicago, which concern now has seven plants busy in making grits of as many colors, each plant producing rock of different color from the others, this to meet the demands of the trade. The latest is one located near St. Louis that takes gravel from the bed of the Mississippi River that gives a buff tone, now so much in demand.

The Marquette Range plant of the company is located near Morgan Heights, a short distance northwest of the sanitarium, where a very substantial construction represents a large investment of money. This plant secures its rock, a compact, green slate, that gives the green color so much sought by architects, and that is so seldom found. To secure a rock that will give a permanent green has been difficult. There is here crushers and grinders such as is found in the ordinary concentrating mill. The flow is the coarse rock from the pit to the top of the building, into the coarse crushers and on down the incline to the fine grinding machines, the waste going out on the west side of the mill into a swamp in which it has settled to a depth of 50 feet, in places. The rock is reduced to 14-mesh, the standard for the needs of the shingle makers, and the chief product, to 300-mesh, this being the finest, and blown out by air blast from the smallest screen stream. This very fine flour material now goes to the manufacturers of billiard and pool balls, of the compositions kind, to makers of hard rubber, bowling balls, and into many other channels, and has only been used a short time. It formerly was waste here, but now constitutes a valuable product. Chemistry has found a way in which it can be employed.
Of the shingle grit the mill is now producing about 125 tons a day, and has a capacity of 250 tons of finished product. The working force fluctuates from 65 to 125 men. A dust mill has just been completed and improvements have been general.

The rock is secured from a slate exposure that rises to a height of 60 to 75 feet above the general level and only a short distance north of the mill. Power drills are used and they have a fine face from which rock is readily taken. They have gotten away from the weathered portion of the mass, so that now little or no sorting is necessary. Formerly the stained, or weathered rock had to be discarded to maintain the quality of the concentrates. There is an unlimited quantity of this rock, diamond drilling proving, it to be of great extent and uniform in quality. They take 16-foot benches in the quarrying, and holes here do not have to be sprung. The rock is taken from the quarry to the mill in small cars and by Ford motors. Second-hand motors are secured at small cost, the rear of the chassis cut away, and a special end substituted. The gears are changed so that the same ratio is had in going forward or back, and the same speed secured. The motors would burn out in backing up the train were this change not made. It is a simple and reliable, as well as cheap power.

The men are well cared for here. There is a bunk house that will care for 85 of them, each man has a bed to himself. There is hot and cold water and baths in this building. The mess hall, close by, can seat 120 men. The kitchen would please the most fastidious woman. There is a concrete basement under this building in which bountiful stores are kept, and where meat keeps cool without ice. Anyhow, the 65 men employed eat 65 pounds a day so fresh supply is frequent. There is a well-fitted shop for the ordinary needs of the plant. As these mills are few throughout the country no one is making parts for them so it is up to the local management to keep them going. Henry Vandenboom, of Marquette, is in charge here and the plant shows his interest and ability.

Not far distant is the plant of the Beaverboard Company. A large money investment was made in its construction, several years ago, but there was some fault and it made only a few carloads of grit. Someone told me they built it backwards.

**Precious Metals Production.**

The Marquette Range has produced $600,000 in gold and silver, gold predominating. This was mostly from the Ropes mine, located a few miles north and west from Ishpeming City.

**Verde Antique Marble.**

The finest verde antique marble in the United States, and the equal to the best found in Italy, is now showing in the bottom of the Michigan Verde Antique Marble Company’s quarry, in the Ishpeming district. Sawing and polishing machinery is now being removed from Marquette City to the quarry, and the present year will probably see the resumption of marble production from this source.

**A Drifting Record.**

Records in shaft sinking and drifting are subjects that are full of interest and create much discussion. I have secured the following facts from the company’s books, of a big job of drifting at the Barnes-Hecker mine, of the Cleveland-Cliffs Iron Company, done in March, 1920. John M. Bush was in charge of the property for the company, and Captain William Tippett was the mining captain. The drift was 9x10 feet, in compact slate, with much water. A mechanical loader was used, and the ventilation was excellent:

<table>
<thead>
<tr>
<th>Number feet drifted</th>
<th>539</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number days worked</td>
<td>77</td>
</tr>
<tr>
<td>Number feet per day</td>
<td>19 1/3</td>
</tr>
<tr>
<td>Number miners in drift</td>
<td>4</td>
</tr>
<tr>
<td>Number continuous hours worked</td>
<td>55 1/3</td>
</tr>
<tr>
<td>Number feet per hour</td>
<td>987</td>
</tr>
<tr>
<td>Number hours worked by miners</td>
<td>2,280</td>
</tr>
<tr>
<td>Number hours worked by trammers</td>
<td>4,474</td>
</tr>
<tr>
<td>Number miners hours per foot</td>
<td>4.23</td>
</tr>
<tr>
<td>Number trammers hours per foot</td>
<td>4.48</td>
</tr>
<tr>
<td>Tons rock per foot of drift</td>
<td>9.70</td>
</tr>
</tbody>
</table>

**Note**—The Cleveland-Cliffs Iron Company has one of the finest hospitals in the Northwest located in Ishpeming. Better take a look through it. Dr. V. H. Vandeveiter is the surgeon in charge. This company also has club rooms at several of its mining locations. The company has for many years observed an award plan for those of its employes or tenants on its lands who have the best-kept premises, best vegetable gardens and best exhibits of vine planting and window box gardening. The homes of the many contestants speak for themselves.
THE ONTARIO AND QUEBEC GOLD FIELDS.

BY WILLIAM H. SELDEN, JR., IRON RIVER, MICH.

It has been the writer's pleasure at different times during the past few years to visit some of the gold mining camps of northeastern Ontario and northwestern Quebec, where a great deal of time was spent in a study of the geological features, both upon the surface and in the underground workings of the mines. Here progress is being made in the discovery and production of precious metals that is not generally known or appreciated by the outside world. The general public considers this section of Canada as a great wilderness, where Indians roam at will, and a few trading posts are to be found at remote points. On the contrary, however, modern cities are springing up, excellent railroad facilities exist, pulp and paper mills, some of the largest in the world, are operating, and hydro-electric development is increasing rapidly.

Not since the discovery of the Witwatersrand Goldfields of South Africa has so much attention been centered on any country's mineral resources as is now shown in Canada. The great Pre-Cambrian formations, which circle Hudson and James Bays, with the facts that are already in evidence as to their productivity, are sufficient to convince anyone that this country has a great future. However, in reality it is still in its infancy. But notwithstanding this fact, Ontario is now a big factor in the world's output of gold. In 1924, Ontario contributed to Canada's output by over 81%. Up to the time of the discoveries at Porcupine, gold in Ontario was not considered an important item in the mineral production of the province, nor in the Dominion.

The following chart gives a clear idea of the relative production and the rapidity with which Canada is coming to the front.

Author's Note:—This article is not a technical paper, it has been written for the purpose of enlightening those who are not familiar with gold mining in Canada; to grasp more easily the general situation, as to the present magnitude and future possibilities of a country that is reaching considerable proportions as a gold producing country.

GOLD OUTPUT BY COUNTRIES.

In order of production in 1924.

<table>
<thead>
<tr>
<th>Country</th>
<th>1924</th>
<th>1922</th>
<th>1920</th>
<th>1915</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transvaal</td>
<td>518,000,000</td>
<td>459,000,000</td>
<td>410,000,000</td>
<td>339,000,000</td>
</tr>
<tr>
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Greatest annual Transvaal production was in 1924. Total 1924: 1,398,060,000.

From 1866, the first year gold was found, in the southeastern portion of the province, to 1910 the total yield amounted to slightly over $2,600,000.00 and the greatest annual output during that period was in the year 1899, when the Lake of the Woods section was at the height of its activity. Production that year came from such properties as the Sultana, Regina and Mikado and amounted to $424,568.00, but their operations were of short duration, as the method of treating gold ores at that time was not such as we have today, thus only the rich pockets were drawn.

As recently as 1910, the year the Porcupine camp began operations, only $68,498.00 in gold came from Ontario, and of this amount over $35,000.00 was from the Porcupine camp. So it can be seen that gold contributed little in the way of wealth to the province of Ontario up to that time. Now the situation is entirely changed. In the brief period of fourteen years, the amount of gold produced annually has increased rapidly, and in 1924, $25,668,754.00 is shown on the Government records as coming from the province.

Comparative figures of the Provinces of Canada are interesting in showing the relative productions for 1923 and 1924:

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OBSTACLES IN THE WAY OF PROGRESS.

During this period, from 1910 to the year 1925, there have been many obstacles which have retarded the development of these newer sections; forest fires, destroying entire mining camps; serious shortage of power; miners' strikes, and four years of the World War, which took the flower of Canada's manhood, leaving only the older and inefficient laborers to operate the mines; greatly increased the cost of all materials entering into mining operations. What was probably more serious than all of these, however, was the lack of faith in Canada by the great mining interests of other countries, and their lack of knowledge of the geological possibilities of the Pre-Cambrian formation. Ontario, however, has shown remarkable and consistent growth since 1910, having today the impressive amount of $154,419,000 to her credit, the bulk of which has come from the gold mines of Porcupine and Kirkland Lake, together with $234,735,000 from her silver mines, to the close of 1924. Those who are most familiar with the conditions predict an output of over $30,000,000, in gold for the year 1925. In fact, the records of production for the first six months of this year show that an amount in excess of the above will doubtless be recorded.

Ontario has been largely backed by her own capital, and of the amount invested in gold mining, Canada has contributed about 60 per cent.
The Gold Bearing Area.

In the matter of the gold bearing area, it is generally believed that, from the west Manitoba line all the way across northern Ontario, and far easterly into Quebec, gold will be found in paying quantities. There are several localities in Manitoba where considerable interest has been aroused over somewhat spectacular showings and work is in progress, more particularly at points a short distance west of the Ontario boundary.

The discovery made about two years ago, at the Noranda-Horne in Rouyn township of northeastern Quebec, is remarkable in its extent and has stimulated prospecting upon an extensive scale and over a very large area, many of the properties show great promise and Quebec also, from the gold mining standpoint, undoubtedly has a great future. At present, the belts from which the major part of production come are Porcupine and Kirkland Lake. It is the extensions of these belts westerly, and easterly into Quebec, where the greatest amount of development is being carried on. A study of the maps will give an idea of the extent to which gold discoveries have been made, and the vastness of Pre-Cambrian area, in which all ores, not only gold, are found, but the silver and nickel ores of Ontario, and the iron ores of Lake Superior, the latter occupying only about 3 per cent of the total known Pre-Cambrian territory.

Discovery of Gold in Northeast Ontario.

It was with great difficulty that the first prospectors, in 1909, were able to convince capital that they had something of value, even though the provincial geologists as early as 1896 made mention in reports, of favorable prospecting ground at or near what is now the town of Timmins in the Porcupine Camp. Early in the summer of 1909 samples of gold ore shown at Haileybury, Ontario and stated to have come from Porcupine Lake, stimulated a few disheartened prospectors to make the trip into Porcupine, after having been unsuccessful in other localities. It was 40 miles in from the end of the “steel,” through difficult country and during the first two years, while the Dome and Hollinger were struggling through the development stage, many hardships were endured, and the romance of that period would make interesting reading, with Alex Gillies, Jack Wilson, Ben Hollinger and several others, the most interesting characters of that time. To pass over this, however, we now have the remarkable situation of the modern city of Timmins, a camp with 20,000 population, Pullman service from Toronto in 22 hours, hundreds of miles of underground workings, and what appears to be the greatest gold camp in North America.
As stated, it was not only difficult to arouse any interest in gold mining in Ontario, because of the great number of failures up to that time, but even at the time when some of the larger mines were 800 and 1,000 feet deep, few really grasped the situation as to the great depth and permanency of the veins. These facts have only been generally acknowledged in the past two or three years and are now proven by not only deep mining, but by deeper drilling. The Hollinger is sinking to 3,000 feet, Dome’s deepest workings are at 1,900 feet, while McIntyre mine has its new shaft’s objective, 4,000 feet. These properties are producing on a very large scale, with smaller operations such as Consolidated West Dome Lake, Vipond and Night Hawk Peninsula mines with 120-ton plants. Ankerite and Paymaster are constructing mills of 250 and 120 tons capacity, respectively, the March mine constructing a small test mill. Coniaurum and Rochester are developing good values at depth, with several smaller operations being carried on. Extending easterly from this, the at present main section, this great belt includes the Night Hawk Peninsula mine at Night Hawk Lake, about 15 miles northeasterly from the Dome, and passes through the Munro-Lightning River areas, where the Croesus, Beatty, Harker and Abitibi mines, are situated and where other properties are being developed.

Continuing into Quebec discoveries have been made in 1925 in La Reine township, and near Amos on the Transcontinental Railroad. South and southeasterly from Porcupine, a distance of some 50 miles is the now prominent Kirkland Lake belt, including West Shining Tree, Matchawan, Kenogami, Kirkland Lake and Larder Lake in Ontario. Then further east on this same belt in Quebec are: Dasserat, Lake Fortune, Rouyn, Hurricanaw and Bell River.

The greatest activity on the Ontario side centers around Kirkland Lake, where such properties as Teck-Hughes, Wright-Hargraves, Lake Shore, Sulvanite and Tough-Oakes are opened to depths of 1,000 feet or more. Further east from these properties, about 12 miles, the Augonaut is producing and Crown Reserve and Associated Goldfields are developing ore reserves, and plan mill construction soon. At a point about 25 miles east of the boundary between the provinces in and adjacent to the township of Rouyn, phenomenal results are being obtained, particularly at the Noranda-Horne, at Amulet and upon the Waite-Montgomery. The total length of this belt, extending from West Tree in Ontario, to the Bell River in Quebec, covers about 200 miles. South of the Kirkland and Larder Lake areas is the section of Boston Creek. The recent finding of greater values at depth and the placing in operation of a mill on the Barry-Hollinger has been the cause of renewed activity here, and there are some very important developments taking place.

Establishment of the fact that values persist with depth, as shown by the work that has been done in the newer camps, there has been the tendency in the last year or so, to revive the older camps, and so far success is being met with in several instances. The Goudreau Gold Mines in the Goudreau district of the Michi-pocten Section, after two years of deep development, recently began operating a 100-ton mill. This property will make its first “clean-up” the last of the year. Exploratory work is being carried on at several other properties in that locality. At the Old Foley mine,
near Mine Center, and west of Port Arthur about 100 miles, a cyanide plant is being erected by English interests. The ultimate mill capacity is expected to be 300 tons per day. This property has been extensively drilled to considerable depth. In the Lake of the Woods district there is renewed activity, after many years of inactivity. This section used to be Ontario's greatest gold camp.

Western Ontario is deserving of greater attention and will, it is felt, become prominent again. Interest is also centering at such points as: Wanapiti, Flying Post, Beardmore, Wabigoon, Schreiber, Onaman, Tianago, Kawkask and Taskota and recent finds have been made as far north as Patten River and Red Lake. The extent to which formations carrying gold are known to exist are shown on the accompanying maps.

THE QUEBEC SECTION.

While nothing of great import has been definitely proven outside of Noranda-Horne, and possibly Amulet, the activity on the Quebec side of the inter-provincial boundary is remarkable in that it covers about twenty-two townships. The main belt is over eleven townships long east and west, and five townships, north and south. These townships are ten miles square, as compared to Ontario’s townships, which are six miles square. The most extensive development work being carried on is at Lake Fortune in Boischatel, the entire township of Rouyn, in the townships of Dufresnoy, Cadillac, Fourniere, Dubuisson, and in the neighborhood of the Bell River. The foregoing is what has been referred to as the eastern extension of the Kirkland Lake Belt. Also what is considered as the eastern extension of the Porcupine-Lightning River belt, is found in La Reine and Destor Townships, and further east at Amos on the Transcontinental Railroad. At various points along the Rouyn belt sinking plants have been installed and work is progressing on levels as deep as six hundred feet. Located in what might be considered the center of this extensive area is the Home property, developed since the fall of 1922, by Noranda Mines. This is a most unusual and interesting property in that the mineralized zone has been traced on surface for over 2,000 feet and is said to be about 1,400 feet wide.

The ore in the main zone has a content of $5.57 in gold and 5.66 per cent in copper, giving an average value of $20.29 per ton, figuring copper, at 13 cents per pound. Reserves in this ore body, to a depth of about 100 feet, are in the neighborhood of $13,000,000. The No. 1 shaft has reached a depth of 300 feet where development is progressing. According to the 1924 report of the Noranda Mines, Ltd., this shaft is in massive sulphides, and to a depth of 111 feet the ore from the shaft averaged $44.45 per ton. The “A” lense at this depth shows a width of 40 feet of ore of $53.12 average value per ton. Lense “B” at this same level is 61 feet wide and averages $27.00 per ton. Lense “C” is 45 feet wide averaging $20.48 per ton. Diamond drilling has proven ore zones to 720 feet vertically. A total of about 20,000 feet of drilling has been accomplished disclosing other ore zones. One of these zones is stated to show a width of twenty feet with an average value of $44.34 in gold. Unofficial estimates place ore reserves above the 300 foot level in excess of $20,000,000.00. Plans now underway call for a smelter. This, together with projected mine developments, it is thought, will cost in the neighborhood of $4,000,000. There is no question
but what the Horne is one of the large mines of the Dominion. Quite remarkable results are also being obtained on Amulet, on three distinct groups of claims. While only surface and tunnel work so far have been done results show values of $5.00 in silver, $12.00 in gold and 9 per cent copper, per ton. Several millions in value are said to have been proven. Further north in Duprat Township is the latest sensation of the Quebec Section. Upon the Waite-Montgomery a sulphide zone has been located, the dimensions of which are 100 feet wide by 175 feet long and thus far has disclosed assays of $40.00 and higher per ton. Drilling operations are to begin here soon.

Note 1—Figures used in connection with ore values on the Home main ore body were taken from the Quebec Bureau of Mines 1924—Report on Mining Operations in the Province of Quebec. Figures in connection with shaft to 111 feet and lenses A, B, and C, were taken from the Noranda 1924 Annual Report.

Note 1-2—Figures used in connection with ore values on Amulet and Waite-Montgomery were taken from the Northern Miner.

THE “RUSH” IN QUEBEC.

Since 1922 and to the close of 1924 there have been staked over 300,000 acres of mineral lands between the Ontario boundary and the Bell River, in Quebec. Such staking activity is unprecedented in Canada, and at present the activity is at its height. There are hundreds of explorations going on, many diamond drills at work, and the area is alive with prospectors, engineers and mining men. One of the unique features of the Rouyn Camp is that daily air service is maintained, taking both mail and prospectors from Haileybury, Ontario, a distance of sixty miles, to Rouyn City. During 1924, this air service made 861 flights, carrying, besides 425 passengers, 64,964 pounds of baggage, freight and mail, without a mishap.

It is expected that by the fall of 1926 the railroad will have been completed from O’Brien, on the Transcontinental line, a distance of forty-five miles, to the Horne property and Rouyn City.

GEOLOGICAL FEATURES AT PORCUPINE.

The Porcupine ore deposits have been discussed at length by many eminent geologists, and while there is considerable variation of opinion, as to the source of the gold, it is now felt that the Algoman porphyry intrusions are not the source from which the gold was derived, as originally conceived, though it undoubtedly caused favorable structural conditions. It is interesting to note in this connection that quartz veins adjacent to and intruding the porphyry carry little or no gold, but that these same veins with the accompanying basic green Keewatin schists, carry an increasing amount of gold as greater distance is reached from the porphyry mass.
Undoubtedly the source of mineralization was deep seated and the ore bodies formed under high temperatures. Evidence of this is to be found in the occurrence of Scheelite and Tourmaline in the ores. In the action that took place, gold was precipitated last, in the brecciated quartz and schistose greenstones, which brecciation and schistosity was caused by the intrusive porphyry masses.

Most of the veins or lodes are of the quartz-pyrite-gold type, in which are to be found auriferous pyrite predominating, calcite and chlorite. In rarer instances, galena, sphalerite, tourmaline and feldspar, are to be found. Native gold is also often found in the brecciated quartz. The iron pyrites are usually very fine grained. Throughout the area the general strike of the veins is northeasterly and southwesterly and they are numerous and parallel. They averaged in gold for 1924, about $8.00 per ton at the Hollinger, $9.40 at the McIntyre and about $10.00 at the Vipond. The veins average in width about 12 feet, and up to 1,800 feet in length and carry downward from level to level with great persistency.

While the foregoing applies more particularly to the Vipond-Hollinger-McIntyre series of veins, at the Dome the ores are found in the schisted Temiskaming sediments, mostly in the graywacke and conglomeratic phases. The striking difference here, as compared with the McIntyre section, is that the ore bodies do not usually persist downward from level to level, and it is often found that they lay only between levels. These ore bodies can be likened to raisins in a bread loaf. The original ore body at the surface was 250 feet wide and upwards of 900 feet long. A part of this was the original discovery and was known as the Golden Stairway. In the early days a guard was posted to guard it.
ore. Other associated minerals are copper pyrites, sphalerite, galena, arsenopyrite and pyrrhotite. Some tellurides have been found, as well as occasional tourmaline crystals in the “Brown Ores.”

**Porcupine Mining Features.**

In going through the underground workings of the great mines at Porcupine one can begin to appreciate the immensity of the situation, and it is only by doing so that the magnitude of the operations can be grasped. The many miles of tracks, the series after series of ore shoots, with here and there diamond drills penetrating new ground, miners working at the numerous faces of ore and electrically operated trains, that handle millions of tons of ore and rock annually, is a sight that is well worth going a long distance to witness. The veins at the Hollinger and McIntyre carry with great regularity from level to level. They average about 12 feet in width, though there are places where they widen considerably above this figure. Though lenticular, the lodes are sufficiently regular to allow stoping far in advance of the output. As a result the mines carry several hundred thousand tons of broken ore. According to the 1924 Hollinger report, the mine had over 850,000 tons of ore broken in stopes ready for the mill. Throughout the main section the veins as well as the wall rocks stand well during stoping operations, so much so that very little timbering is necessary. Shrinkage stoping is the general practice and with this method practically no dilution occurs. Diamond drilling is one of the important items in preliminary work as well as during mining operations. Many short holes are drilled to locate parallel blind veins and to direct stoping. Referring again to the 1924 report on Hollinger, it shows over 88,000 feet of drilling for that year. Sampling is a very important item, each development breast is sampled every five feet, and in stopes as high as 80 per cent is sampled. A typical sample is four inches wide and averages about a pound per linear foot. The mine workings are practically dry.

*Preparation of Ore for the Mills at Porcupine.*

Standing at the Timmins railroad station and looking across Miller Lake, which is now completely filled with tailings, one’s first glance at the Hollinger surface plant is somewhat of a surprise, and its magnitude creates a lasting impression, especially when one finds that the buildings cover about six acres of land. Then when it is realized that over 5,000 tons of ore, crushed to the fineness of powder, passes through this great plant daily, it is indeed an inspiring sight, particularly to one who is only familiar with the usual surface plants of the Lake Superior Iron districts. Going through this great plant, passing the many stamps, ball and rod mills, large tanks and Oliver filters is a most interesting experience. However, the only phase of the treatment of the ores discussed at this time will be its preparation for the mills.

In Hollinger’s practice, the ore is first crushed on the 1,550-foot level, passing through a 48-inch by 60-inch Buchanan jaw crusher, it is reduced to 8-inch size. It then drops to a 1,000-ton pocket on the 1,700-foot level, where it is hoisted to surface in 6-ton skips. (Skips to be increased to 7-ton capacity.) At the surface the ore enters through No. 7½ Gyratory crushers set at 4 inches. The fines pass through revolving screens, having 1¼ inch openings, the coarser materials going to four No. 5 Gyratory crushers and then by conveyor belt to bins where it is fed into three 60-inch by 24-inch rolls. All the ore is automatically weighed as it leaves the 4,000-ton crushed ore bin, and taken over an incline tram, in 6-ton cars, to the mill, where by conveyor belt it is fed to the stamp, ball and rod mill bins. These bins have a combined capacity of 5,600 tons daily. The above operations take place at Central shaft, which has a total height from the mill loading pockets to the sheave wheels, of 260 feet.
At the Dome mine ore is crushed to 9 inches underground, at the 850-foot and 1,450-foot levels. It is then hoisted to a 300-ton shaft house bin and then delivered to crusher building by means of a 24-ton car. A Gates Gyratory No. 7½ crusher reduces ore to 4½ inches and then it passes through two jaw crushers reducing size to 1½ inches. The ore then passes over 42-inch by 18-inch surface rolls, reducing size to 1-inch. From here the ore is taken to top of mill and fed to forty stamps and three ball mills. The ball mills handle 75 per cent and the stamps handle the remainder.

At the McIntyre mine all ore is brought to the surface before being crushed. It then passes through a No. 7½ Allis-Chalmers Gyratory crusher, and is fed to two 60-inch by 30-inch Traylor rolls by belt conveyor. The ore is then transported in 1,200-pound buckets, by aerial tram, to the mill, a distance of about 1,000 feet. At the mill the ore is taken from the bins by conveyor belt to the two Hardinge 8-foot by 3-foot ball mills, which travel at 224 r.p.m. They total about 36 tons when in operation and carry about 36 per cent moisture. Thence the material enters tube mills and Dorr classifiers. Details can be seen on the accompanying flow sheet. The mill crew consists of 38 men and the total cost per ton of ore milled is about $0.95.

**FACTS ABOUT PORCUPINE.**

Statistics are usually dry affairs, however, figures tell a better story than any narrative that might be written. Therefore, it seems advisable to give a few facts that will bring out the great extent of past and present operations, and, in contemplation of the future, even greater things can be looked for.

**HOLLINGER.**


Note—The data on crushing was compiled from Volume 33, part 2, 1924, Department of Mines report on the Porcupine area and balance of information on cyanide processes of the Dome, Hollinger, McIntyre, Vipond and Consolidated West Dome Lake, is obtainable through this source.

Upon these properties production has come from about 60 veins. Since commencement of operations, and to the close of 1924, approximately 9,500,000 tons of ore have been mined. Hollinger is considered the greatest gold-quartz mine in the world. The mine is at present paying $393,000 in dividends every 30 days, making the impressive annual dividend total of $5,108,000. The company’s surplus is approximately $9,000,000. The number of men employed is 2,758 divided as follows: miners 1,719, mechanics 436, mill men 26, engineers 91, clerks 48, miscellaneous 204. The average wage is $5.10 per day. There are 1,500 samples taken each day. All ore is handled through Central shaft. This shaft is 2,400 feet deep and has 6 compartments, four of which are skip-ways. The Schumacher shaft is being sunk at the rate of 250 feet per month with 3,000 feet as the present objective. It is stated that the Hollinger has over 70 miles of underground workings.

The recent installation of a new compressor, driven by a 1,645-h.p. motor, gives an additional 10,000 cu. ft. of air, and adds 100 drilling machines to the mines expansion plans. At present there are 240 drilling machines used and the drill sharpening plant handles over 10,000 drills per day. It takes approximately one year to mine out a level. Of the $59,000,000 in reserves shown in the annual report at the close of 1924, slightly over $1,000,000 is all that is included in the total below the 1,400-foot level. Vein 84 is said to have a total value of $21,400,000, of which $5,500,000 remains to be drawn. Last year this mine produced 1,659,475 tons through its central shaft. This is equivalent to 33,100 freight cars of 50 tons capacity. Contrast Hollinger’s record of $26,000,000 in dividends in 14 years, with the great Homestake’s record of 825,640,000, in dividends in the last 20 years. The Homestake is the largest United States gold mine. The mill handled 4,559 tons daily in 1924. Present plans are to handle 6,000 tons per day and 1926 will probably see 8,000 tons per day produced.

**MCINTYRE.**

The McIntyre Porcupine Mines is composed of the Pearl Lake. McIntyre, Plenaurum and Platt Veteran claims. McIntyre has a
surplus of over $3,000,000, is producing about $300,000 per month, with the mill handling 1,100 tons per day, and is at present paying 20 per cent dividends. There are six veins from which the foregoing production has come. No. 7 vein is stated to show a value in production and ore reserves of over $13,700,000 and is one of the big veins of the district. On the 2,175-foot level this vein has a length of 1,800 feet, is 7½ feet wide and averages about $9.00 per ton. No development work has been done on this vein below the 2,750-foot level. The main shaft has reached a depth of 3,000 feet. The new shaft now being sunk, has 4,000 feet as its objective, is 20 feet 4 inches by 13 feet 8 inches outside dimensions, has five compartments, will cost in the neighborhood of $2,000,000. This shaft will be the deepest shaft in Canada and is considered as one of the greatest achievements of the North. The mine employs 800 men. Mining and milling costs are about $3.10 and $0.95 per ton respectively, while the average gold recovery for 1924 was $943 per ton.

Note 1—Northern Miner.
2—Ontario Department of Mines.
3—Estimate.

**DOME.**

The Dome Mines, Ltd., is composed of the Dome and Dome Extension. For the first 6 months of 1925 Dome had an average recovery of $8.12 per ton. Dome’s greatest underground ore body is 140 feet wide in places, and 600 feet long. As far as width is concerned this is the largest body of gold ore in Canada.

**GEOLOGICAL FEATURES IN THE KIRKLAND-LARDER AREA.**

As in the Porcupine section the general trend of the mineralized area is northeast-southwest. There are three major zones. At Kirkland Lake, the main section of this area, are located the Teck-Hughes, Lake Shore, Wright-Hargraves, Tough-Oakes, Kirkland Lake and Sylvanite, extending over a distance of about two and one-half miles along a complicated faulted zone, which cuts conglomerate, syenite and feldspar-porphry, the principle rocks of the district. This fractured zone consists of a series of faults, which in some instances form the foot and hanging walls of the ore bodies. The general dip of these faults is about 83 degrees south and while they have a general trend as stated above, the distance between walls vary in widths up to 40 feet. While the ore usually occurs along one or the other wall, there are places where the ore exists over the entire 40 feet, between these walls. The characteristic ore is a brecciated mineralized red porphyry, carrying blue quartz bands and has as filling, ankerite, iron pyrites, sericite, native gold, and the tellurides, calaverite and altaite. On the 1,000-foot level of the Lake Shore, ore shoots are said to aggregate 1,800 feet in length.
The next zone of importance is at the Argonaut mine, about 12 miles east of Kirkland Lake. Here there are a series of parallel veins which carry a percentage of copper. Southeasterly from the Argonaut is the third zone, upon which the Crown Reserve and the Associated Goldfields have been developing to depths of 1,000 feet. The mines of Kirkland Lake are unique in that the ores carry a higher gold content on an average than do the ores at Porcupine. The 1924 annual report of Lake Shore gives as the average recovery $23.97 per ton. Wright-Hargraves has had an average recovery of $11.31 for the past three years; Teck-Hughes in 1924 showed an average of over $23.00 per ton. Until recently, all the mine workings have been shallow. Now, however, the Kirkland Lake mine is developing at a depth of 1,975 feet, Teck-Hughes is sinking a new shaft 1,700 feet, to develop high grade ore cut by diamond drill, and other properties are working in the neighborhood of 1,100 and 1,300 feet.

The Kirkland Lake mine operations at about 2,000 feet have been watched with much interest, and it is gratifying to know values are running $40.00 per ton at this depth. This is another proof of the deep seated origin of the gold ores of Ontario and is also proof of increased values at depth. The Kirkland Lake mine now proposes to sink to about 3,000 feet. There is a great deal of development being carried on throughout these sections upon other shear zones and considerable success is being met with in several instances.

MINERALIZED PORPHYRY WITH QUARTZ VEINLETS, SHOWING FAULTING-FACE, IN WEST DRIFT, NO. 1 VEIN, 300-FOOT LEVEL, LAKE SHORE MINE.
taxation. It is conducive of development, of large ore reserves, which are, or should be, a benefit to a country. The rate of tax is: 3 per cent on profits in excess of $10,000, and up to $1,000,000; 5 per cent on profits in excess of $1,000,000 and up to $5,000,000 with a slightly increasing rate above $5,000,000. With an exemption of $10,000 the smaller properties are given a chance, and where profits may be $20,000, 50 per cent is exempt from taxation; whereas if profits are $100,000, 10 per cent is exempt, and so on.

MINING LAWS.

To acquire mining claims it is necessary to obtain a miner’s license which costs $5.00 per annum. This allows the holder to stake three 40-acre tracts of Crown Lands, upon which the license gives privilege to prospect. These claims must be properly marked by corner posts and the claim staker must file application for claims within fifteen days of the staking, at the office of the nearest Mining Recorder. If the claims become of record, then the staker has five years in which to do 200 days assessment work. Thirty days’ work must be completed within three months of date of recording. Then four annual installments must be performed of 40 days each. The balance of ten days may be performed any time within the five-year period. Patent is granted within six years of recording, provided assessment work has been completed within the specified time, upon payment of $2.50 per acre in unsurveyed territory. This makes the holder the owner in fee simple; thereafter the claims are taxable at 5 cents per acre per annum.

RAILROADS.

Railroads have always played an important part in the opening of new mining sections and this applies to Canada probably more than any other country. It was the building of the Canadian Pacific that found Sudbury, which has produced over 80 per cent of the world’s nickel. It was the building of the Temiskaming and Northern Ontario in 1903, from North Bay to the farming section at the north end of Lake Temiskaming, that caused the discovery of the famous Cobalt Silver deposits. Cobalt and the surrounding territory has mined over 350,000,000 ounces of silver. The extending of this line north from Cobalt was the indirect cause for the discovery of Porcupine. To supply the mines and explorations along the Kirkland-Larder Lake section a branch line has recently been constructed as far as the Crown Reserve mine, and will shortly be finished to the Quebec boundary line, a total distance of about thirty miles. From south of Cobalt, a branch line has recently been completed to the South Lorrain silver area, a distance of about eighteen miles. At South Lorrain are located the Keeley silver mine and Mining Corporation’s properties and many explorations. Now, the forty-five mile branch line from O’Brien on the Transcontinental to Rouyn, Quebec, is to be completed before the close of 1926, to supply the needs of that rapidly developing area.

HYDRO-ELECTRIC POWER.

During the years from 1910, when the first units were built for mining purposes, and up to 1:920, there was a gradual increase in hydro-electric power. However, from 1920 to 1924 a serious situation developed that has only recently been rectified. The mines, during this period, were in the process of rapid expansion and new mines were demanding power. In 1922 and 1923, during the low water periods, acute shortage was felt and the mines were forced to curtail production for a time, with no chance of expanding operations. In 1924 this condition became relieved with the bringing in of 20,000 h.p. from the Kakake Falls, Quebec plant which is located 75 miles Southeast of Porcupine. This year will doubtless see the completion of the Island Falls plant, located about 80 miles north of Porcupine. Present turbine capacity is over 74,000 h.p. and upon completion of the Island Falls station on the Abitibi River, there will be a total of about 100,000 h.p. available for mining purposes. This should be sufficient to supply any increase in demand for several years to come.

PRESENT AND FUTURE PRODUCTION.

It is interesting to note the marked advancement of Ontario’s gold output for 1925 over 1924 and it is also interesting to contemplate what the year 1926 will show in the way of an increase in tonnage of ore milled. For the first six months of 1925, a marked improvement occurred. The total from the two main camps was over $14,578,000, whereas for the same period of 1924 only about $12,834,000.
POWER HOUSE UNDER CONSTRUCTION AT STURGEON FALLS, MATTAGAMI RIVER. LOCATED 30 MILES NORTHWEST OF THE PORCUPINE CAMP. HAS A CAPACITY OF ABOUT 10,000 H.P.

With the exception of the years of the war, and the period during which power shortage existed, production from the gold mines has shown a rapid increase. This has been due not only to the increase of milling capacity at the larger mines, but by the addition, from time to time, of new mills. The addition of new mills is undoubtedly more noticeable at this time, and for 1926, than at any previous period in the history of Ontario and by the close of 1926 there is the possibility of the total mill capacity being double that of 1924.
Notes: 1—Produced $1,079,591. Idle during development on 2,000-foot level.
2—Commenced milling in October, 1925.
3—First producer at Kirkland Lake.
4—Commenced milling in 1925, at 50 tons.
5—Produced $2,871,847 to 1921, idle at present.
6—Idle during development.
7—Contemplated.
8—Under construction.
9—Closed.
10—Capacity not known—possibly 1,000 tons.

CONCLUSIONS.

Of the many countries that produce gold, there are few showing any recent gain in their gold production, and no really important discoveries have been made in the United States for a long period. In the many articles written on the depletion of mineral reserves or the finding of new mineral fields, the mention of the Ontario section is the only reference made of important gold discoveries in recent years. It is true, Canada while being third in order of production is far behind the Transvaal. In 1924, the Transvaal had a record of $198,000,000. The United States $51,900,000 and Canada $31,500,000.

But in reality Canada is young in the production of gold in any quantity and when I speak of Canada, I refer more particularly to the Pre-Cambrian shield, of which Quebec, Ontario and Manitoba make up the larger part. No real interest has been taken in these fields by the outside world, except in the producing mines, until the last two years. It has been with great difficulty that the Canadians have interested any large amount of outside capital. Now, interest is developing in sections of the newer camps which have heretofore been considered as having little or no value, and renewed interest is shown in the older sections which were abandoned years ago, and the indomitable will of the prospector keeps reaching out for new fields to explore.

All this is due to several reasons. Probably the most important of which is the present familiarity with the formations that have heretofore been more or less of a mystery. Also the knowledge now at hand as to the great depth and permanency of the gold bearing formations, and the conviction that management, scientifically directed, can make many properties, formerly overlooked, or abandoned, payable mines. It is needless to say that this country is deserving of greater attention, and remarkable as has been its progress, even with the many obstacles that have in the past arisen, this country is on the eve of a period of activity that will make it one of the greatest precious metal mining countries of the world.

It would not be fitting to draw this article to a close without making reference to the men who have been and are now, identified with the mining industry of this wonderful and productive country:

To the governmental departments, which have in charge the study of the districts and the publication of geological information, great honor is due. To the people of Canada, who have given their support for the advancement of this great mining industry, much credit is also due. To the management of the mines, their efficiency and aggressiveness, their willingness to suffer the hardships, to overcome obstacles, to the end of increased production and greater profits, through economical operation, is a mark of distinction that will go down in history as a great achievement. To the prospector, probably the most interesting character of the “North Country,” who suffers much and usually gains little, who tramps the unexplored areas, and fights the elements, to search out the treasures of the earth, all credit is due. For, were it not for these staunch men of the wilds, there would be no Porcupine, no Kirkland Lake, no Rouyn.

To all of these I owe a debt of gratitude, for assistance, courtesy, and many interesting experiences.

BUSH.

“May you suffer from the pack—
Sack upon your blooming back;
May you hit a trail where windfalls interfere;
May you curse the murd’rous flies
That close up both your eyes—
But as sure as fate you’ll hustle back next year.

Be it river, be it lake,
Be it muskeg, (watch it shake!)—
It’s the life that gets its grip upon a man
So it’s no use saying ‘No’!
You have simply got to go
Quick in answer to the bush-call—if you can!”

J. C. M.

Courtesy of Canadian Mining Journal.
FORESTRY AND THE MINING INDUSTRY IN THE LAKE SUPERIOR REGION.

BY RAPHAEL ZON, UNIVERSITY FARM, ST. PAUL, MINN.*

Not infrequently one hears statements to the effect that present-day civilization is founded on iron, coal, and concrete, that the use of wood belongs to a more primitive stage of civilization, and, therefore, if wood were to disappear altogether there would be no halting in our progress. How little these good people understand the dependence of underground mining for metal or coal upon wood?

They need only to be taken to some deep iron mine in the Lake Superior region and made to watch the long lines of mine cars loaded with lagging, cribbing, and stubs collected around the collar of the shaft, waiting to be lowered into the bowels of the earth. They would learn what an insatiable “monster” the mine is, with the shaft as its mouth, greedily devouring enormous quantities of timber. Night after night, month in and month out, whole forests are thrown down the maw of this monster in a vain effort to satisfy its hunger, and still it continuously clamos for more and more.

For every ton of ore mined, for every ton of coal dug, the forest must pay a tribute. Close to 300,000,000 cubic feet of timber are annually consumed in the mining operations of this country, aside from the large quantity of lumber used by the mines in shafts and surface construction. This may not seem big in comparison with the total timber consumption of the United States, amounting to nearly 22½ billion cubic feet a year, but the cost of timber is becoming an important factor in the rapidly increasing items of expense in mining.

The amount of wood used in underground mining varies with the kind of mineral mined, the nature of the deposits, and the methods of mining. Experience, however, shows that the average quantity of timber used per ton of mineral mined is 0.33 cubic foot per ton for bituminous coal, 0.7 cubic foot for anthracite coal, 0.9 cubic foot for iron ore (underground mining), and 0.75 cubic foot for other ores—gold, copper, lead, zinc, etc.

Based on the quantity of iron ore mined from underground workings in the Lake Superior region in 1920 and the average timber consumption of 0.9 cubic foot per ton of ore mined, the Federal Bureau of Mines estimates the total annual timber consumption of mining in the Lake Superior iron ore district at 27,500,000 cubic feet, exclusive of the lumber used by the mines in other construction. According to Government statistics collected in 1905, the consumption of round timber in the Lake Superior iron mines was about 12,000,000 cubic feet. In the last 15 years, therefore, it has increased two and a quarter times.

In 1905, the average cost of round timber in the Lake Superior iron region was 5 cents a cubic foot and of sawtimber $12.30 per thousand board feet. The present average cost for all varieties, ranging from 6 to 14 inches in diameter and in length from 8 to 16 feet, is about 16 cents a cubic foot, delivered. The average cost of mine timbers within the last 15 years has risen, therefore, about three times. The annual bill for mine timber alone used in underground workings in the Lake Superior mines is, therefore, close to $4,500,000.

No figures are available of the amount of lumber used by the iron mines of the Lake Superior region in surface construction. It would be safe, however, to place it somewhere in the neighborhood of 25,000,000 board feet a year. At present, the average price of lumber is probably not less than $35 per thousand, delivered to the mine. This adds another million, dollars to the timber bill of the iron mining industry, making a grand total of some 5½ million dollars.

It is surprising how varied are the forms in which timber is used in underground mining—posts, caps, collar braces, lagging, cribbing, angle braces, blocks, head blocks, booms, scabs, spiles, sprays, stringers, stubs, and wedges.

In addition to the mining timbers proper, there is much lumber and dimension stock used in miscellaneous mine and mill equipment, such as chutes requiring timbers and planks cut to a standard measure, hundreds of running feet of ladders, guides for the cages, track ties, mine cars and trucks, tanks, launders, conduits, concentrating tables, jigs, flotation machines, classifiers, battery blocks, foundation timbers, and even the small powder sticks 6 or 7 feet long and 1½ inches in diameter, apparently of little consequence, yet footing up in the aggregate to a considerable total.

To complete the picture, mention should be made of the large quantities of lumber used in surface structures. Wood is still used wholly or in part in the construction of headframes, shaft houses, breakers, tipples, tramways, ore bins, coal bunkers, trestles, flumes, concentrating mills, stamp mills, mine buildings, timber framing and carpenter shops, blacksmith shops, machine shops, power houses, change houses, and supply houses. However, steel and concrete is now more generally used at the larger mines for surface structure and shafts.

*Director, Lake States Forest Experiment Station.


Yes, iron and coal are undoubtedly the foundation of our present-day economic and industrial life, but these industries in turn largely depend upon a supply of timber.

So far no other material has been found that can meet the varied conditions of service required in underground support as wood. Economies in the use of mine timber are possible. The preservative treatment of wood,
salvaging of mine timbers, and similar measures may
tend to reduce the cost of mine-timber maintenance, but
the problem of a continuous timber supply will ever be
present. Mining and forestry, therefore, are closely
interwoven.

In the past, and even today over still large areas, parallel
with mining of minerals underground there is going on
“timber” mining on the surface. The race, apparently, is
between mining of minerals underground and mining of
timber on the surface, as to which will be exhausted first.
Will the mineral mine be exhausted before the “timber”
mine, or the timber be gone before the richer deposits
underground are worked out? Such race need not exist,
because the forest, unlike the mine, is a renewable
resource which generously responds to human effort.
The forest, if properly handled, can furnish all the mine
timbers the industry will need and still continue to be a
source of wealth long after mining in the locality may
become unprofitable. In the shifting changes of values,
with the possible development, for instance, of new iron
deposits in Brazil or elsewhere, who knows whether the
forest on the surface in the long run, say within the next
30 or 50 years, will not prove to the owner a more
valuable asset than the ore underground.

In some mining regions the problem of obtaining mine
timber is becoming difficult as, for instance, in the
anthracite region of Pennsylvania. The Pennsylvania
coal mines in 1905 paid on the average 6.6 cents per
cubic foot for round mine timber and $15 per thousand
board feet for sawed lumber. In 1921 the cost had
advanced to 27½ cents per cubic foot for round timbers
delivered to the mine. Of this 57 per cent represents
freight charges. Twenty to twenty-five years ago in the
anthracite region the best grades of red and white oak,
chestnut, and pitch pine timber could be obtained locally.
At present, perhaps, 75 per cent or more of the timber
used in the Pennsylvania mines is second-growth yellow
pine, shipped in largely from the South. The average
quality of timber now being used is greatly inferior to that
of similar species 15 to 20 years ago. It has even been
reported that some anthracite operators have tried to
obtain shipments of Douglas fir brought by Ships from
Oregon by way of the Panama Canal.

In the bituminous districts of central and western
Pennsylvania mine timber has become more and more
difficult to obtain. Round timbers, such as props, ties,
posts, and caps, are shipped in from distances one
hundred to several hundred miles from the mine.

Practically from every mining region reports come that
the more durable varieties of timber are becoming
scarcer and the source more remote from points of
consumption. Consequently less durable timbers must
now be used in many localities. As the lumber industry
in the region declines, the supply of mine timber
becomes scarcer and more costly, because in many
places the mine timber is a by-product of the lumber
industry. There is a close relationship between the cost
of mine timber in the mining region and the distance
from which the mine timber must be obtained.

There is still a fairly plentiful supply of mine timber in the
Lake Superior region, although its quality is now poorer
and the cost is three times greater than it was 15 years
ago. Instead of the white and red: pine, there is now
being used a great deal of jack pine and hemlock and
also such hardwoods as hard maple and yellow birch,
also small quantities of tamarack, ash, elm, and spruce.
The mining industry of the Lake Superior region, if it had
given to the forests a fraction of the thought that it gives
to the improvement in mining processes, would have no
need to worry as to where the mine timbers of tomorrow
will come from.

As a general rule, the larger mining companies own
large tracts of timberland, as it is a common policy with
them to own the surface as well as the underground. If
there is any class of timberland owners who should give
thought to the perpetuation of their timber supply, it is
the mining companies. Some of them began their
mining operations in the early 40’s of the last century,
and some of them will be still mining in the same region
after the 20th century has rolled by. Since it is of
advantage for a mining company to own the surface, the
obstacles which the average timberland owner may
rightly or wrongly conceive to be in the way of the
practice of forestry do not exist, at least in the same
measure, in the case of such mining companies. They
carry the land whether they grow timber on it or not.

What, then, should be the policy of the mining industry,
as a whole, towards the forest lands in the Lake Superior
region? Should it be the average lumberman’s
shortsighted policy of removing the old timber as fast as
possible, letting the cut-over land be burned and become
idle, or will it be a longer view of handling the
timberlands as a renewable resource, protecting it from
fire, so that the land, besides supplying continuously
mine timbers and lumber needed by the industry, may
also be an independent source of wealth to the owner.

First, how large a forest area would be needed to
provide the mining industry of the Lake Superior region
with a continuous supply of mining timber and sawed
lumber. The total annual consumption of wood,
including sawed lumber, by the mining industry of the
Lake Superior region may be placed close to 30,000,000
cubic feet. At an annual production of only 40 cubic feet
per acre, an area of some 750,000 acres under forest
management would be sufficient to maintain a
continuous supply of timber for the mines.

The present forest area, partly in old timber and partly
cut over and burned over, is not producing on an
average such an amount of timber a year. It may take
30 to 50 years before such an area can be brought up to
produce this amount of growth continuously. In the
beginning, it may, therefore, be necessary to draw upon
a much larger forest area, say two or three times as
large, or about 2,000,000 acres. Such an area would
probably also take care of any future increase in the
mining output and, therefore, of any increase in the
present mine timber consumption. Two million acres are
only a fraction of the forest land now available in the
Lake Superior region which is not being used for any other purpose and which will not be needed for agricultural use for several generations to come, if at all.

So much for the needs of the mining industry as a whole. Concretely, however, the problem must be faced separately by each individual mining company. What, then, can the individual mining company do towards providing a plentiful supply of mine timbers at a reasonable price?

Conditions, of course, will vary with each individual company, the size of its operations, whether it is located within a region of abundant farm woodlots or whether or not it owns forest land, and the character of the timberland owned by it. If mining operations are carried on within a fairly well-settled wooded region, it may be more economical to depend for its mining timbers upon the farmers growing such timber in their woodlots. If the market is good, the farmers may be interested to grow such timber for the mining companies. In the Lake Superior region, however, settlement is still sparse and while there may be some settlers who in clearing their land would cut some mine timbers, this supply is not certain and cannot be solely relied upon by any large mining company.

The measures which the mining company, owning forest lands, can economically adopt will vary according to the character of its timberlands. If the company still owns large tracts of mature timber, the problem is comparatively simple. It involves merely the adoption of conservative logging methods and protection of the timber left on the ground. If most of the timber has already been cut off, the land badly slashed and burned over, the problem is more complicated. If the cut-over land contains some promising young growth or some sources of seed supply, rigid fire protection may bring about in the course of time a natural regrowth on the land. If the cut-over land is too badly burned and cannot be expected to come up to any new forest growth within a reasonable time, replanting may be the only solution.

Planting, however, should be resorted to only as an extreme measure because of its expense, the long-time investment involved, and the still large fire risk prevailing in the Lake Superior region. It cannot be recommended as a general procedure applicable to every mining company. There may be concerns which would be justified in undertaking planting operations on a large scale if there are no nearby sources of mine timber. England has recently started upon a large reforestation program and has planted up within the last five years some 30,000 acres to supply chiefly mine timber for English collieries. This is, however, a government undertaking. The government can afford to carry long-time investments for the benefit of the country as a whole.

The most prevalent type in the Lake Superior region, however, is the mining company which owns timberlands, part of which is still covered with old timber, part contains some second growth, while a larger or smaller part has been cut over and badly burned. Since these are the more typical conditions of the forest land owned by the larger mining companies in the Lake Superior region, they deserve chief consideration, while other conditions must be treated as special cases. As an illustration, we may assume a mining operation that requires, say, a million cubic feet of mine timbers a year. How should such a company, owning forest land partly timbered, partly second growth, and partly burned over proceed to provide for a permanent future supply of timber?

1. The first step is, of course, to determine thoroughly the actual amount of different kinds of mine timber, dimension stock, and lumber that such an operation requires now and may require in the future. The character of its requirements, whether large timber or small-sized timber are needed, will largely determine the method of handling its forest.

2. The next step is to take an actual inventory of the forest land owned by the company, both as to the amount of standing timber and second growth, and the area covered by each class of timber.

3. Some actual field data should be secured as to the annual growth that takes place on these lands.

4. On the bases of the annual requirements of the company and the possible growth on the land, there should be blocked out as close to the center of the mine operations as possible a sufficient area to meet the present and future needs of the mining company. Within this blocked-out area, there should be included sufficient old timber to supply the needs of the mining operations until the second growth and the burned-over land can begin to produce a supply of mine timbers.

5. The entire area, including the old timber, second-growth, and burned-over land, should be carefully protected from fire. Where the State provides adequate fire protection, the cost to the owner of protecting the forest land against fire will be small. Where the protection afforded by the State is still inadequate, the mining company should have a system of fire protection of its own. This should function, however, in cooperation with the State fire protection force.

6. The old timber should be cut in such a way as to utilize to the fullest degree the potential capacity of the soil. In other words, if the timber is cut clean it should be cut in such a way as to secure an immediate regrowth of the desirable species. Or, still better, only the mature timber that has already stopped growing or is growing very slowly should be removed, while the thrifty trees, still growing at a rapid rate, should be left on the ground to form the basis of a second cut. The badly burned-over areas should be assisted here and there, where natural regrowth is slow, by planting so as to get a uniformly dense growth over the entire area.

7. A carefully thought-out plan of utilization should be followed. In other words, where a certain kind of mine timber can be obtained from tops of trees, these tops
should be worked up into such products, instead of using young, thrifty trees or valuable old mature timber.

8. A wood preservative plant should be installed so as to prolong the life of the mine timbers and in this way reduce the drain upon the forest.

9. In certain types of mining, where it is economically justifiable, some of the mine timbers should be salvaged and used over again,

By such handling of the forest lands, if the bulk of the land is in hardwoods, an annual growth of from 40 to 50 cubic feet per acre may be obtained. If a large proportion of the land is covered with pines, jack, white or Norway, higher yields amounting to from 60 to 80 cubic feet per acre per year may be expected.

A point which must be borne in mind all the time is that no forest can be used to the greatest advantage if it is used for mine timbers only. A forest is a diversified crop. The greatest returns from a forest are obtainable when each kind of tree and each portion of the tree is used in the form of the product that brings the highest return. In a forest, therefore, there are always some saw-log timber, possibly some pulpwood, and a great deal of mine timbers and cordwood. A mining company, managing its forest lands, especially if it owns a large forest tract, should be prepared to be in the logging and lumber business so that it could dispose, to advantage, of the material that it does not need itself. Mine timbers, in a properly handled forest, may be made to a large extent a by-product of the lumber industry.

Certain kinds of mine timbers may be obtained from the tops of trees and the larger limbs. A great many mine props may be obtained from thinnings of too dense stands, and such thinnings will not only pay for the cost of logging but actually benefit the remaining timber by stimulating its growth and shortening the time in which the trees will reach the desired sizes. In a properly handled forest from 35 to 40 per cent of the product of the tree will be in the form of sawlog material, while the rest is in the form of mine props, ties, and cordwood.

A mining company, therefore, that needs about a million cubic feet a year, if it wishes to have a continuous supply of mine timbers of its own should have a minimum of 25,000 acres of well-stocked forest. If the land is not fully stocked, or there is a too large proportion of young second growth or a great deal of land of low productivity, this area, at least in the beginning, should be considerably larger. At present, taking all kinds of land—old timber, second growth, and burned-over land—the growth is probably not over 15 to 20 cubic feet per acre per year. Under such conditions, it would not be safe to start with an area less than 50,000 to 60,000 acres.

What should be the cost of such forest practices? It is difficult to say definitely, as there are only a few companies that have actually put such a plan into operation, and, therefore, there are not many cost figures available. One mining company, at least, in the East which handles its forest on such a basis feels that it is a paying proposition. From the experience of handling National Forests, it is safe to estimate that the cost of handling the forest lands on such a basis, aside from taxes, should not exceed 20 to 25 cents per acre per year, or for an area of some 50,000 acres, about $12,500 a year. Such an expenditure will not only provide a future supply of mine timber, but it will repay itself many times in a more efficient utilization of the forest products and in the increased value of the land. This cost will naturally vary with the efficiency of fire protection afforded by the State. Where the State assumes the entire responsibility for fire protection and can render effective service, this cost may be smaller. Where, however, the company must assume the larger burden of fire protection, the cost will be higher. The possibilities of handling profitably the forest lands on such a basis will also be influenced by the existing system of taxing cut-over land. Both forest taxation and forest fires, however, are being gradually solved in Michigan and Minnesota, and within a few years they may not be as bothersome as in the past.

The mining companies, especially those which own their own forest lands, are therefore, confronted with the alternative of either handling their forest land as a renewable resource, providing a continuous and ample supply of mine timbers for their mining operations at a reasonable cost, removing the increasing difficulties and cost, in obtaining mine timbers, reducing the cost of mining operations, and creating a supplemental source of wealth, or allowing the land to become idle waste, either to be abandoned for non-payment of taxes or carried as a distinct burden upon the mining operations, and exposing itself to the hazards of seeking mine timbers at distant markets in competition with other wood-using industries.

Which will they choose?

EXPLORATION FOR IRON ORE IN THE LAKE SUPERIOR DISTRICT.

BY RALPH S. ARCHIBALD, NEGAUNEE, MICH.*

During the last twelve years there has been a great decrease in exploratory work for new deposits of iron ore in the Lake Superior district. Prior to this period, there were several diamond drill contractors employed continuously on the various iron ranges. Since that time, there has been a gradual falling off in the number of these exploration companies until at the present time there are only two or three engaged in this work, and they are employing a very limited number of drills, most of which are engaged in explorations to extend the limits of present known ore bodies.

The reason for this decrease has been the over-development of the mining industry. Prior to this date, a great many deposits on the Mesabi range had been explored, and were in the hands of large land or exploration companies. Since then, there has been a