

· PRODUCTION AND VALUE
OF
MINERAL PRODUCTS IN MICHIGAN
FOR
1916 AND PRIOR YEARS

MICHIGAN GEOLOGICAL AND BIOLOGICAL SURVEY

Publication 24.
Geological Series 20.

MINERAL RESOURCES OF MICHIGAN

WITH

STATISTICAL TABLES OF PRODUCTION
AND VALUE OF MINERAL PRODUCTS

FOR

1916 AND PRIOR YEARS.

PREPARED UNDER THE DIRECTION OF

R. C. ALLEN

DIRECTOR, MICHIGAN GEOLOGICAL AND BIOLOGICAL SURVEY



PUBLISHED AS A PART OF THE ANNUAL REPORT OF THE BOARD OF
GEOLOGICAL AND BIOLOGICAL SURVEY FOR 1916.

LANSING, MICHIGAN
WYNKOOP HALLENBECK CRAWFORD CO., STATE PRINTERS.
1917

BOARD OF GEOLOGICAL AND BIOLOGICAL SURVEY, 1916.

EX OFFICIO:

THE GOVERNOR OF THE STATE,
HON. ALBERT E. SLEEPER.

THE SUPERINTENDENT OF PUBLIC INSTRUCTION,
HON. FRED L. KEELER.

THE PRESIDENT OF THE STATE BOARD OF EDUCATION,
HON. THOMAS W. NADAL.

DIRECTOR,

R. C. ALLEN.

SCIENTIFIC ADVISORS.

Geologists.—Dr. L. L. Hubbard, Houghton; Prof. W. H. Hobbs,
Ann Arbor; Prof. W. H. Sherzer, Ypsilanti; Prof. E. C. Case,
Ann Arbor.

Botanists.—Prof. E. A. Bessey, East Lansing; Prof. F. C. Newcomb,
Ann Arbor.

Zoologists.—Prof. W. B. Barrows, East Lansing; Prof. J. Reighard,
Ann Arbor; Dr. Bryant Walker, Detroit.

LETTER OF TRANSMITTAL.

*To the Honorable, the Board of Geological and Biological Survey of
the State of Michigan:*

Gov. Albert E. Sleeper.
Hon. Thomas W. Nadal.
Hon. Fred L. Keeler.

Gentlemen:—Under authority of act number seven, Public Acts of Michigan, Session of 1911, I have the honor to present herewith Publication 24, Geological Series 20, the sixth of a series of annual statements of the production and value of the mineral products of Michigan.

Very respectfully,
R. C. ALLEN,
Director.

CONTENTS.

Letter of Transmittal	Page 5
-----------------------------	-----------

PART I. METALLIC MINERALS.

Michigan Copper Industry in 1916. Walter E. Hopper	15
Iron Ore Industry	67
Iron Ore Shipments by Districts	68
Marquette District	68
Gwinn District	74
Gogebic District	74
Menominee District	76
Crystal Falls District	78
Iron River District	80
Summary of Iron Ore Shipments by Ranges	82
Iron Ore Shipments by Counties	83
Graphic Record of Shipments from Michigan Iron Mines	82
Number of Men Employed in Michigan Iron Mines	83
List of Active Iron Mines	84
Iron Ore Reserves of Michigan	88
Appraised Value of Michigan Iron Mines	90
Value of Michigan Iron Ore Shipments in 1916	92
Costs, Profits, Losses, and Assessments Iron Mines of Michigan 1906-16	93

PART II. NON-METALLIC MINERALS.

Portland Cement Industry. R. A. Smith	117
---	-----

Miscellaneous Non-Metallic Minerals.

Salt	155
Gypsum	161
Coal	166
Limestone	173
Lime	177
Brick and Tile Products	178
Clay	182
Pottery	183
Sand-Lime Brick	186
Sandstone	189
Grindstones and Scythestones	192
Sand and Gravel	192
Glass Sand	194
Natural Gas	196
Petroleum	197
Mineral and Spring Waters	198
Marble	199
Shale	200
Slate	201
Trap	201
Graphite	202

CONTENTS.

Mineral Paints	Page
Quartz	202
Feldspar	203
Celestite	203
Summary Table of Mineral Products in Michigan 1911-16	204

PART III. RESULTS OF DEEP BORINGS. 209

APPENDIX.

Directory of Mineral Producers in Michigan for 1916	257
---	-----

LIST OF ILLUSTRATIONS.

	Page
Figure 1. Geological map of the Porcupine Mountains showing copper explorations and developments	17
Figure 2. Geological map of area between White Pine River and Lake Superior	21
Figure 3. Graphic records of the shipments of iron mines of Michigan	82
Figure 4. Geological map showing location of Portland cement plants and areas in which occur deposits of limestone and shale suitable for use in the manufacture of Portland cement	126
Figure 5. Map of known marl deposits in the Southern Peninsula of Michigan	132
Figure 6. Map showing location of mineral industries in Michigan	155
Figure 7. Section of Henry R. Ford Well at Dearborn, Michigan	248

PART I. METALLIC MINERALS.

THE MICHIGAN COPPER INDUSTRY IN 1916.

WALTER E. HOPPER.

MICHIGAN COPPER INDUSTRY IN 1916.

GENERAL REVIEW.

Michigan copper mines made a record production for the district during 1916. According to the U. S. Geological Survey, the total production of copper in Michigan in 1916 was 273,692,525 pounds, valued at \$67,328,361, and that of silver was 716,640 fine ounces, valued at \$471,549, a combined value of \$67,799,910. This is an increase of \$21,078,251, or 45 per cent, over the value of the output in 1915.

The average price of copper per pound for 1916 was \$0.246, compared with \$0.175 in 1915. The average price of silver for 1916 was \$0.658 per fine ounce; for 1915 it was \$0.507. The average value per ton of ore treated was \$5.34, compared with \$3.76 in 1915.

The smelter production, or the output of refined copper, in 1916 was 269,794,531 pounds, which represents an increase of 30,838,121 pounds over the smelter production for 1915.

In 1916 the amount of ore milled was 12,364,114 short tons, which yielded 420,551,291 pounds of concentrates and 268,279,876 pounds of copper. In 1915 the amount milled was 12,334,700 short tons, which yielded 400,178,132 pounds of concentrate and 265,283,378 pounds of copper. The average recovery of refined copper per ton of ore milled in 1916 was 21.7 pounds, compared with 21.5 pounds in 1915.

The year 1916 was one of unusual profits for the Michigan copper companies. A total of \$28,840,348.59 was paid in dividends by 15 companies. This amount compares with \$15,189,653 paid by 10 companies in 1915. Practically all the producing mines made an increased production, and with the high price received for copper sold, incomes from mining operations were exceptionally large. A number of the developing companies were able to increase operations, and two or three of the companies paid off all debts and ended the year with a balance of assets.

Production was forced to the maximum, and 1916 shows the largest production in the history of the district. Severe winter storms in the early part of the year, and consequent transportation trouble, affected the year's production, especially at the Ahmeek, Allouez, Centennial, LaSalle, Osceola, Mohawk and Wolverine. The princi-

pal factor which affected adversely the year's production at all mines was the general scarcity of labor throughout the district. This condition was somewhat improved during the latter part of the year.

Wages during 1916 were the highest in the history of the district. At the Calumet & Hecla and subsidiary companies the 10 per cent premium for the first six months of the year, announced on December 31, 1915, was continued throughout 1916, together with an additional payment of 25 cents per day for each day worked from July 1 to December 31, if the person was in the employ of the company on the latter date. On December 13 notices were posted announcing that the 10 per cent premium would be continued until July 1, 1917 and that from January 1 to July 1, 1917 a 50 cent bonus for each day worked would be paid employees on regular pay days.

At the Quincy wages were advanced seven and one-half per cent March 1, making a total of 15 per cent above normal, and from July 1 an additional bonus of 25 cents per day was given the men. This bonus was advanced to 50 cents per day January 1, 1917. All the companies found it necessary to increase wages from 10 to 20 per cent, and at practically all mines a bonus of 50 cents a shift will be paid beginning January 1, 1917.

Curtailed operations, due to shortage of labor and storms, the advanced cost in materials and supplies, and the increased wages in all departments increased the costs over the year 1915. Extraordinary advance in ocean freight rates and marine and war risk insurance during 1916 also increased the total cost considerably in a few cases.

The most important metallurgical development during the year was the successful inauguration of the ammonia leaching process at the Calumet & Hecla mill. This process was developed from the bottle stage in the laboratory to the present 2,000 ton plant in four years' time, entirely by C. & H. engineers. The present plant has been a commercial and metallurgical success from the beginning.

In connection with the leaching of sands, experiments were conducted by the Calumet & Hecla and by the Michigan College of Mines on the flotation of copper in the slimes, with encouraging results. Minerals Separation machines of 50-ton capacity have been installed at the Calumet & Hecla and White Pine mills.

At the close of the year production was limited only by stamping facilities. Every mill in the district except the Adventure was operating and almost all at full capacity.

16
pal
min
Thi
yea
V
dis
per
Dec
an
Jul
pai
not
Jul
for
A
Ma
l a
bor
con
cen
pai
C
var
all
nar
anc
cas
J
wa
the
bot
yea
bee
I
duc
Mi
sul
ins
L
fac
ing

CONSTRUCTION WORK.

Notwithstanding the shortage of labor, increased cost of material, and higher wages, considerable construction work was done throughout the district in 1916.

The total cost per pound for construction at the Calumet & Hecla was 0.60 cents. At the Isle Royale out of a total cost per pound of 15.75 cents the construction cost was 0.71 cents. Ahmeek expended \$320,833.77 for construction and the Copper Range \$337,371.91, about twice the amount spent in 1915. Mass spent \$94,556.63 for new construction, Victoria \$59,802.95, White Pine Extension \$43,938.84, South Lake \$37,125.24, Mohawk \$34,924.26, Keweenaw \$26,842.89, New Arcadian \$25,607.86, Quincy, \$24,080.52, Allouez \$22,321.35, Wihona \$20,278.71, White Pine \$17,592.97 and Franklin \$15,053.47. All this work was for improvements at mines and mills towards increased production and for the betterment of the employees. A number of the companies in the development stage expended considerable money for machinery and equipment which will enable them to carry on more extended development and exploration work.

EXPLORATION AND DEVELOPMENT WORK.

The producing mines confined all efforts to forcing production to its maximum, and there was little opportunity for extended exploration of new territory.

Practically all of the companies in the development stage continued diamond drill and underground exploration with encouraging results. During the year Wyandot and Keweenaw made mill tests of ore taken out during development work.

The Copper Range began a diamond drill exploration on lands south of the company's operating mines. Mayflower and Old Colony discontinued their diamond drilling and will form a consolidated company to sink a shaft to develop the mineralized ground disclosed by the drilling.

The most extensive exploration work was carried on in Ontonagon county. Several new companies conducted diamond drill explorations, and in other cases old mines were unwatered and explored.

The Adventure mine was reopened in May and unwatered down to the seventh level. Mining operations were started in November, and production gradually increased to about 300 tons per day.

The Michigan continued exploration and development work, begun in the summer of 1915, and the results of the year's underground work were exceedingly encouraging.

At the White Pine Extension, a new company organized in the summer of 1915, the shaft was sunk to a depth of 242 feet, and drifts and crosscuts were driven to explore the copper-bearing Nonesuch beds. A 100-ton experimental mill will probably be built in the summer of 1917.

Southwest of the White Pine Extension, the Porcupine Exploration Company, organized early in the year, carried on a diamond drill exploration along the extension of the Nonesuch formation to the southwest. About 16 holes were drilled, and although some good values were found, the company unfortunately did not consider the showing sufficient to warrant the continuation of the exploration.

Onondaga continued diamond drilling until the summer of 1916, when work was discontinued to await other developments in that section of the district.

In May, 1915, the Algonac Mineral Development Company began a diamond drill exploration of lands between the White Pine Extension and the Nonesuch. A total of 52 drill holes was put down to explore the Nonesuch formation. The results of this work were very satisfactory, and work was discontinued in July, 1916.

In June, 1916, the Cass Copper Company was organized by a group of Copper Country men and purchased 1,980 acres of land in the vicinity of the old Norwich mine. The company holds under option 2,680 additional acres. Diamond drilling was started, and results to date are sufficiently encouraging to warrant the continuation of the exploration.

In the summer of 1916 Mr. R. F. Looney, of Houghton, issued a report on the old Carp Lake mine and offered at private subscription at \$3.00 per share a limited number of pre-organization syndicate shares. The property consists of 1,610 acres on Lake Superior about 22 miles west of Ontonagon. The mine is one of the oldest in the Michigan district, and former operations consisted of the exploration of a copper-bearing sandstone. During 1916 the mine was unwatered and some exploration work done.

About the first of November work of pumping out the old Flint Steel mine was started. One of the old shafts will be used to thoroughly explore the Butler lode. The property lies between the Mass and the Michigan mines.

In the spring of the year the Tremont & Devon Mining Company began preparations to clean out the old adits and pits on its property, which adjoins the Victoria to the west. Diamond drill exploration was started to explore the Devon and Forest lodes.

About the middle of October it was reported that supplies were being shipped into Ontonagon county, preparatory to undertaking

exploration work at the old Waukulla property. A few weeks later it was announced that W. J. Landon of Winona, Minnesota, owner of the Waukulla property, was planning a thorough geological examination and exploration, based on explorations already conducted. The Waukulla property consists of 480 acres northeast of Lake Gogebic in sections 19 and 20, 49-42, in Ontonagon county. Some exploration was done in the latter seventies.

Another extensive exploration project in Ontonagon county was started the latter part of October, 1916. The E. J. Longyear Company began diamond drilling in the Iron River Silver district north of the White Pine. The work was undertaken for E. F. Anderson of Wausau, Wisconsin, and associates, who hold options on several thousand acres of land in townships 51-41 and 51-42. These lands were systematically drilled to determine whether the sandstone and shale contain copper or silver in sufficient quantity to mine at a profit. Through the courtesy of E. J. Longyear Company we are able to print the following report on the results of these explorations.

RESULTS OF DRILLING IN THE NONESUCH FORMATION BETWEEN THE WHITE PINE MINE AND LAKE SUPERIOR.

BY CLYDE S. LONGYEAR.

Introduction.

This summary covers the exploration work done by E. J. Longyear Company during the winter of 1916-17 in Township 51, ranges 41 and 42, on the Nonesuch Formation between the White Pine Mine and Lake Superior, about 15 miles west of Ontonagon, Michigan.

Drilling was started in the middle of November, 1916, since when 17 holes have been drilled, varying in depth from 38 to 592 feet. All these holes were vertical holes, and all were drilled in the Nonesuch Formation, with the exception of two which encountered the red sandstone foot-wall.

The Nonesuch Formation.

The formations are relatively flat in this district, the dip averaging from 12 to 15° to the East. The Nonesuch Formation belongs to the Upper Keweenawan series, and is overlain by the Freda sandstone, a fine-grained, reddish sandstone. The upper 200 to 300 feet of the Nonesuch consists of banded brown and grey shales, grading occasionally into thin beds of brown or grey grit. Below this member is

the upper grit, a coarse-grained grey grit, from 40 to 50 feet in thickness. Underlying this upper grit is 50 to 200 feet of grey shales, mostly very fine-grained. This is underlain by 15 to 30 feet of calcareous banded shale which is fairly coarse and is almost a grit in some places. This banded shale is very easily recognized and serves as a "marker," showing that the mineralized lodes are within 40 to 50 feet.

Below this "marker" is a grey grit known as the Lower Grit, about 20 feet thick, and very similar in appearance to the Upper Grit. The No. 1 shale lies immediately below this, from 5 to 14 feet thick. The mineralization occurs within the bottom 5 or 6 feet of this shale, and extends for a distance of one or two inches into the No. 1 sandstone, or first lode. This sandstone has averaged about three and one-half feet, and has varied in thickness from 1 to 7 feet. The parting shale, immediately below, is from 2 to 11 feet thick, averaging a little less than 8 feet. Below this is the No. 2 sandstone, or second lode, about 3 to 4 feet in thickness. This is underlain by a red sandstone and conglomerate—the foot-wall. At the White Pine Mine and the White Pine Extension, a third lode about 2 to 4 feet thick of grey sandstone and copper has been struck in some of the holes at a depth of from 50 to 100 feet below the second lode. Two attempts were made to strike this lode on these lands, but were not successful.

Mineralization and Faulting.

The mineralization here is confined to the No. 1 shale, and the No. 2, or parting, shale. This, in the main, is the case also at the White Pine Extension Mine, but at the White Pine Mine the main values are found in the No. 1 and No. 2 sandstone. Calcocite was found in these two sandstones in some of the holes drilled here, but no native copper. Some of the holes encountered native silver, but in small quantities. Silver occurred in small amounts in the upper portions of the Nonesuch in the brown shale. The copper for the most part has been fine-grained, appearing between bedding planes of the black shale, and following the small cracks and fissures across the bedding. In some places the copper is in thin flakes from $\frac{1}{8}$ to $\frac{1}{4}$ of an inch across the face. The highest values, however, have come from the finely disseminated copper, rather than the flaky variety.

While there may be some question as to the original source and the manner of deposition of the Nonesuch copper, the drilling here has shown the principal mineralized areas to be in the immediate vicinity of the three northeast and southwest faults.

the
nes
mo
car
son
us
fee
J
20
Th
Th
sh
su
an
pa
in
se
a
Pi
4
of
T
nc

N
W
v
fo
n
h
p
n
o
t
t
c
v

DETAILS OF OPERATIONS OF THE MINING COMPANIES IN 1916.*

Adventure Consolidated Copper Company.

Preliminary work towards reopening the mine was started in May. All surface plants including the No. 3 rockhouse and No. 3 hoist, were overhauled and put in shape for operation.

No. 3 shaft was found to be filled with water nearly to the surface, and the old timbering in the shaft was so badly decayed that the shaft was partly closed by caving ground from surface to the third level, where it enters solid rock. Unwatering was accomplished as far as the third level by means of a pump and air lift. Below this level the water is being removed by bailing. It was necessary to retimber the shaft entirely down to the third level.

As each level was reached, the drifts were cleaned up and the tracks and air pipes installed as far as the drifts were found to be open. Closed drifts are being cleaned out as rapidly as possible.

Mining operations were started the latter part of November, and shipments of ore to the Winona mill were begun about the middle of December. Production was gradually increased up to the end of the year and by May 1, 1917 should amount to about 300 tons per day.

The lodes which will be developed and mined at the Adventure are the Butler, North Butler, Knowlton and Evergreen. The lodes, where opened, show on the whole a satisfactory copper content.

Almeek Mining Company.

Almeek made a record production in 1916. All costs were considerably higher than they have been for the past three years, and the yield of refined copper per ton of ore stamped was the lowest of the past nine years.

All four shafts were in operation during the year. At No. 1 shaft all openings and stopes showed ground of average quality, except the workings on the 8th, 10th, 14th and 16th levels south, where the copper occurs in small bunches.

At the No. 2 shaft all drifts and stopes showed copper contents fully up to the average of the mine. In the higher levels the copper is uniformly distributed throughout the lode but from the 16th level down the copper particles, although heavier, are not so uniformly distributed.

The mass copper fissure vein north of No. 2 shaft produced during the year 1,221,845 pounds of copper. All openings on the fissure de-

*For details of production, costs, dividends, assessments, assets and liabilities see statistical tables.

veloped good values and the vein has a promising appearance. On the 10th level, at a point 950 feet west of the Kearsarge lode, the drift intersected a small crossing which seems to have thrown the mass fissure vein out of place, or to have cut it off entirely. The drift was swung to a direction at right angles to the general strike and continued as a crosscut to a point 1,352 feet west of the Kearsarge lode, where the Kearsarge conglomerate was intersected. This crosscut was extended through the conglomerate lode, which is 36 feet wide at this point and carries a small amount of copper in streaks. A drift was driven near the foot side of the lode 127 feet north and 82 feet south but did not develop ground of commercial value. In the south drift, 55 feet from the crosscut, a fissure was encountered which extended 26 feet into the hanging and 60 feet into the foot, and from which 12 tons of mass copper was produced.

All openings at No. 3 shaft showed ground of average quality for that end of the mine, but the stoping has proved that the copper occurs in bunches. The "Fulton fissure vein" crosses No. 3 shaft just below the 17th level. On the 15th level south this vein was followed 95 feet to the east and 136 feet to the west. A number of fair sized masses of copper were obtained in the fissure; work at this point has been discontinued.

At the No. 4 shaft all openings for the year showed ground of average quality for that end of the mine. During 1917 a vigorous campaign of opening will be conducted.

At the stamp-mill No. 7 stamp went into commission July 1 and No. 8 will be ready in February, 1917. Some La Salle ore was stamped when sufficient Ahmeek ore was not available to keep stamps to full capacity.

For premiums and bonuses see Calumet & Hecla Mining Co.

Algolah Mining Company.

The operations of the Algolah during 1916 consisted of sinking the shaft 80 feet to a total depth of 558 feet. The cost of sinking was \$47.59 per foot.

Difficulty in obtaining delivery of a new boiler and very unsatisfactory labor conditions were responsible for the small amount of development work done.

Shaft sinking will be resumed as soon as labor conditions permit.

Algonac Mineral Development Company.

This company carried on diamond drill exploration work on lands between the White Pine Extension and the Nonesuch. The work was begun in May, 1915 and discontinued in July, 1916. See map of Ontonagon county.

A total of 52 drill holes was put down along the strike to explore the Nonesuch formation which is mineralized to the west at the White Pine Extension and to the east at the Nonesuch. The line of holes drilled extends from the S. W. $\frac{1}{4}$ of the N. W. $\frac{1}{4}$ of section 8 in a general northeasterly direction through the S. E. $\frac{1}{4}$ of the S. E. $\frac{1}{4}$ of section 5 to the center of the east half of section 4. Another line of holes extends from the N. W. corner of section 9 east along the north lines of sections 9, 10 and 11.

The results of the drilling indicate a fold in the formation and a fault running through about the west half of section 10.

The beds were found to be fairly well mineralized, and several cores were exceedingly rich in native copper.

Allouez Mining Company.

Allouez's production for 1916 showed an increase of 175,831 pounds over that of 1915, the previous record production of the company. Costs were higher than in 1915 but lower than costs in the four years preceding 1915.

Copper returns from the stopes tributary to No. 1 shaft were somewhat below average, this being especially true as stoping operations on the north side gained toward the shaft.

At the No. 2 shaft stoping operations yielded better than average copper returns, with especially good ground stoped toward the extreme north on the 14th to 17th levels inclusive. The mine to the north of No. 2 shaft will be equipped with electric locomotives on a 125-volt trolley system.

For premiums and bonuses see Calumet & Hecla Mining Co.

Baltic Mining Company.

Baltic's operations during 1916 showed an increase in production over that of 1915. The yield of copper per ton of ore stamped was 33.64 pounds.

No. 2 shaft was the chief producer, and the ground opened during the year was fair. At the bottom of shafts Nos. 3 and 4 developments have shown some improvement. The west lode was worked throughout the year from all the shafts, although almost all the production from this lode came from Nos. 4 and 5 shafts.

Equipment will be set up in the addition to the mill building in the early part of 1917, and when this is finished, complete regrinding of all coarse tailings will be possible.

Calumet & Hecla Mining Company.

During the year 1916 the C. & H. produced 76,762,240 pounds of refined copper, of which amount 71,349,591 pounds was produced by the mine, and 5,412,649 pounds was recovered by the reclamation plant at Torch Lake. The total cost per pound of copper produced from the mine was 11.63 cents, and the price received for copper sold varied from 22½ cents to 35½ cents per pound.

On the conglomerate lode the work of removing shaft pillars and cleaning up arches and the backs of old stopes was continued throughout the year, and about 78 drills were employed in this work. A total of 476,310 tons was secured from these operations.

Openings on the Osceola lode continued to show about the same grade of ore. The production from foot-wall stopes was about 33½ per cent of the total production from this branch. Shaft openings are far in advance of drifts.

No work was done on the Kearsarge lode during 1916. No work was done at the Manitou-Frontenac and St. Louis branches during the year.

At the stamp-mills both the No. 1 and the No. 2 regrinding plants operated satisfactorily throughout the year. The remodeling of No. 1 plant should be finished during 1917. The comparative results for 1916 for the two plants on mill tailings are as follows:

	No. 1	No. 2	Total
Tons coarse tailing crushed	364,581	182,705	547,286
Pounds per ton in material treated....	13.98	13.98	13.98
Pounds copper saved per ton.....	3.79	4.98	4.18
Pounds copper produced.....	1,380,344	909,453	2,289,797
Cost per pound, excluding smelting and selling	6.32c	4.30c	5.51c

The leaching plant was started on a limited scale in July, but owing to slow deliveries of material, was only half in commission at the end of the year. The cost, exclusive of smelting and selling expense, was under six cents per pound.

The whole plant of 2,000 tons daily capacity will be in operation before the spring of 1917 and will be able to handle only tailings from No. 2 regrinding plant. Results thus far have been so satisfactory that an addition of 2,000 tons capacity will be built to take care of the tailings from the stamp-mill.

The reclamation plant ran continuously throughout the year. The results of this plant, including leaching are as follows:

	Year 1916	Since starting
Tons tailings treated	545,727	727,459
Pounds per ton in material treated	21.06	21.24
Pounds copper saved per ton	9.92	9.62
Pounds copper produced	5,412,649	6,995,451
Cost per pound, excluding smelting and selling....	4.58c	4.39c

The new furnace at the smelter went into commission November 1.

On December 23, 1916 the Calumet & Hecla sold its 11,297 shares of Seneca Mining Company for \$60 a share, receiving \$672,420. In making this sale, it was stipulated that the other shareholders should receive an offer of \$60 a share for their shares, provided these were presented within a reasonable time. The Calumet & Hecla, therefore, has no further interest in the Seneca Mining Company.

On July 15, 1916 the fiftieth anniversary of the opening of the mine was celebrated, by a general holiday. Long service medals were given to 1,371 employees.

The ten per cent premium for the first six months of the year, announced December 31, 1915, was continued throughout 1916, together with an additional payment of 25 cents per day for each day worked from July 1 to December 31, if the person was in the employ of the company on the latter date; this payment to be made on the first pay day in January, 1917. On December 13 notices were posted announcing that the ten per cent premium would be continued until July 1, 1917, and that from January 1 to July 1, 1917, a 50 cent bonus for each day worked would be paid employees on regular pay days.

The above statement of premiums and bonuses also applies to the following Calumet & Hecla subsidiaries: Ahmeek, Allouez, Centennial, Isle Royale, La Salle, Osceola, Superior and White Pine.

Carp Lake Mine.

In the summer of 1916 interest was revived in the old Carp Lake mine, located about 22 miles west of Ontonagon near Lake Superior. The property consists of 1,610 acres and was formerly worked in 1863.

About the middle of June, 1916, Mr. R. F. Looney, of Houghton, who holds the controlling interest in the property, issued a report on the mine by Mr. Jerry Rourke, of Hancock, and offered at private subscription at \$3.00 per share a limited number of pre-organization syndicate shares.

According to the report of Mr. Rourke, the ground leaving Lake Superior rises gradually for a half mile or more, where it becomes steeper and reaches the backbone of the Porcupine Mountains at

an elevation of 1,100 feet above the lake and at a distance of one mile from the shore line. To within 100 feet of the top of the mountain, the formation is sandstone, which is capped by a flow of trap rock. The upper 30 feet of sandstone just under the trap rock is impregnated with native copper, forming the vein, which on account of the physical features, may be easily traced throughout the property. The sandstone, trap and the vein, which follows the stratification of the sandstone, all strike east and west and dip north toward and under Lake Superior. All of the 30 feet of sandstone is not mineralized, the copper occurring principally in the upper six feet and the lower ten feet, with 15 feet or so of barren sandstone between. The copper occurs in lenses up to several inches in thickness and as sheets along the bedding planes. The mineralization is uniform for a distance of a mile along the vein, as exposed in the old workings and in a number of cuts and shallow shafts along the outcrop.

Exploration work was carried on at the property during the summer months. Three old shafts were unwatered and cleaned out, and the old workings examined. It is reported that all shafts opened show the upper six foot strip of rich copper and that a crosscut in No. 9 shaft determined the lower mineralized strip to be as rich as where opened on the face of the cliff, at which point Mr. Rourke states the amount of copper to be remarkable.

Cass Copper Company.

The Cass Copper Company was organized in June, 1916 under the laws of Michigan, with a capital of 150,000 shares, par value \$25. The men interested in the syndicate are well known mining and business men of the Copper Country and associates from Chicago, Minneapolis and southern Michigan.

The company has purchased 1,980 acres of land in Ontonagon county in the vicinity of the old Norwich mine. (See map of Ontonagon county). Besides the 1,980 acres the company holds under option about 2,600 acres lying to the east and north of the Norwich.

A geological survey of the property was made by A. H. Meuche, and diamond drilling was started to explore the Forest lode. Five holes have been drilled in section 6, two holes in the N. W. $\frac{1}{4}$ of section 12 and one hole in the S. W. $\frac{1}{4}$ of section 1.

Although no copper of commercial value has been found to date, the results of the work are very encouraging and the exploration will be continued.

Centennial Copper Mining Company.

Severe winter storms in the early part of the year and consequent transportation trouble, together with the general scarcity of labor affected Centennial's production during 1916. The total production, however, showed an increase over that of 1915.

Openings to the north of No. 2 shaft disclosed some promising stretches of ground. Stopes for the year yielded average copper returns.

The Centennial has granted the Wolverine a license to mine a triangular piece of ground about one acre in area, in the N. E. $\frac{1}{4}$ of the N. E. $\frac{1}{4}$ of section 12, Town 56, Range 33 in exchange for similar rights on an equal amount of land in the N. W. $\frac{1}{4}$ of the N. W. $\frac{1}{4}$ of section 7, Town 56, Range 32.

For premiums and bonuses see Calumet & Hecla Mining Company.

Champion Copper Company.

Champion made another record production during 1916. At a total cost per pound of 7.80 cents and a yield of 35.87 pounds of refined copper per ton of ore stamped, the mine produced 33,601,136 pounds of refined copper. Net profits were \$5,870,606.26.

Openings made during the year developed good ground. The filling of old stopes is about completed, and less sand will probably be required for fill in the future. Towards the end of the year shaft sinking was resumed, no work of this kind having been done for nearly three years. The mill is now equipped for complete regrinding.

Cherokee Copper Company.

Exploration work was continued at the Cherokee with very encouraging results.

In April a site for the shaft was cleared, foundations laid, machinery installed and in July shaft sinking was started.

Cherokee is exploring an uncorrelated, epidote amygdaloid, from 30 to 45 feet in width, striking in general N. 45° E. and dipping about 62°. The amygdaloid has been opened on surface for about 1,200 feet along the strike, and good mineralization has been found in all surface openings.

At the end of the year the shaft was down about 250 feet. At a depth of 110 feet drifts were driven northeast and southwest in order to determine the strike and character of the foot-wall. At the end of the east drift a crosscut was made through the lode and into the hanging-wall the lode showing a width of 26 feet. The open-

ings at the 110 foot level total about 120 feet. At a depth of 220 feet No. 2 plat was cut, and drifting is now under way.

The shaft throughout its total depth of 250 feet, with the exception of only 30 feet, has shown persistent mineralization of an encouraging character. The 30 feet showed slight mineralization compared with the other openings.

Copper is found in heavy form in a very irregular banded structure, the banding conforming more or less to the general strike of the lode and in the upper part of the shaft shows a decided tendency to follow rather closely the foot-wall. This, however, is becoming less pronounced with depth, and at the 200 foot level and bottom of shaft heavy copper has been found 12 feet from the foot-wall. Besides the heavy banded form of copper, shot copper and very fine granular particles appear at irregular intervals in the lode.

An assessment will probably be called in the spring, and operations during 1917 will be watched with interest.

Contact Copper Company.

Operations of the Contact during 1916 were restricted to a continuation of the diamond drill exploration of the beds crossing the southeastern portion of section 11, 52-36. The object of the work was the further investigation of the No. 8 Wyandot amygdaloid lode.

The No. 8 amygdaloid was cut in both of the holes drilled and was found to be generally soft and carrying a very small amount of exceedingly fine copper. The dip of the beds was found to be about 66°, which agrees with the dip of the formations farther west on the property at the horizon of the Winona lode.

The four holes drilled in this part of the property have disclosed a formation of about 35 feet average thickness, showing a uniformly favorable character of rock with a small degree of mineralization. Supt. G. S. Goodale considers the results encouraging and warranting further exploration of the No. 8 amygdaloid.

In order to protect the company's cash resources, further work on the property was suspended June 29, pending results at the Wyandot to the south. Diamond drill investigation of the same horizon is also being made by the Copper Range on lands to the north. The directors thought it wise to await further developments at both these points before resuming active operations at Contact.

Copper Range Company.

Operations of the Copper Range during 1916 showed a net income of \$6,078,189.65. This is equivalent to net earnings of \$15.40 per share. \$10 per share was paid in dividends, and the balance added to working capital.

The total production of the Copper Range mines, Baltic, Trimountain and one-half of Champion, was 37,946,930 pounds, an increase over the previous year of 911,288 pounds. The average yield of copper per ton of ore stamped was 33.07 pounds. Each of the three mines showed an increase in output for the year.

Considerable development work was done, and new stoping ground was developed equal in tonnage to that extracted during the year. The Copper Range secured an option from the St. Mary's Mineral Land Company on about 3,500 acres of land south of the Copper Range mines. A preliminary exploration is now being made of this land by diamond drilling.

Copper Range purchased from the South Range Mining Company for \$50,000 about 5,000 acres of scattered lands in Houghton and Ontonagon counties.

The Trimountain Mining Company will probably be dissolved in 1917.

Flint Steel.

Work of pumping out the old Flint Steel mine for the purpose of examination of the workings was started November 3d. This work was completed December 16th. Mr. Samuel Brady of the Michigan, who was in charge of the work, states that the work thus far has resulted in no activity at the property, though it is hoped that it may ultimately do so.

The property consists of the east $\frac{1}{2}$ of the N. E. $\frac{1}{4}$ and the S. E. $\frac{1}{4}$ of section 11 and all of section 12, between the Michigan and the Mass.

Nipissing has taken an option on the property, and the unwatering was for the purpose of a thorough exploration. Flint Steel was last worked in 1875 on a fissure vein.

Franklin Mining Company.

Franklin had a very successful year in 1916. Production was considerably increased, and new development work opened up very good ground. The future of the Franklin is very promising. At the end of the year all notes payable, amounting to \$155,000 had

been paid from earnings, and the company now has no indebtedness of any kind outside of current expenses.

Drifts in the Allouez conglomerate tributary to No. 1 shaft were extended on levels 21 and 26 to 36 inclusive, and stoping was begun in this newly developed section of the mine. The ground developed to the north is below average grade with some well mineralized areas of small extent.

To the south nine drifts were carried to the dividing line between No. 1 and No. 2 shafts. These drifts developed average stoping ground throughout practically their entire lengths, with the best values showing in the ends towards No. 2 shaft. Two other drifts, the 27th and 32nd, were extended beyond the downward extension of the center line of No. 2 shaft to test the ground through which this shaft is to be sunk. These drifts disclosed a greater width of lode, carrying more copper per ton, than is to be seen in the section of the mine now being worked.

Early in the spring work was started to reopen No. 2 conglomerate shaft which had caved to surface. The work of cleaning out and retimbering this shaft is being pushed as rapidly as possible, as it is very desirable to resume sinking in order to develop and mine the good ground opened by the south drifts from No. 1 shaft.

The long crosscut on the 32nd level was driven through the Kearsarge lode and stopped on the foot-wall side of the Wolverine sandstone, 4,542 feet from the Pewabic amygdaloid. Copper in sufficient quantity to warrant further exploration was found on the foot-wall side of the Kearsarge amygdaloid, but owing to shortage of men, no drifting was done.

It has been the custom at the Franklin, because of a very soft hanging-wall, to leave the upper portion of the lode, amounting to one-third to one-half of its width, as a beam to support the hanging of trap. In the latter part of the year a rope haulage was installed on the 29th level south, and a system of stoping was begun with a view of removing practically the entire width of lode including the floor pillar of the level above and allowing the trap hanging to cave behind the men. Similar systems were installed on two other levels, and the results have been exceedingly favorable. Others are being put in as rapidly as possible. This new system makes possible a recovery of a greater tonnage from a given area of lode, a reduction in the cost of stoping, an increased production and a marked decrease in tramming cost per ton.

Every effort was made to increase production, and at the end of the year the ore sent to the mill showed an increase in tonnage of

more than 40 per cent over the average for the first six months. Three of the four units at the mill are now stamping Franklin ore, and when mining begins in No. 2 shaft, the fourth, which is now doing custom work, will also be supplied with ore.

Hancock Consolidated Mining Company.

Although operations at the Hancock were carried on under a great many difficulties, the results for the year were fairly satisfactory. Practically all dead work in the nature of driving long crosscuts and opening up work for chutes between levels has been completed. The mine at the close of the year was in far better physical condition than at any time in the past, and production should be increased 100 per cent in 1917.

Development work in the lower levels exposed average ground. The copper is better distributed than in the upper workings, and considerable mass copper is being encountered. Crosscuts were driven to the West branch, which is 115 feet west of the main lode, at two of the lower levels. The average width of this lode is about four feet. It is buncy but carries good grade ore and considerable mass copper.

The development work was confined to blocking out ground for mining in the lower workings tributary to No. 2 shaft and to extending levels south from Quincy No. 7 shaft into Hancock territory from the 66th to 71st levels. The ground mined south of No. 7 shaft was well mineralized.

Electric haulage is being installed on the lower levels of No. 2 and No. 7 shafts and when completed will make possible the handling of a greater tonnage at a far lower cost.

Houghton Copper Company.

Houghton Copper produced 204,274 pounds of refined copper during 1916, at a yield per ton of ore stamped of 10.55 pounds.

Stoping was carried on both north and south of the main shaft on the 6th level, where the shaft is now bottomed. At the 450 foot level a crosscut was driven through the Superior lode which showed a width of 28 feet. Drifting was done both north and south, and, while the lode showed some copper, it was not encouraging.

The winze was sunk 113 feet below the 1,020 foot level, and a crosscut was driven through the Superior lode which showed a width of 40 feet with good ore on both foot and hanging sides. Drifts to north and south on the Superior lode at this level opened fair ground. The lode is now being cut out on the north side of the

winze and hoisted as ore. President Paine states that the main lode on the 12th level looked to be as good as, or better than any other place in the mine, but not good enough to warrant the sinking of the main shaft from the 6th to the 12th level.

The crosscut from the winze was extended from the Superior lode to the west and driven through the West lode, which showed a width of 15 feet. The distance from the hanging of the Superior lode to the foot of the West lode is 123 feet. Drifts to north and south on the West lode encountered some nice heavy bunches of copper, but only a very small proportion of the ground opened showed any copper.

Indiana Mining Company.

Search for the body of felsite from which the No. 2 drill core was obtained was continued at the Indiana during 1916. Crosscuts to the east and drifts north and south on the 1,150 and 1,400 foot levels were made in an endeavor to locate this much desired deposit.

Felsite was found on both levels, and the contact between it and the trap was followed for several hundred feet in different directions. Copper was found at a number of places in the felsite near the contact, but not in commercial quantities. No. 2 drill hole was not found, but No. 9 hole was cut by one of the openings at the 1,400 foot level, at about 100 feet northeast of its theoretical position.

Concerning this extended exploration work in search of the rich deposit, General Manager Edwards states as follows: "All the exploration work done at the 600, 1,150 and 1,400 foot levels, taken in connection with the large amount of diamond drilling in addition to No. 2 hole, leads to the conclusion that the deposit from which No. 2 drill obtained the rich core cannot be of very great size or have any regular trend, otherwise it would have been encountered at some other point in the work. This cannot be considered as proved as yet, and it is not the intention to convey the idea that all hope of locating a valuable deposit on this part of the property has been abandoned, but, after serious consideration, the directors decided that the prospects of developing a mine within a reasonable time were brighter in the horizon of the South Lake amygdaloid lodes."

Late in the year No. 2 shaft was started in the S. W. $\frac{1}{4}$ of section 21, and by the end of the year had reached a depth of 124 feet. The shaft will be sunk on the dip to 300 feet, at which depth the

group of South Lake lodes will be explored by crosscutting and drifting.

Isle Royale Copper Company.

Isle Royale made a profit of \$1,396,655.01 in 1916. Three dividends, amounting to \$750,000, were declared during the year. A notable increase in production was made, and ground developed during the year is good.

The No. 1 shaft was unwatered and timbered to the bottom, 79 feet below the 16th level. All openings from this shaft, with the exception of 70 feet of crosscutting, were on the West lode, and about 38 per cent developed ground of apparent commercial value. About eight per cent of the total tonnage shipped to the mill came from this end of the mine.

Sinking was carried on at No. 2 shaft. The inclination of this shaft is being flattened in order to reach the West lode, in which future sinking will be done. About 65 per cent of the openings from this shaft to the south in the Isle Royale lode disclosed ground of average copper content. In the drifts in the West lode north of the shaft about one-half of the ground opened contained copper.

At the No. 4 shaft about 75 per cent of all ground opened shows copper values fully up to the average of the mine. On the 6th level north at a point 200 feet from the shaft, a crosscut has been started into the foot to explore an amygdaloid which lies about 350 feet east of the Isle Royale lode.

At the No. 5 shaft about 73 per cent of the ground opened shows copper.

At the No. 6 shaft good values are exposed at the bottom of the shaft, which is now 58 feet below the 17th level in the lode. About two-thirds of the ground opened during the year shows copper.

Sinking was carried on at No. 7 shaft. At the end of the year the bottom was in the lode 59 feet below the 7th level, where good copper values are exposed. Drifts tributary to this shaft developed fair ground.

At the various shafts considerable construction work was done. Several improvements were made at the mill, which ran with great efficiency all the year.

For premiums and bonuses see Calumet & Hecla Mining Company.

Keweenaw Copper Company.

All work during 1916 was conducted on the property of the Phoenix Consolidated Copper Company.

Sinking of No. 1 shaft was continued, and the total depth of shaft is 1,616 feet. Drifting during the year was in general towards the foot-wall side of the Ashbed lode. A total of 4,899 feet of drifting was done to the east and to the west, and practically all openings developed fair to good copper ground.

The "Old Phoenix" fissure was explored from a point where it was cut on the 7th level east by a crosscut northward to the hanging wall of the Ashbed lode. No copper was found in this fissure except where it cuts the lode near the foot-wall, at which point good values are exposed. This fissure will be explored to the south as soon as more men are available.

The Ashbed lode was explored by diamond drills on five different levels. A total of 32 holes was drilled, and the results show that where copper was not found in the drifts, the drill cores generally show copper either in the hanging or foot-wall.

In the latter part of the year preparations were made to commence stoping and milling. A rockhouse and railroad trestle were constructed, and track laid, connecting the mine with the stamp-mill. The mill was overhauled, and stamping was commenced on October 13th.

Four Overstrom and three Wilfley tables constitute the concentrating equipment of the mill. It was found that the Overstrom tables did not make a satisfactory recovery, and they will be replaced by four Wilfley tables. The total copper content per ton of ore stamped was 15.98 pounds, but there was a mill loss in copper per ton stamped of 6.02 pounds. As soon as possible arrangements will be made with the Minerals Separation North American Corporation to begin tests with its process for the further saving of copper values in the finer grades of materials treated in the mill.

Lake Copper Company.

Operations at the Lake during the year ending April 30, 1917, resulted in a total excess of receipts over expenditures of \$108,194.94. The production of refined copper for the 12 months ending April 30, 1917 was less than that for the nine months ending April 30, 1916. The recovery of refined copper per ton of ore stamped dropped from 26.42 to 21.14 pounds.

Considerable attention was devoted to the Knowlton and Butler lodes in the north portion of the property. The old Knowlton shaft was used to explore these lodes and the exploration gave encouraging results. Production will begin from stopes on the Knowlton lode in the summer of 1917. At the same time more extensive developments on the Butler lode will be pushed.

At the Lake shaft the work during the fiscal year consisted chiefly of opening and stoping the levels already developed. Considerable stoping ground was opened up in the upper levels.

New work was done on the seventh level south, about 200 feet south of any stopes in that portion of the mine. This work showed fairly good ground. On the 11th level, the lowest level of the mine, the east lode was drifted on for about 400 feet. The lode showed fairly good mineralization, but it was so narrow that work on it was stopped.

The Butler-Knowlton series of veins on the north side of the property was explored by means of the Knowlton shaft, which was down 600 feet. The shaft was unwatered, and hoist and compressor installed. A crosscut was driven from the Knowlton lode 550 feet to the Butler lode on the sixth level east. This crosscut was continued 100 feet further to the Ogima lode where 30 feet of drifting was done without promising results.

Drifts were driven east and west from the crosscut on the Butler lode and they have shown good results. The lode is very well mineralized and averages about 15 feet in width. The Knowlton lode is being worked on the third, fourth and sixth levels, and at all of these points is carrying good values.

Lake Milling, Smelting and Refining Company.

At the No. 1 mill, Point Mills, a concrete reservoir and a steel tower were built to afford water storage for protection against fire. These are fed by an electric pump located on a small creek east of the mill.

At the No. 2 mill, Hubbell, owing to the general shortage of labor and to slow deliveries of material, work progressed slowly on the two new stamp units. It will probably be early summer, 1917, before either of the units will be in operation.

La Salle Copper Company.

Besides the general scarcity of labor and transportation trouble, which affected production, operations at La Salle were also retarded by insufficient stamping facilities. The Franklin mill continued to stamp La Salle ore but in amounts gradually decreasing, and since October 1 the Ahmeek mill has been handling a portion of La Salle's product.

At the No. 1 shaft mining operations consisted of stoping on four levels and drifting on one other level. The stopes in general were

rather lean, with patches of fair ground occurring irregularly. The water in this shaft was lowered from the 15th to the 17th level.

At the No. 2 shaft sinking was resumed and carried below the 20th level. Where the lode was opened near the hanging, fair copper contents were found. A small amount of stoping was done on two levels north in fair ground. Openings were extended on alternate levels and disclosed fair stoping ground on the north side of the shaft. On the south side the openings indicate stretches of poor and fair stoping ground, the lower levels being the best.

By an arrangement with the Osceola Cons. Mining Co., the 42d level south of No. 6 shaft, Osceola mine, was extended into La Salle territory for exploratory purposes. At the end of the year this opening had reached a point 692 feet south of the Osceola boundary, with a very encouraging showing of copper throughout this distance. This drift will be extended as much farther as seems advisable, and the 45th level drift, which is now near the La Salle line, will also be extended in the same way.

For premiums and bonuses see Calumet & Hecla Mining Company.

Mass Consolidated Mining Company.

Credit is due to Supt. E. W. Walker for the very satisfactory results obtained during 1916 and for the present condition of the mine. Production was increased, and the yield of copper per ton of ore stamped was 16.51 pounds, compared with 14.35 in 1915. The total operating profit for the year was \$525,083.98; two dividends of \$1.00 each were paid, amounting to \$194,634, and \$235,893.95 was added to balance of assets.

Cost of labor was 18 per cent higher than in 1915, and all supplies showed an equivalent increase, yet the actual cost of producing copper increased only about six per cent over the cost in 1915.

The results obtained underground were very satisfactory, as the work done on the 5th level at "C" shaft shows that the Evergreen lode is well mineralized as far west as "C" shaft in entirely new territory, and there was obtained from the Butler lode an increased production of ore per unit of lode area.

Development work done during the year added to the reserves a tonnage in excess of the extraction. In addition to the reserves added by regular development work, there are now available all the workings of the old Evergreen mine which has been unwatered. Connections are now being made from the present workings to the old mine, and inspection of the old workings shows a large amount of favorable stoping ground which will soon be available for production.

Numerous additions and improvements were made to the equipment which will not only make possible an increase in production but will permit the work to be done more economically and without the delays experienced due to the limited power plant.

Mayflower Mining Company.

Diamond drill exploration was continued at the Mayflower during 1916.

At the close of 1915 hole No. 41 had reached a depth of 2,569 feet. The continuation of this hole, however, disclosed a bed of soft, sandy material which made further drilling impossible. The hole was abandoned in February at a depth of 2,635 feet, without disclosing the position or character of the Mayflower lode.

It was considered advisable to make another effort to locate the lode at depth, and No. 42 hole was started in February, about 600 feet along the strike northeast of No. 41. Hole No. 42, to a depth of about 2,100 feet, where it cut the St. Louis conglomerate, indicated a uniformly favorable condition of the strata and agreed in general with the results obtained in No. 41. Below the St. Louis conglomerate and to a depth of 2,653 feet, several zones of crushed and decomposed ground were encountered which made the operation of the drill difficult. The small portion of core obtained at this depth showed a condition apparently similar to that disclosed at the bottom of No. 41. With further progress practically impossible, drilling operations in this hole were abandoned on October 10th at a depth of 2,697 feet.

The earlier drilling on the property, however, had developed sufficient promise that the directors of the company thought it advisable to make further exploration by means of a shaft, provided an arrangement could be made with the adjoining Old Colony Copper Company for a division of the expense. The only satisfactory way that could be found for dividing the expense was by a consolidation of the two companies. The new consolidated company will probably be formed before the spring of 1917.

Michigan Copper Mining Company.

Operations at the Michigan during 1916 were carried on as planned when work was resumed in July, 1915. The results of this work seem to justify the belief of Supt. Brady that a new and prosperous mine will soon be producing on the Michigan property.

In the spring of the year sinking in "E" shaft on the Butler lode was completed to a total depth from surface of 630 feet. In the

progress of the work of shaft sinking, little or no copper was found until a point about 50 feet above the 6th level was reached, when it appeared in very considerable quantities upon the hanging side of the shaft. This mineralization was followed by the shaft in the work of development to a point about 15 feet below the 6th level, at which point it was cut off by a flat slip, dipping from the east side of the shaft.

At the 6th level drifts were driven to west and east of shaft, and some very good ground opened up. By means of a raise over the top of the fault, a more or less continuous run of good ground, of undetermined width, was traced through to the 5th level above, at which point the ground is still of undetermined width and of excellent character.

About the first of June a main crosscut was started south 20° east on the 6th level from a point about 25 feet east of the shaft line. This crosscut was driven for a total distance of 526 feet, or to a point about 50 feet beyond the foot-wall side of the Evergreen lode. The results obtained by this work are interesting and very satisfactory. The crosscut will be continued to No. 8 conglomerate.

In driving this crosscut several belts of mineralization were crossed. From one of these about one-half ton of mass and a number of tons of excellent ore were obtained. Two or three different zones of shearing were encountered, all of which were more or less mineralized. One of these which is well mineralized with mass and fine copper is believed to be identical with the fault line which was found to have cut off the rich ground on the hanging side of the Butler lode in the shaft.

The Ogima lode was reached by the crosscut at a distance of 180 feet. Separated from the main amygdaloid part of this bed by a trap parting about five feet in thickness, is another strong zone of shearing. This zone conforms in strike and dip with the Ogima lode and, where intersected by the crosscut, was found to carry copper in very satisfactory quantities.

A drift was driven about 250 feet west on the Ogima lode, and a crosscut made into the foot for about 75 feet. The drift for the first 100 feet showed fine shotty copper in commercial quantities, through a width of five to eight feet. At 100 feet a cross fissure, striking about N. 45° E., was encountered, which was fairly well charged with sheety masses about one inch in thickness. To the west of this fissure the copper contents of the lode appeared to diminish for about 80 feet. Beyond this point sheety masses, associated with some excellent ore, appeared upon the hanging side of the drift, while the amygdaloidal character of the main Ogima lode

appeared to diminish. Further drifting to the west indicated warping of the Ogima hanging to the south and the presence of a bed of trap, striking north and south, which has caused the faulting of the Ogima lode. A crosscut following the east side of this trap was driven for 75 feet from the hanging of the drift. Ragged masses and fine copper were found in this direction, and the face of the crosscut was still in copper-bearing ground when work was suspended.

The main crosscut passed through the hanging of the Evergreen lode 175 feet from the Ogima lode. The Evergreen lode was found to have a width of 48 feet and a dip of 43° to the northwest, with a strike of N. 70° E. Drifting on this lode was carried about 180 feet to the west through somewhat buncy but fairly well mineralized ground. The ground opened up by this drift is characterized by a general uniform run of fine copper upon the foot side which, upon meeting cross slips, seems to be carried well into the hanging. One point opened by widening of the drift showed mineralized ground 16 feet wide, with copper still in the hanging.

On the 5th level drifting was done to east and west of the shaft. Promising ground was found to the east. A crosscut was driven 150 feet north on this level for the purpose of intersecting another parallel line of shearing which outcrops a little over 100 feet to the north of the shaft. A drill hole in the face of the crosscut found copper ground along the extension of the crosscut.

Various improvements were made at the mill and this work is being pushed as rapidly as possible.

There was shipped during the year a little over 90,000 pounds of mass copper, taken from openings on the Butler, Ogima and Evergreen lodes during development work. There is in stock at the mine about 4,200 tons of ore.

Mohawk Mining Company.

New openings made during 1916 in ground tributary to No. 1 shaft showed less mineralization than openings made during 1915. This was due largely to local disturbances found north of the shaft which necessitated considerable drifting in barren ground.

Exploratory crosscuts were driven to the east and west on the 21st level at a point 670 feet south of No. 2 shaft. The crosscut through the hanging to the west had reached a distance of 641 feet at the end of the year and the crosscut in the foot to the east a distance of 579 feet. Several amygdaloids were intersected, but none warranted further investigation at the present time. The Wolver-

ine sandstone was encountered in the east crosscut at 325 to 351 feet from the foot-wall of the Kearsarge lode.

At the No. 2 shaft drifting on the 22nd level north opened poor ground, and drifting on the same level to the south fair ground. No. 2 will possibly be eliminated during 1917.

New openings in Nos. 4, 5 and 6 shafts show the lode to be of excellent quality. North of No. 6 shaft a fissure, varying in width from eight to 15 feet, has been traced from the 7th to the 11th levels. Indications of copper were found at each level, but the extent of the mineralization into the foot and hanging of the Kearsarge lode has not yet been determined.

Extensive repairs were made in No. 4 shaft, and several improvements installed in No. 6. Little new work was done at the stamp-mill.

Naumkeag Copper Company.

All the exploration work for 1916 was confined to the workings from No. 4 adit at the north end of the property.

Drift No. 2 south was driven on the old Pewabic lode to a point about 2,000 feet southwest of the adit and is the most southerly opening on the property. No copper was found in this portion of the lode.

A crosscut to the east from No. 2 drift was driven to a point about 1,150 feet, but only one of the beds disclosed showed copper. A drift will be driven to explore this bed, as diamond drilling indicated that it was mineralized. In a crosscut west from drift No. 2 south conglomerate No. 16, the Hancock No. 3 and the Atlantic lodes were cut but were barren.

In sinking the main winze or shaft from the 190 foot level there was some copper showing for about the first 15 or 20 feet but not in any large amount until a depth of about 370 feet was reached. In the winze at this depth some good bunches of copper were found. In the north drift on the 400 foot level the copper showing was fair. In a crosscut northwest from the south drift on the 400 foot level several feet of good looking ore was disclosed, about eight or ten feet in the hanging-wall of the main lode. Work on the 400 foot level will be vigorously prosecuted.

New Arcadian Copper Company.

The general plan of development work was continued at No. 1 shaft. The shaft was sunk 333 feet and is now bottomed at a depth of 1,500 feet. Drifting was done on six levels, crosscutting on four levels, and some stoping was done on four levels. The lode appears

to be very persistent, and the mineralization has been very satisfactory. The openings on the 1,500 foot level show the same persistence of mineralization at depth. The lode on the bottom level is wide, being over 20 feet in some places, and is very well charged with copper.

About 1,800 feet south of No. 1 shaft No. 2 shaft was sunk 169 feet, and 245 feet of drifting done on the Old Arcadian lode. The showing was encouraging, but on account of scarcity of labor, operations were suspended at this point.

During the year 1,391 tons of ore was shipped to the Franklin mill and yielded 32,307 pounds of refined copper. There is now several thousands tons of ore on hand which will be shipped to the Franklin mill in the spring of 1917.

New Baltic Copper Company.

The New Baltic controls 800 acres of land on the copper range in Houghton county. Diamond drilling has found several well mineralized beds, including the No. 8 conglomerate.

In the No. 7 drill hole, the last to be drilled on the property, No. 8 conglomerate was intercepted at a depth of 1,192 feet. It was found to be 41 feet thick with a dip of about 52°. Copper in varying quantities was noted in beds at 329 feet, 493 feet, 652 feet, 792 feet and also in No. 8 conglomerate at 1,196 feet.

The persistence of mineralization is indicated in the correlation of the New Baltic hole No. 7 and the New Arcadian hole No. 24, located about 500 feet to the northwest. In hole No. 24 copper was found in an amygdaloid at 790 feet, which corresponds to 493 feet in No. 7 New Baltic, and also in a bed at 980 feet, which corresponds to 652 feet in No. 7 hole. The New Arcadian lode is no doubt the bed cut at 792 feet in New Baltic No. 7 hole.

The satisfactory results of the diamond drilling led to the locating of a shaft about 500 feet southwest of the N. $\frac{1}{4}$ post of section 16, 55-33, to intercept the northerly extension of the New Arcadian lode.

Sinking of the shaft was started in October, and, after passing through about 60 feet of overburden, was finally bottomed on the desired amygdaloid bed. The shaft will be sunk as rapidly as possible, probably to a depth to correspond with the 250 foot level of the New Arcadian mine.

North Lake Mining Company.

Development work was carried on continuously throughout the year with encouraging results.

Shaft sinking was continued and in June had reached a depth of 821 feet. On the 800 foot level crosscuts were driven northwest and southeast. At the end of the year the southwest crosscut was breasted in No. 8 conglomerate and as nearly as can be calculated had 688 feet farther to go to reach the first of the South Lake lodes. These lodes were opened from the crosscut on the 300 foot level and carried copper but development work on that level was abandoned owing to breaking through into overburden at two points.

The southeast crosscut passed through a good looking amygdaloid at 679 to 728 feet from the shaft, which showed fine copper throughout. A drift is now being driven along the foot-wall to explore this lode. Results to date have been very encouraging.

The southeast crosscut will be continued indefinitely, as there are several more known copper-bearing amygdaloids to be cut by it which were discovered by diamond drilling. The one which showed the best copper in the drill cores should be cut by the crosscut at 1,480 feet from the shaft.

Old Colony Copper Company.

On December 20, 1916 the following announcement was made to stockholders of Old Colony by the directors of the company:

"Your directors desire to state that a plan has been agreed upon by the Boards of Directors of the Old Colony Copper Company and the Mayflower Mining Company for a consolidation of the two properties on an equal basis. The consolidated company will have about \$100,000 as a fund with which to begin shaft sinking to develop the mineral deposit which has been disclosed on both properties by the drilling just concluded. This sum will be contributed in approximately equal amounts by the two companies, and an assessment of 50 cents per share has therefore been levied on the shares of the Old Colony Copper Company to provide its share of this fund. The consolidated company, which is to be known as 'Mayflower-Old Colony Copper Company', will have an authorized capitalization of 200,000 shares, \$12.00 per share paid in, and will acquire all the property and assets of both companies on a share for share basis, and will be under the direction of Mr. H. F. Fay, identified with both companies since their organization, as President.

"The drilling campaigns heretofore conducted by both companies have developed to date a total tonnage on both properties, on an as-

sumed dip of 50 degrees, of approximately 32,000,000 tons, and have proven the continuity of the lode for a distance of about one mile on the strike. The work has been entirely original research in a territory never before explored, but the results thus far obtained indicate that it is a lode of unusual width, and the general average of all the values shows it to be a formation with a high degree of mineralization. The drilling has encountered many puzzling geological problems, but it has been thoroughly and scientifically performed, and has developed a mineral deposit which has been most persistent in the extensive area covered by the investigation.

"The results secured to date warrant shaft sinking to open up the deposit revealed by the diamond drilling, and a consolidation is the natural solution of the question of how best to demonstrate the value of both properties, and it is apparent that through a consolidation a duplication of mining operations can be avoided and many other economies effected.

"The two companies now have sufficient machinery and equipment to carry on shaft sinking to a considerable depth and also dwellings to accommodate the force required for this work."

Onondaga Copper Company.

Diamond drilling was discontinued in the summer of 1916, and, while the treasury has ample funds to resume exploration work, it is not probable that anything will be undertaken in the immediate future.

Osceola Consolidated Mining Company.

Osceola had another profitable year in all three branches in 1916.

Osceola Branch.

The grade of ore mined was even better than in 1915, and the yield per ton was 14.89 pounds. Mining operations were limited to No. 6 shaft. The workings south of No. 6 shaft near the boundary continued in good ground all the year. The 38th and 39th levels were particularly rich; the 40th and 41st reached the boundary line and the 42nd was driven across the line into La Salle territory.

North Kearsarge Branch.

At this branch more copper was produced in 1916 than in any other year since 1911. Only two shafts operated most of the time, and snow storms in the early part of the year hindered shipments to the extent of ever two weeks' production.

Repairs in No. 3 shaft, begun in June, 1915, were completed in the summer of 1916; hoisting was resumed in June, and production

gradually increased until it amounted to 450 tons per day at the end of the year.

Changes and improvements in drilling machines and drill steel were used to good effect throughout the mine. The average recovery of copper per ton of ore treated was considerably better than in recent years.

The mine is in good condition, and No. 3 shaft's production will probably be increased as fast as that of South Kearsarge falls off.

South Kearsarge Branch.

At this branch the recovery of copper per ton of ore was better than for several years, and on the whole 1916 was unusually profitable. A third more ore was produced during 1916 than was anticipated at the beginning of the year.

Mining the pillars of No. 2 shaft was continued to a limited extent, and a start was made on No. 1 shaft pillars. These pillars contain about 650,000 tons available for mining. During 1916 over a third of the ore treated came from foot-wall work, from cleaning out old stopes and from an old stock pile on the surface. With these sources exhausted, next year's product will be considerably reduced.

For premiums and bonuses see Calumet & Hecla Mining Company.

Porcupine Exploration Company.

This company was organized early in the year 1916 to explore the Nonesuch formation in the Porcupine Mountain district. The acreage controlled by the company is shown on the map of Ontonagon county.

Beginning at the N. $\frac{1}{4}$ post of section 23, about 16 diamond drill holes were put down in sections 23, 22 and 27 of 50-44. The general direction of the line of drill holes was about S. 35° W. The angle of all the holes was 60° and the holes varied in depth from 250 to 800 feet.

The beds cut by the drill and the average dips of the beds to the southeast are as follows:

Beds	Dips	
	Shallow	Deep
Freda sandstone about .....	..	59
Upper Grey Shale Group about.....	47	59
Upper Grit	52	63
Lower Banded Shale	50	60
Quartz Banded Shale	47	57
Lower Grit	47	57
No. 1 Shale	48	59
No. 1 Sandstone	46	60
No. 2 Parting Shale	46	59
No. 2 Sandstone	54	60
Red Sandstone	50	62

In the last few holes drilled the dip changed somewhat, indicating a bend in the formation to the west. Also in the last few holes drilled the copper values changed from native copper to chalcocite. The values found occurred at the base of the No. 1 shale, in the No. 1 sandstone, in the No. 2 shale and sometimes in the No. 2 sandstone.

Mr. A. G. Ballenberg, who was in charge of the exploration work, states that the only reason work was discontinued was the lack of copper in commercial quantities.

Quincy Mining Company.

Operations of the Quincy during 1916 showed a mining income of \$2,785,778.73.

There was a large amount of development work done throughout the mine, and in all of the openings the lodes developed averaged fairly well in copper. The yield of refined copper per ton of ore treated was 17½ pounds.

At the No. 2 shaft the ore was of better grade than in 1915, with the usual percentage of mass copper. The drifts on the various branches of the Pewabic lode continued throughout the year in good average grade ore. The lower levels of this shaft averaged better in copper than similar drifts during 1915.

Shafts Nos. 6 and 8 were sunk during the year. All drifts averaged well in copper, and more copper was found than in similar drifts the previous year. At No. 6 a better showing of copper is especially noticeable in the extreme lower levels.

Since about the middle of the year No. 7 shaft has been used to

hoist water during a part of one shift and for Hancock operations during the other full shift.

Extensive general repairs were made to buildings and ore dressing machinery at the stamp-mills. The smelter was extremely busy throughout the year, and about November 1st the briquetting plant, which had been idle for over five years, was again started in order to increase the capacity of the works.

Seneca Mining Company.

On April 13, 1916 the announcement was made that a syndicate composed of Thomas F. Cole, of Duluth, Tucker, Hayes & Bartholomew, with some associates, had secured control of over 60 per cent of the stock of the Seneca Mining Company, control of which was owned by the Calumet & Hecla Mining Company. The Seneca adjoins the Mohawk and Ahmeek and carries the Kearsarge lode on the dip.

It was further announced that a new corporation would be organized having 200,000 shares of stock. Thomas F. Cole was to be president of the new company and W. J. Uren, general manager. Immediate operations were planned to develop the south end of the property by sinking a shaft. This deal, however, did not materialize for various reasons.

In the early part of December announcement was made that Tucker, Hayes & Bartholomew, in association with Lewisohn Brothers of New York, had secured a renewal of the option from the Calumet & Hecla, carrying control of the Seneca Mining Company. It was proposed to form a new company, the Seneca Copper Company, with 250,000 shares, 200,000 shares to be issued at \$15 per share. W. J. Uren was named as general manager.

On December 23, 1916 the Calumet & Hecla sold its 11,207 shares of Seneca for \$60 a share, receiving \$672,420. In making this sale, it was stipulated that the other shareholders should receive an offer of \$60 a share for their shares, provided they were presented within a reasonable time.

Operations at the new Seneca will probably be begun in the spring of 1917 under the direction of W. J. Uren.

South Lake Mining Company.

South Lake continued development work, and total openings up to the end of the year 1916 show approximately one mile of drifts on the various lodes, a large proportion of the ground opened being of suitable character for stoping.

The long drift on No. 3 east at the 600 foot level south is being driven to make a connection with the Lake mine. This drift has opened considerable stretches of very good ground.

Production began in May with 627 tons of ore treated at the Franklin mill. This amount was increased gradually to 3,500 tons in December; a total of 20,057 tons being sent to the mill in the eight months from May to December inclusive. This 20,057 tons yielded, including mass, 476,280 pounds of concentrates. The estimated yield of refined copper is 285,600 pounds.

A steel rockhouse of modern design was constructed and is now in successful operation. Production during the first month of 1917 will probably be increased to double the average for the last eight months of 1916.

Superior Copper Company.

Operations during 1916 were confined to No. 1 shaft; no new work was attempted at No. 2 shaft during the year.

On the 17th level in the Superior lode, the last two available stopes are now being mined, and, with the exception of one stope on the 15th level, all ground above this point has been worked out.

On the 18th, 19th, 20th and 21st levels in the West lode, about 1,800 feet of drifts show copper ground of apparent value, representing about 150,000 tons of ore, stoping of which has not yet been started. If to this tonnage is added about 100,000 tons which remains in present active stopes, there is a total of approximately 250,000 tons still to be mined. This available ore lies within the only copper shoot evident in the lower drifts. The shoot has been found to extend from the 18th to the 21st levels and lies about 1,200 feet south of No. 1 shaft. It has not, however, shown sufficient size to warrant driving such long drifts in order to reach it, and it has therefore been decided to sink to the 33d level before conducting the further explorations which will probably determine the future of the mine.

During 1916 the shaft was sunk for the most part in trap rock between the Superior and West lodes. The shattered nature of the ground retarded sinking considerably, and the sinking was discontinued temporarily at a point below the 29th level. Sinking will be resumed as soon as possible and will be continued to the 33d level, at which point an extensive exploration of the various lodes will be conducted.

Tamarack Mining Company.

Tamarack's production for 1916 was nearly double that of 1915. The yield of refined copper per ton of ore treated was 18.2 pounds compared with 17.9 pounds in 1915. Good ground was opened in the newer stopes at the North Tamarack branch.

Tamarack made a good profit, although costs were very high. The regrinding plant at the mill was completed in the summer, but no machinery has as yet been installed.

The Tamarack mine is deep, and mining is expensive, but operated on a large scale and probably at considerable initial expense, Tamarack could make a profit even on 15 cent copper.

In the latter part of 1915 the Calumet & Hecla suggested that it might consider a purchase of the Tamarack property if an agreement could be reached as to its value. Mr. W. E. Parnall was accordingly employed by the Tamarack to examine and report on the value of the property. Mr. Parnall reported a valuation of the assets, other than ore in the ground, at \$4,616,734, from which would be deducted the company's debts of \$349,286. He found it impossible to place a value on the ore deposits. Mr. Parnall was of the opinion that a different method of mining on a large scale would be profitable.

Mr. MacNaughton, general manager of the mine, believed that it would not pay to operate Tamarack because of the high costs. He did not consider the unopened ore bodies of any value and did not believe that increasing the production would be profitable.

The result of several months' negotiations was that the Calumet & Hecla offered to purchase all the assets of the Tamarack, except its holdings of Mineral Range Railroad stock, for \$3,563,486, and to assume and pay the existing debts of the company. That meant \$59 a share to Tamarack stockholders. The offer was conditional upon the completion of the sale and delivery of the Tamarack property by June 1, 1916.

The sale was blocked by G. A. Hyams, a stockholder of the Tamarack. Late in August the directors of the Calumet & Hecla determined that under existing circumstances it was for the best interests of the company to distribute among its stockholders its holdings of Tamarack stock. A dividend was declared of 20,000 shares of the capital stock of Tamarack to be delivered to stockholders on August 31, 1916, at the rate of one-fifth of a share of the capital stock of the Tamarack for each share of the stock of the Calumet & Hecla. This distribution of Tamarack stock by the Calumet & Hecla to its shareholders was followed by the resignation of James

MacNaughton as general manager of the Tamarack. Mr. Charles S. Smith was elected president and Charles H. Altmiller, secretary and treasurer of the Tamarack company, and the main offices were removed to 50 Congress Street, Boston.

Tremont and Devon Mining Company.

The Tremont and Devon adjoins the Victoria to the west. In the spring of 1916 diamond drill exploration was started on the property, and three holes were drilled before the work was discontinued.

It is reported that in the first hole drilled the Devon lode was cut, showing 11 feet of good ore, and that in the third hole drilled the Forest lode was cut, showing nine feet of excellent ore. In this third hole the Devon lode, which is just above the Forest lode, did not show commercial values.

Trimountain Mining Company.

Trimountain's production for 1916 showed an increase of 417,662 pounds over that of 1915. Underground openings maintained the average quality. The use of waste stamp-sand for filling stopes was begun towards the end of the year, and a total of 17,700 cubic yards was run into the mine through old No. 1 shaft. Electric haulage was installed underground on several levels.

In March the stamp-mill was destroyed by fire. Fortunately there was sufficient surplus stamping capacity at the Baltic mill to treat the output of Trimountain, so no loss of production resulted.

Victoria Copper Mining Company.

Victoria made a record production of 1,661,832 pounds in 1916. Profit from mining operations was \$176,806.56. The company, however, carried on considerable construction work which reduced the profit for the year to \$85,330.87.

The improvements for increasing production made during the year consist of a new shaft to the 2,600 foot level, doubling of the shaft-house and equipment, doubling of the rockhouse and rock crushing capacity, a new Nordberg hoist and an auxiliary steam power plant at the stamp mill to supply power at times when the water is low. There is now shaft and hoisting capacity to take care of all exploration and development work in opening the mine to a depth of 5,000 feet.

The copper content per ton of ore stamped increased slightly. Stopes on the 23d, 24th and 26th levels were heavy producers throughout the year, and the other stopes throughout the mine were about normal. Very little development work was done during 1916.

With the new hoist now in operation, production in 1917 should show a marked increase.

White Pine Copper Company.

No. 2 vertical shaft was sunk to a point 151 feet below the 2d level. The collar of this shaft is 150 feet north of the main fault which is almost vertical. The lodes on the south side of the fault have been found by diamond drilling to be from 600 to 700 feet lower than the lodes on the north side. To further explore the lodes on the south side, No. 2 vertical shaft is now being sunk to a point 600 feet below surface, where it will be deflected southward along a curve of 500 feet radius and should enter the lode south of the fault at a point 970 feet from surface. From this point the shaft will follow the lode which dips at an angle of 45° to 50°.

No sinking was done at shafts Nos. 3 and 4. Drifts to east and west of No. 3 shaft showed fair or average values. The 4th and 5th levels west disclosed ground of poor quality and a much faulted lode.

At No. 4 shaft drifts were extended on all six levels. The greater part of the ground opened by these drifts is poor, with average ground showing in a few places.

Considerable diamond drilling was done during the year to locate the lodes south of the fault. A deep surface hole and four underground holes have cut the lodes. These holes are located from 100 to 200 feet south of the fault and are spread along a line parallel to the fault for over 2,400 feet. As mentioned above, this drilling has shown the lodes south of the fault to lie from 600 to 700 feet lower than those immediately north of the fault.

The average yield of refined copper per ton of ore treated was 22.27 pounds in 1916.

No changes were made at the stamp-mill during the year. A 50-ton Minerals Separation flotation unit is on the ground, preparatory to testing its efficiency in saving fine copper.

For premiums and bonuses see Calumet & Hecla Mining Company.

White Pine Extension Copper Company.

White Pine Extension is developing three mineralized beds of the Nonesuch formation. These beds are known as No. 1 shale, No. 2 shale and No. 3 sandstone. No. 1 shale is a wide shale, five feet along the foot of it assays about 15 pounds of copper per ton. Below this shale, with six feet of barren sandstone intervening, is No. 2 shale, four and one-half feet in width, assaying from 22 to 30 pounds per ton. About nine feet below the No. 2 shale, as exposed in underground crosscutting, is a fine-grained sandstone, 18 to 24 inches thick, assaying as high as 60 pounds per ton in some openings.

A vertical shaft has been sunk to a depth of 242 feet, 23 feet of which was through overburden. At a depth of 55 feet a crosscut was driven into the hanging of the shaft for a distance of 30 feet, exposing both No. 1 and No. 2 shale. No. 2 shale was drifted upon for 24 feet.

At a depth of 219.8 feet the second level was established, and a crosscut was driven in to the hanging for a distance of 45 feet. At the end of the year No. 2 shale had been drifted upon for a distance of 327 feet north and 338 feet south.

At intervals of 100 feet crosscuts were made from the drift on No. 2 shale into the hanging, exposing No. 1 shale, and at 100 feet north and 100 feet south of the shaft crosscuts were driven into the foot, showing the No. 3 sandstone. It is intended to continue this system of exploration on No. 1 shale and No. 3 sandstone by crosscuts as the drifts on No. 2 shale are extended.

A site has been selected for a 100-ton experimental mill, and plans for the mill are now under consideration in accordance with recommendations by T. G. Chapman of Tucson, Arizona. Prof. Chapman obtained a recovery of 85 per cent from White Pine Extension ore in the metallurgical laboratory of the Michigan College of Mines, by a combined process of slime tables and oil flotation.

Winona Copper Company.

Openings at Winona during 1916 showed about the usual run of ground, those in No. 1 King Philip, showing perhaps the best. By increasing the size of motors driving the Hardinge mills and using steel balls instead of flint pebbles, the amount ground in each mill was materially increased.

During the year a wooden shaft and rockhouse was constructed at King Philip No. 1 shaft.

The total production of refined copper in 1916 was considerably higher than in 1915, but the yield of copper per ton of ore treated dropped to 13.39 pounds.

Wolverine Copper Mining Company.

Wolverine's production for the year ending June 30, 1916, with the exception of 1913-1914, was the lowest since the year 1901-1902. This decrease in production was due to severe winter storms, heavy rains in the spring and to a shortage of labor for some months.

Openings made during the year showed fair to good mineralization. In addition to regular stoping and drifting, about 50 per cent of the ore hoisted was obtained by cutting out the lode along the foot in older and more recent stopes.

President Stanton states that the decrease in copper contents of ore is noticeable as the bottom limits of the company's territory are approached, but as the ore is of considerable commercial value, the mine will be opened to the bottom. It will require two years or longer to reach the bottom of the mine, and the directors believe that it will then require all of ten years to exhaust the mine, estimating a production equal to the average of the past three or four years.

Wyandot Copper Company.

Work during the year ending March 31, 1917 was confined largely to stoping on the 8th and 9th levels both east and west of the winze. Drifts on the 10th level were extended both east and west of the winze, and some drifting was also done on the 8th level drift west of the winze, all with more or less encouragement.

Supt. F. L. Van Orden states as follows:

"Our showing has been too encouraging to close the exploration without further investigation, yet, on the other hand, it has not been sufficiently encouraging to warrant us in assuming or believing we have an embryo mine."

Further efforts will be confined to drifting only, east and west of the winze. The 10th level drift west carries copper in more persistent quantities than any other opening to date.

During the year a mill test was made of 1,605 tons of ore which

refined 12.54 pounds of copper per ton, with 5.26 pounds left in the tailings.

A large storage bin is filled with selected ore ready for milling, and in addition to this there is some selected tonnage underground. A second mill test at a mill equipped with regrinding machinery should show much better results than the first test.

LIST OF ACTIVE COPPER MINING

Name of Company.	Location of Mine or Property.
Adventure Consolidated Copper Co.	Greenland, Ontonagon Co.
Ahmeek Mining Co.	Akmeek, Keweenaw Co.
Algomah Mining Co.	Lake Mine, Ontonagon Co.
Algonac Mineral Development Co.	Porcupine Mt. District, Ontonagon Co.
Allouez Mining Co.	Allouez, Keweenaw Co.
Baltic Mining Co.	South Range, Houghton Co.
Calumet & Hecla Mining Co.	Calumet, Houghton Co.
Carp Lake Mining Co.	Porcupine Mt. District, Ontonagon Co.
Cass Copper Co.	West of Victoria, Ontonagon Co.
Centennial Copper Mining Co.	Calumet, Houghton Co.
Champion Copper Co.	Painesdale, Houghton Co.
Cherokee Copper Co.	Between Indiana & Winona, Ontonagon Co.
Contact Copper Co.	Elm River, Houghton Co.
Copper Range Co.	Painesdale, Houghton Co.
Flint Steel.	Between Michigan & Mass Mines, Ontonagon Co.
Franklin Mining Co.	Demmon, Houghton Co.
Hancock Consolidated Mining Co.	Hancock, Houghton Co.
Houghton Copper Co.	North of Superior Mine, Houghton Co.
Indiana Mining Co.	Indiana, Ontonagon Co.
Isle Royale Copper Co.	Houghton, Houghton Co.
Keweenaw Copper Co.	Phoenix, Keweenaw Co.
Lake Copper Co.	Lake Mine, Ontonagon Co.
La Salle Copper Co.	South of Osceola Mine, Houghton Co.
Mass Consolidated Mining Co.	Mass, Ontonagon Co.
Mayflower Mining Co.	East of Wolverine Mine, Houghton Co.
Michigan Copper Mining Co.	Rockland, Ontonagon Co.
Mohawk Mining Co.	Mohawk, Keweenaw Co.
Naumkeag Copper Co.	Houghton, Houghton Co.
New Arcadian Copper Co.	East of Quincy Mine, Houghton Co.
New Baltic Copper Co.	East of Franklin Mine, Houghton Co.
North Lake Mining Co.	Lake Mine, Ontonagon Co.
Old Colony Copper Co.	East of Calumet, Houghton Co.
Onondaga Copper Co.	Porcupine Mt. District, Ontonagon Co.
Osceola Consolidated Mining Co.	Osceola, Kearsarge, Tamarack, Houghton Co.
Porcupine Exploration Co.	Porcupine Mt. District, Ontonagon Co.
Quincy Mining Co.	Hancock, Houghton Co.
South Lake Mining Co.	Greenland Jr., Ontonagon Co.
Superior Copper Co.	North of Baltic Mine, Houghton Co.
Tamarack Mining Co.	Calumet, Houghton Co.
Tremont & Devon Mining Co.	West of Victoria, Ontonagon Co.
Trimountain Mining Co.	Trimountain, Houghton Co.
Victoria Copper Mining Co.	Victoria, Ontonagon Co.
White Pine Copper Co.	Porcupine Mt. District, Ontonagon Co.
White Pine Extension Copper Co.	Porcupine Mt. District, Ontonagon Co.
Winona Copper Co.	Winona, Houghton Co.
Wolverine Copper Mining Co.	Kearsarge, Houghton Co.
Wyandotte Copper Co.	East of Winona, Houghton Co.

COMPANIES OF MICHIGAN, 1916.

General Office.	General Manager.	Superintendent.
32 Broadway, New York	James MacNaughton	E. W. Walker.
12 Ashburton Place, Boston	R. M. Edwards	S. Russell Smith.
60 Congress St., Boston	James MacNaughton	Thomas Bennett.
1905 Dime Bank Bldg., Detroit		Fred B. Close.
12 Ashburton Place, Boston		F. W. Ridley.
82 Devonshire St., Boston	F. W. Denton	Albert Mendelsohn.
12 Ashburton Place, Boston	James MacNaughton	John Knox.
Houghton, Mich.		Jerry Rourke.
Houghton, Mich.		A. H. Meuche.
12 Ashburton Place, Boston	James MacNaughton	F. W. Ridley.
82 Devonshire St., Boston	F. W. Denton	
Houghton, Mich.	W. A. Hodgson	J. A. Thomas.
70 State St., Boston		G. S. Goodale.
82 Devonshire St., Boston	F. W. Denton	
		Samuel Brady.
60 Congress St., Boston	R. M. Edwards	Enoch Henderson.
Hancock, Mich.	John L. Harris	
705 Sears Bldg., Boston		R. R. Seeber.
60 Congress St., Boston	R. M. Edwards	Thomas Bennett.
12 Ashburton Place, Boston	James MacNaughton	James E. Richards.
Calumet, Mich.	W. J. Uren	
82 Devonshire St., Boston		E. W. Walker.
12 Ashburton Place, Boston	James MacNaughton	Ole Hallingby.
79 Milk St., Boston		E. W. Walker.
705 Sears Bldg., Boston		G. S. Goodale.
15 William St., New York		Samuel Brady.
15 William St., New York	Theo. Dengler	W. F. Hartman.
61 Broadway, New York		S. S. Lang.
Houghton, Mich.	R. H. Shields	Otto Lieber.
Houghton, Mich.	R. H. Shields	
60 Congress St., Boston	R. M. Edwards	Thomas Bennett.
705 Sears Bldg., Boston		G. S. Goodale.
Houghton, Mich.	R. C. Pryor	H. W. Fesing.
12 Ashburton Place, Boston	James MacNaughton	F. H. Haller.
1517 Conway Bldg., Chicago		A. G. Ballenberg.
32 Broadway, New York	Chas. L. Lawton	
60 Congress St., Boston	R. M. Edwards	Thomas Bennett.
12 Ashburton Place, Boston	James MacNaughton	Ocha Potter.
12 Ashburton Place, Boston	James MacNaughton	J. T. Been.
Calumet, Mich.	W. H. Gibson	
82 Devonshire St., Boston	F. W. Denton	Roy Reynolds.
60 Congress St., Boston		George Hooper.
12 Ashburton Place, Boston	James MacNaughton	Thos. H. Wilcox.
15 William St., New York	Theo. Dengler	W. R. Bolley.
705 Sears Bldg., Boston		R. R. Seeber.
15 William St., New York	Theo. Dengler	W. R. Bolley.
68 Devonshire St., Boston		F. L. Van Orden.

MINERAL RESOURCES OF MICHIGAN.

SUMMARY OF RESULTS OBTAINED BY MICHIGAN COPPER MINING COMPANIES IN 1916.

	Tons of ore treated.	Cost of mining, transportation, and stamping per ton.	Pounds of concentrate obtained.	Pounds of refined copper produced.	Percent of refined copper in concentrate.	Pounds of refined copper per ton of ore treated.	Cost per pound at mine, excluding construction.	Cost per pound, construction.	Cost per pound smelting and freight, commission and eastern office.	Cost per pound interest paid.	Other costs per pound.	Total cost per pound.	Price received for copper sold.
Adventure.....	1,164,010	\$1.46		19,500		20.7	7.04c	1.33c	3.17			11.54c	30.0c
Ammeek.....	566,960	1.589		24,142,158		18.02	8.82	0.21	1.82			10.85	25.72c
Allouez.....	369,287	3.36		10,219,200		33.62	9.26		0.85			10.85	25.305
Baltic.....	3,166,274	2.03		12,425,804		22.53		0.60			0.74c	10.85	25.28
C. & H. (all ore) ¹				71,349,591								11.63	25.48
C. & H. (conglomerate)	1,727,794	2.63		51,785,016		29.97						10.75	
C. & H. (Osceola lode)	1,438,480	1.32		10,564,575		13.60						11.84	
Centennial.....	150,617	1.916		2,367,400		15.72	12.18		1.26			13.44	25.02
Champion.....	936,656	2.42		33,601,198		35.87	6.08		1.06		0.66c	7.80	25.28
Franklin.....	267,286			3,116,566									25.432
Hancock.....	203,112			2,824,924		13,908							28.093
Houghton.....	19,444,35		365,880	204,274		10.35							29.21
Isle Royale.....	925,419	1.53		12,412,711		13.4	11.38	0.71	3.10	0.05c	0.51c	15.75	25.86
Keweenaw.....	6,915		105,694	68,880		9.96							
Lake.....	70,440		2,346,970	1,489,247		21.14							29.726
La Salle.....	144,829	1.79		1,380,352		9.53	18.80	0.01	2.12	0.03		20.96	25.68
Mass.....	287,900		7,314,630	4,752,558		16.51						15.37	26.276
Mohawk.....	664,547	1.54	18,468,100	13,824,983		20.82	7.35		1.17			8.85	25.28
New Arcadian.....	41,301			19,32,307									24.0
Osceola.....	1,284,681	1.36	26,901,015	19,586,501		15.2	8.91	0.34	2.44			11.69	25.73
Quincy.....	1,204,026		33,864,280	21,065,612		17.5							25.5
South Lake.....	20,057		476,280	3,085,600		16.38	12.62		1.99			14.61	24.67
Superior.....	182,315	2.07	9,477,943	6,918,507		18.2	9.95						
Tamarack.....	363,649			8,720,538		24.94					0.26	11.10	25.28
Timountain.....	349,504												
Victoria.....	146,690		2,568,396	1,661,832		22.27	9.35	0.42	2.82	0.11		12.70	25.26
White Pine.....	188,890	2.082		4,207,449		13.39							28.03
Winona.....	161,828.55		3,700,180	2,167,255		17.07	8.11	0.11	1.32			9.54	20.62
Wolverine (1915-16)	388,898	1.39	9,127,790	6,641,492		12.54							23.75
Wyandot.....	1,605			19,973									
Totals.....	6,406,504.90		114,717,158	339,599,108									

¹This increase is due mainly to the extraordinary advance in ocean freight rates and marine and war risk insurance during 1916.

²Besides the mine production 5,412,649 pounds was recovered from the sand bank at Torch Lake.

³Estimated.

SUMMARY OF FINANCIAL STATEMENTS OF MICHIGAN COPPER MINING COMPANIES FOR 1916.

	Balance of Assets (+), Liabilities (-), December 31, 1915.	Operation Expenditures.	Receipts.			Net Profits from Operations.	Paid in Dividends.	Balance of Assets (+), Liabilities (-), December 31, 1916.
			Sale of Copper.	Sale of Silver.	Assessments.			
Adventure.....	+81,357.79	\$61,625.17	\$5,850.00	\$16,503.60	\$84,628.50	\$2,800,000.00	+553,783.73	
Ahmeeek.....	+1,583,654.13	2,785,781.47	6,210,244.67				+2,233,363.65	
Algonah.....	-18,133.65	26,044.53			70,000.00		+26,470.14	
Alouez.....	+963,810.83	1,109,168.55	2,586,011.13	47,668.20	60.00	900,000.00	+1,545,813.56	
Atlantic.....	+246,329.89	10,847.75					+259,657.34	
Bohemia.....	+128,741.30	3,259.11					+131,087.86 ¹	
Baltic.....	+1,440,516.25	1,379,943.53	3,141,243.25			7,500,000.00	+3,233,184.00	
Calumet & Hecla.....	+8,256,445.92	318,268.42	592,268.76			90,000.00	+10,758,601.75 ²	
Centennial.....	-273,118.50	2,638,194.31	8,494,367.18			6,014,540.96	+448,368.48	
Champion.....	+1,815,868.46						+1,671,933.76	
Cherokee.....	+39,791.62							
Cliff.....	+24,113.49	3,278.34					+21,335.14	
Contact.....	+18,948.96	18,937.16					+5,922.50	
Copper Range.....	+3,390,463.21	5,098,593.80	13,840,167.49			3,941,648.00	+5,558,460.25	
Franklin.....	+30,022.43	642,521.15	792,623.00			162,071.95	+192,094.02	
Hancock.....		771,514.86	755,946.16		117,016.00	103,687.70		
Houghton.....	+24,763.49	78,694.63	27,714.61		3,520.00		+24,419.50	
Indiana.....	+14,574.35	46,178.93					-30,236.62	
Isle Royale.....	+414,524.88	1,865,968.93	3,209,537.18	53,086.76		750,000.00	+362,359.02 ³	
Lake.....	+254,164.08	342,302.56	442,696.25					
La Salle.....	+94,636.49	289,397.94	354,409.23	13,843.80			+173,491.58	
Laurium.....	-19,312.88	5,159.91					-24,472.79	
Mass.....	+213,361.07	825,367.97	1,248,779.94	1,359.37		104,634.00	+449,255.02	
Mayflower.....	+52,990.74	17,728.87			7,081.00		+45,314.00	
Michigan.....	-117,907.16	82,625.40	16,074.52		25,960.82		-158,497.22	
Mohawk.....	+1,763,784.71	1,226,805.76	3,496,860.09			1,700,000.00	+2,333,839.04	
New Arcadian.....	+66,742.93	118,415.47	7,753.68		24,140.50		+21,315.53	
New Baltic.....	+20,360.92	60,882.38			60,659.00		+21,648.34	
North Lake.....	-15,656.20	56,188.99			100,000.00		+28,587.47	
Old Colony.....	+35,666.75							

Onondaga.....	+46,585.10							
Osceola.....	+1,728,237.33	2,288,974.46	5,040,012.69			1,826,850.00	+2,677,546.88	
Pacific.....	+26,639.36	2,663,176.30	5,374,715.32	26,159.10		1,760,000.00	+2,706.71	
Quincy.....	+1,664,956.46	173,717.94	37,129.63				+2,663,615.35	
South Lake.....	+16,958.11						+2,212.17	
St. Mary's.....	+289,544.32	443,532.05	748,732.40	26,732.72		480,000.00	+56,104.26	
Superior.....	+216,274.86					100,000.00	+434,312.98	
Tamarack.....	+1,204,980.94	992,575.24	2,204,557.06				+2,492,088.59	
Trumountain.....	+1,158,144.13						+15,389.97	
Union Copper.....	+13,745.45							
Victoria.....	+112,280.45	384,898.04	293,296.84			85,330.87	+197,611.32	
White Pine.....	+130,786.05	534,136.79	1,062,802.29	62,131.83		116,675.63	+613,907.75	
White Pine Extension.....		113,833.99					+48,233.19	
Winona.....	+293,324.11	545,201.97	473,583.08		9,044.00		+330,045.30	
Wolverine.....	+757,310.67	634,067.94	1,369,285.99			660,000.00	+862,528.72 ⁴	
Wyandot.....	+23,733.04	48,304.69	5,143.05		26,268.00		+16,643.63 ⁵	

¹For year ending Feb. 28, 1917.²Dividends received from other mining companies amounted to \$2,226,930.³For year ending April 30, 1917.⁴For year ending June 30, 1916.⁵For year ending March 31, 1917.

IRON INDUSTRY.

STATISTICAL TABLES.

IRON ORE SHIPMENTS FROM THE MARQUETTE RANGE.

Name of Mine.	1907 and prior years.	1908	1909	1910
American (Sterling)	127,113	23,222	90,001	163,290
Ames	6,298			
Barnum (Cliff Shaft)	801,851			
Bay State	16,637			
Bessemer (See Lillie)				
Bessie	59,097			
Beaufort (Ohio)	432,683	61,035	72,987	23,427
Blue (See Queen Group)				
Boston (with American)	62,542			
Braastad	136,636			
Mitchell	831,445			
Winthrop				
Breitung No. 1				
Breitung Hamatite No. 2	161,061	55,849	129,673	114,202
Buffalo	217,730			
Cambria	1,814,925	85,977	136,815	150,422
Champion	4,382,873	313	11,199	18,746
Chase				
Chester (See Rolling Mill)				
Chicago	9,012			
Cleveland	2,806,298			
Cleveland Hematite (Included under Cleveland)				
Cleveland Cliffs Group	13,924,094	438,379	877,433	955,374
Columbia (Kloman)	94,813			
Curry	16,671			
Dalliba (Phoenix)	59,114			
Detroit	140,841			
Dexter	118,512			
Dey	2,709			
East Champion	76,002			
East New York	327,604			
Edison	893			
Edwards (See Sampson)				
Empire	40,565	53,537	108,993	53,687
Erie	8,136			
Etna	1,091			
Fitch	31,817			
Foster	171,893			
Foxdale	31,447			
Gibson	16,357			
Goodrich	49,754			
Grand Rapids (Davis)	110,736			
Green Bay (See Bay State)				
Hartford	1,237,905	278,366	250,680	183,471
Himrod				
Holmes				
Hortense (North Champion)	30,574			
Home (P. and L. S.) (Now Volunteer)	26,022			
Humboldt (Washington)	713,961			
Imperial	212,982	48,231	115,478	83,404
Indiana (See Bay State)				
Iron Cliffs	1,700,537			
Iron Mountain	393			
Isabella				
Jackson	3,868,453		11,060	40,320
Keystone (See East Champion)				
Lake				
Lake Angeline	7,784,751	220,410	280,298	244,923
Lake Superior	14,320,173	261,955	349,435	271,445
Lillie	1,678,150	8,632	61,708	10,121
Loyd				
Lucy (McComber)	516,244	1,115	1,672	11,257
Maas	32,378	29,036	159,197	208,103
Magnetic (Stock Pile)	292			
Manganese (Negaunee)	6,359			

See foot notes 1, 2, 3, 4, 5, 6, 7, 8, 9 and 10 on page 72.

IRON ORE SHIPMENTS FROM THE MARQUETTE RANGE.

1911	1912	1913	1914	1915	1916	Total
195,197	122,211	162,253	84,845	87,514	246,163	1,301,809
						6,298
						801,851
						16,637
						59,097
2,683				21,139	40,007	653,961
						62,542
						136,636
						831,445
63,497	57,085	30,994	49,590	174,107	70,328	345,601
72,688	63,995	83,280	27,705	176,620	80,655	865,728
85,954	69,904	169,153	132,834	159,443	195,612	217,730
						3,001,039
						4,413,131
		52,930	19,708	39,059	72,344	184,041
						9,012
						2,806,298
514,305	1,032,836	922,005	672,428	1,631,358	1,022,461	20,990,673
						94,813
						16,671
						59,114
						140,841
						118,512
						2,709
						76,002
						327,604
						893
16,954	33,124	38,348			47,110	392,318
						8,136
						1,091
						31,817
						171,893
						31,447
						16,357
						49,754
						110,736
						1,950,422
			14,466	44,669	65,029	124,164
				17,373	3,379	20,752
						30,574
						26,022
						713,961
86,959	53,943	37,543				638,540
						1,700,537
				10,807	5,893	17,093
				36,255	97,368	133,623
22,303	53,559	1,519	20,241	56,026		4,073,481
167,258	151,910	102,762	128,073	19,513		9,099,898
167,352	169,326	164,834	133,519	199,920	422,473	16,460,432
25,597	26,119					1,810,327
28,003	44,224	135,746	123,211	195,975	281,502	808,661
16,676	72,724					619,688
24,926	46,664	171,475	55,903	267,190	259,897	1,254,769
						292
						6,359

See foot notes 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11 and 12 on page 73.

IRON ORE SHIPMENTS FROM THE MARQUETTE RANGE.—*Concluded.*

Name of Mine.	1907 and prior years.	1908	1909	1910
Marquette ¹	152,847			
Mary Charlotte	717,647	99,104	240,433	197,522
Mesabi's Friend	16,043			
Michigamme ⁶	880,362			
Miller	4,756			
Milwaukee-Davis	375,451			
Mitchell	17,780	11,539		23,428
Moore	68,131			
Morris				
National	150,216			
Negaunee	3,017,691	232,219	312,217	348,818
Negaunee Construction Works	12,708			
New York (York)	1,123,071			
New York Hematite	37,587			
North Champion (See Hortense)				
North Republic	289			
Nonpareil (St. Lawrence)	23,395			
Northwest	1,687			
Norwood	5,753			
Ogden	986			
Pascoe	59,806			
Pendill	45,993			
Palmer	14,172			
Palmer (Cascade) (See Volunteer)				
Pioneer	15,409			
Pittsburg & Lake Angeline (See Lake Angeline)				
Platt	73,844			
Portland			79,652	49,584
Primrose	6,040			
Prince of Wales ²	32,415			
Quartz	491			
Queen ²	180,866			
Queen Group ³	4,974,391	104,098	237,509	230,119
Republic	5,948,895	67,999	176,575	150,732
Republic Reduction Co.	47,174			
Richards	8,261			
Richmond	524,895	60,994	102,566	95,772
Riverside	16,160			
Rolling Mill	393,630	52,147	133,139	115,193
Saginaw	451,424			
Salisbury ⁵	686,411			
Sam Mitchell (See Mitchell)				
Sampson (Argyle)	267,805			
Shadt	1,261			
Section 12	21,887			
South Buffalo ²	245,412			
Spurr	165,244			
Star West (Wheat)	204,649			
St. Lawrence (See Nonpareil)				
Sterling (See American)				
Taylor	32,970			
Teal Lake (See Cambria)				
Titan	90,371			
Volunteer (See also Home)	1,393,175			
Washington		20,625	44,716	96,769
Webster	34,905			
West Republic	133,077			
Wetmore	50,870			
Wheeling	433,771			
Winthrop ³	1,335,839			
Wheat (See Star West)				
Totals	83,716,337	2,214,782	3,983,436	3,840,129

See foot notes 1, 2, 3, 4, 5, 6, 7, 8, 9, and 10 on page 72.

IRON ORE SHIPMENTS FROM THE MARQUETTE RANGE.—*Concluded.*

1911	1912	1913	1914	1915	1916	Total
340,335	250,700	262,431	57,138	159,817	164,447	152,847
						2,489,574
						16,043
						880,362
						4,756
7,781	11,536	10,310		6,572		411,650
21,387	21,141	15,970				111,245
						68,131
	1,529	18,394	29,063	80,546	58,497	188,029
						150,216
140,040	442,190	327,447	247,484	480,521	523,735	6,072,362
						12,708
						1,123,071
						37,587
						289
						23,395
						1,687
						5,753
						986
						59,806
						45,993
						14,172
						15,409
						73,844
						272,036
			45,324	97,476		6,040
						32,415
						419
						180,866
						7,238,899
295,962	224,862	235,648	178,574	473,961	283,775	7,226,887
113,137	156,867	135,879	52,562	215,182	209,059	
						47,174
						8,261
47,293	117,873	138,394	129,551	177,304	181,154	1,575,796
						16,160
96,584	115,784	163,287	98,010	130,900	253,943	1,552,617
						451,424
						686,411
						267,805
						1,261
						21,887
						245,412
						165,244
						204,649
						32,970
						90,371
51,240	9,008	47,220	38,438	118,851	106,987	1,664,919
62,010	66,540	60,171	1,659		6,631	359,121
						34,905
						133,077
						50,870
						433,771
						1,335,839
2,666,121	3,415,654	3,487,993	2,340,326	3,778,098	4,694,669	114,137,545

See foot notes 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11 and 12 on page 73.

- ¹Under Iron Cliffs 1890-1895; under Cleveland-Cliffs group after 1895.
²Under Queen group after 1890.
³Under Cleveland-Cliffs group after 1883.
⁴Includes Cleveland after 1883; includes Barnum, Foster, Iron Cliffs, Michigamme and Salisbury after 1895.
⁵Under Iron Cliffs 1891-1895; under Cleveland-Cliffs group after 1895.
⁶Under Cleveland-Cliffs group after 1895.
⁷Under Winthrop after 1892.
⁸Includes Buffalo, Prince of Wales, Queen and South Buffalo after 1890.
⁹Prior to 1890, see Braastad; includes Marquette after 1892.
¹⁰Included in Cleveland-Cliffs Group.

- ¹Iron Trade Review reports 152,063 tons shipped in 1915 by Breitung Hematite No. 1 and No. 2 combined.
²See foot note No. 1.
³Iron Trade Review reports 634,837 tons shipped in 1915.
⁴Iron Trade Review reports 203,922 tons shipped in 1915 by Mary Charlotte. Figure includes Himrod shipment.
⁵See foot note No. 4.
⁶Isabella shipment not reported by Iron Trade Review.
⁷Does not include Gwinn district. Does include west end of range in Baraga county.
⁸Iron Trade Review figure.
⁹Iron Trade Review reports 177,000 tons shipped in 1915.
¹⁰Iron Trade Review reports 130,902 tons shipped in 1915.
¹¹Iron Trade Review reports 18,850 tons shipped in 1915.
Total for Marquette range 1915, Iron Trade Review, 3,746,591 tons. See foot note No. 7.

IRON ORE SHIPMENTS FROM THE GWINN DISTRICT. (GROSS TONS)

	1907 and prior years.	1908	1909	1910
(Austin).....	195,950	111,229	125,858	188,588
Gwinn.....				
(Princeton) Swanzy or Chesire.....	1,192,204	36,033	42,934	89,441
Stegmiller.....			39,869	48,842
(Stephenson).....	6,305	52,588	64,075	225,726
Total.....	1,394,459	199,850	272,736	552,597

IRON ORE SHIPMENTS FROM THE GOGEBIC RANGE, MICHIGAN.

	1907 and prior years.	1908	1909	1910
Ada (included in Ironton).....				
Anvil and North Anvil.....	662,408	35,937	22,927	7,235
Ashland.....	4,867,933	259,611	259,612	231,506
Asteroid.....				
Aurora (Norrie-Aurora Group after 1904).....	3,961,684			
Bessemer.....	20,889			
Blue Jacket.....	1,799			
Brotherton.....	1,552,632	96,776	103,090	102,626
Castile.....	8,265		26,982	20,197
Chicago.....	68,727			
Colby.....	2,221,948	58,305	170,095	194,754
Davis (Wisconsin).....	103,961			
Eureka.....	224,148	122,324	115,662	41,611
Federal.....	36,443			
First National.....	1,997			
Geneva.....	7,108			
Imperial (See Federal).....				
Iron Chief.....	12,199			
Iron Chief No. 2.....	551			
Iron King (See Newport).....				
Ironton.....	479,359	92,932	277,594	109,025
Jack Pot.....	99,090			
Meteor (Comet).....	216,367			
Mikado.....	811,273	86,617	99,195	52,715
New Davis (See Davis).....				
Newport and Bonnie.....	4,257,295	579,390	1,008,354	1,182,324
Norrie-Aurora Group (after 1904).....	15,994,361	773,243	977,054	1,333,006
Pabst (Norrie-Aurora Group).....	2,366,583			
Palms.....	1,284,489			
Pike.....	70,255	6,303	22,174	3,324
Plymouth.....				
Puritan (Ruby).....	109,572			50,019
Royal.....				
Section 13.....				
South Chicago.....				
Sparta.....	4,862			
Sunday Lake.....	1,102,133	111,130	93,712	115,486
Tilden.....	4,822,945	111,184	154,506	99,937
Vaughan (See Aurora) (Norrie-Au- rora Group after 1904).....				
Wakefield.....				
Wisconsin (See Davis).....				
Yale (West Colby).....	286,841	14,874	71,458	108,253
Total.....	45,658,117	2,348,626	3,402,415	3,652,918

¹Iron Trade Review.
²Iron Trade Review reports 112,932 tons shipped 1915. This figure includes 17,692 tons shipped from the Minnewawa (Wisconsin).
³Iron Trade Review reports 1,408,516 tons shipped 1915.
⁴Iron Trade Review reports 838,875 tons shipped 1915.
⁵Iron Trade Review reports 442,422 tons shipped 1915.

IRON ORE SHIPMENTS FROM THE GWINN DISTRICT. (GROSS TONS)

1911	1912	1913	1914	1915	1916	Total
110,839	102,530	107,365	30,493		64,521	1,037,373
230			20,159	57,910	143,708	222,007
54,442	143,519	53,479	13,607	17,171		1,642,830
45,122	50,963	45,431	40,972	40,272	65,420	376,891
135,474	214,386	96,298	93,796	243,458	368,739	1,500,845
346,107	511,398	302,573	199,027	358,811	642,388	4,779,946

IRON ORE SHIPMENTS FROM THE GOGEBIC RANGE, MICHIGAN.

1911	1912	1913	1914	1915	1916	Total
310	55,610	238	5,771	744,749	120,355	955,540
151,478	211,927	2,635	123,702	94,622	70,466	6,273,492
20,569	70,239	42,419	135,120	13,468	88,867	370,682
						3,961,684
						20,889
						1,799
65,015	148,930	70,138	47,662	107,244	107,814	2,401,927
23,597	136,703	57,595	36,569	75,596	131,422	516,906
				30,977		99,704
41,673	245,195	305,744	291,947	315,913	423,553	4,269,127
98,609	65,723	14,562	23,430	128,414	206,319	1,040,802
						36,443
						1,997
		31,303		34,416	86,922	159,749
						12,199
						551
63,359	173,135	166,123	51,138		148,200	1,560,865
						99,090
						216,367
		33,111	2,094	1,044	23,741	1,109,790
				5,434	4,997	10,431
555,853	966,435	1,139,666	702,861	483,058	1,310,595	12,537,821
883,910	1,500,758	1,503,451	985,199	1,407,770	1,855,863	27,214,615
	39,152	88,644	173,792	444,673	528,746	2,366,583
						2,559,496
						102,056
					330,496	330,496
	90,683	64,463	58,410	80,367	308,534	762,048
		10,659	11,686	8,004	11,527	41,876
		3,844		32,356	48,070	84,270
				1,274		1,274
56,096	155,485	110,374	54,327	136,211	188,771	4,862
138,387	158,191	97,686	114,777	99,516	110,733	2,123,725
						5,907,862
		15,261	313,050	651,302	1,061,753	2,041,366
154,944	76,772	89,482	19,074	42,632	149,155	1,013,485
2,253,800	4,094,938	3,847,398	3,150,609	4,591,040	7,316,899	80,315,830

⁶Iron Trade Review reports 76,702 tons shipped 1915.
⁷Iron Trade Review reports 45,171 tons shipped 1915.
⁸Iron Trade Review reports 40,248 tons shipped 1915.
Total for Gogebic range 1915 Iron Trade Review 4,595,498 tons.
Total for Gwinn district 1915 Iron Trade Review 358,787 tons.

IRON ORE SHIPMENTS FROM THE MENOMINEE DISTRICT, MICHIGAN.

	1907 and prior years.	1908	1909	1910
Antoine.....	1,353,792			
Aragon.....	5,362,941	226,354	246,984	241,046
Breen.....	75,425			
Briar Hill.....	14,981			
Chapin.....	15,203,149	391,620	587,647	465,543
Clifford & Traders.....			103,626	91,081
Cornell.....	49,302			
Cuff.....	58,419			
Cundy.....	807,967	1,410	5,512	
Curry.....	416,928			
Cyclops.....	286,093			
Eleanor (Appleton).....	18,719			
Emmett.....	66,655			
Forest.....	11,988			
Half and Half.....	7,524			
Hamilton.....	96,072			
Hersel.....	955			
Indiana.....	17,871			
Keel Ridge.....	93,101			
Loretto.....	1,085,053	13,354	96,613	116,048
Ludington.....	1,001,518			
Millie (Hewitt).....	354,056	3,322	10,887	
Munro.....	227,542	27,773	23,241	20,022
Norway.....	1,291,352			
Penn Iron Mining Co.....	4,233,133	176,211	428,004	344,760
Perry.....	3,138			
Pewabic.....	6,086,946	365,341	465,453	380,376
Quinnesec.....	499,756		3,147	744
Saginaw (Perkins).....	443,322	38,669	19,994	
Stephenson.....	39,350			
Sturgeon River.....	19,404			
Verona.....	130,975			
Vivian.....	395,356	10,056		14,827
Vulcan (with Penn Mines).....	1,668,654			
Walpole.....	19,089			
Total.....	41,470,486	1,254,110	1,991,108	1,674,447
METROPOLITAN TROUGH.				
Groveland.....	40,036	9,123	24,933	26,462
Metropolitan.....	107,027			
Northwestern.....	35,810			
Total.....	182,873	9,123	24,933	26,462
CALUMET TROUGH.				
Calumet.....	106,132	15,222		

IRON ORE SHIPMENTS FROM THE MENOMINEE DISTRICT, MICHIGAN.

1911	1912	1913	1914	1915	1916	Total
						1,353,792
201,269	244,812	230,958	188,765	302,275	244,478	7,489,882
						75,425
						14,981
357,598	327,999	369,822	341,493	385,174	557,485	18,987,500
90,940	74,144	95,311	66,329		113,362	634,793
						49,302
						58,419
						844,889
						416,928
						286,093
						18,719
						66,655
						11,988
						7,524
						96,072
						955
				52,570	44,162	114,603
						93,101
18,579	135,177	158,257	45,449	68,806	174,173	1,911,509
						1,001,518
18,556			361			387,182
9,303	20,100	18,509			17,622	364,112
377,026	426,743	416,410	214,827	368,451	419,340	1,291,352
						6,985,565
						3,138
352,598	279,771	364,176	299,228	178,013	301,125	9,072,987
						503,647
						501,985
						39,350
						19,404
						130,975
5,971	28,800	27,177				482,187
						1,668,654
						19,089
1,431,840	1,537,546	1,680,620	1,156,452	1,355,289	1,871,747	55,423,645
33,758	12,468	9,251				156,031
						107,027
						35,810
33,758	12,468	9,251				298,868
	35,587	18,976				175,917

¹Iron Trade Review reports 384,654 tons shipped 1915.

²Iron Trade Review reports 411,393 tons shipped 1915.

Total for Menominee range 1915 Iron Trade Review 1,397,711 tons.

IRON ORE SHIPMENTS FROM THE CRYSTAL FALLS DISTRICT, MICHIGAN.

	1907 and prior years.	1908	1909	1910
Alpha	1,370			
Amasa Porter				65,473
Armenia	311,608			
Balkan				
Bristol (Claire)	1,598,242	190,300	396,825	270,742
Carpenter				
Columbia	942,703			
Crystal Falls	1,733,969	296	986	
Delphic	33,770			
Dunn	1,319,646	8,829	193,396	136,144
Fairbanks	8,500			
Genesee (Ethel)	405,854		65,585	66,185
Gibson	16,357	4,548	36,246	45,202
Great Western	1,635,236	124,246	112,747	80,709
Hemlock	1,393,503	83,834	112,481	115,407
Hilltop	20,229			
Hollister	10,469	10,671	25,842	49,434
Hope	28,530			
Judson				
Kimball	16,224			
Lamont (Monitor)	555,341			3,183
Lee Peck	2,844			
Lincoln	239,970		1,657	
Magnate	6,844			
Mansfield	939,652	44,633	118,713	114,357
Mastodon	425,708			
McDonald			1,114	6,022
Michigan	153,184	603		17,922
Monongahela	9,310			
Odgers				
Paint River (Fairbanks)	371,289			
Ravenna				
Richards				
Sheldon & Shafer (Union) (See Col- umbia)				
South Mastodon	8,203			
Tobin	873,427	161,642	359,668	235,812
Warner				
Youngstown	151,425			
Total	13,213,407	629,602	1,425,261	1,206,592

IRON ORE SHIPMENTS FROM THE CRYSTAL FALLS DISTRICT, MICHIGAN.

1911	1912	1913	1914	1915	1916	Total
						1,370
					80,492	80,492
51,862	150,808	83,202	50,501			713,454
322,729	438,900	379,169	172,006	144,284	229,195	373,479
			51,147	378,831	462,801	4,610,545
				284,187	240,114	575,448
						942,703
						1,735,251
						33,770
232,092	242,304	61,080	52,883	8,304		2,254,678
						8,500
25,342	4,248			1,184		568,398
56,528						158,881
84,338	3,342	50,464		35,759		2,126,840
107,753	126,132	113,201	46,449	28,172		2,126,932
			8,223			28,452
5,022		25,251	16,430			143,119
						28,530
			6,619		162,519	169,138
				19,533		35,757
						558,524
						2,844
						241,627
						6,844
54,646		190,503				1,462,504
						425,708
5,240	1,384	16,499				30,259
		27,917	9,471	112,721	28,483	350,311
					21,920	21,230
					53,176	53,176
						371,289
127	18,303	70,766	49,308	116,735	3,476	258,715
			7,069	92,807	29,381	129,257
						8,203
308,456	319,318	154,896	65,351	18,624	146,113	2,643,307
				46	33,751	33,797
						151,425
1,254,135	1,304,739	1,172,948	535,457	1,241,187	1,491,421	23,474,757

¹Iron Trade Review reports 378,786 tons shipped 1915.

²Iron Trade Review reports 284,088 tons shipped 1915.

³Iron Trade Review reports 116,724 tons shipped 1915.

⁴Not reported by Iron Trade Review.

⁵Not reported by Iron Trade Review.

⁶Iron Trade Review reports Hemlock 28,172 tons, Michigan 112,680 tons shipped 1915.

Total for Crystal Falls district 1915 Iron Trade Review 1,240,946 tons.

IRON ORE SHIPMENTS FROM THE IRON RIVER DISTRICT, MICHIGAN.

	1907 and prior years.	1908	1909	1910
Baker.....			45,003	39,417
Baltic.....	865,200	129,037	174,426	171,930
Bates.....				
Bengal.....				
Berkshire.....		3,440	34,295	97,999
Beta.....	4,211			
Caspian.....	236,320	102,628	189,023	171,334
Cortland.....				
Cottrell.....				
Chatham-Riverton.....	14,883	45,826	68,730	51,988
Davidson No. 1.....				
Davidson No. 2.....				
Chicago.....				
Fogarty.....	7,949	32,560	77,356	51,071
Forbes.....				
Hiawatha.....	210,683	138,190	136,739	128,884
Homer.....				
Iron River.....	904,587			
James (Osana).....	2,360	59,760	90,851	78,388
*Dober-Isabella.....	65,192			
Nanaimo.....	373,460	305		
Riverton (Dober and Isabella).....	922,825	47,073	171,200	84,269
Rogers.....				
Selden.....	2,092			
Sheridan.....	116,299			
Tully.....				2,726
Virgil.....				
Wauseca.....				
Wickwire.....				
Youngs.....	151,141	70,094	154,150	98,399
Zimmerman.....		1,832	10,303	25,555
Total.....	3,877,202	630,745	1,152,076	1,001,960

*Riverton.

IRON ORE SHIPMENTS FROM THE IRON RIVER DISTRICT, MICHIGAN.

1911	1912	1913	1914	1915	1916	Total
3,290		24,286	113,733	41,378		267,107
66,502	100,736	130,631	29,206	10,078	110,965	1,788,711
				45,171	72,275	117,446
		23,259	5,539	39,615	140,961	209,374
22,272	33,422		23,826	15,413	38,470	269,137
						4,211
165,660	306,914	295,841	279,379	479,083	448,631	2,674,813
	17,499	26,823	15,316			59,638
58,054	135,298	107,604	19,455	45	75,089	75,134
				132,664	188,807	823,309
215	27,614	115,499	70,881	86,103	96,518	396,830
45,219	98,760	79,948	51,686	66,327	67,731	409,671
108,947	149,619	137,002	114,849	155,411	100,640	766,468
67,616	84,074	124,568	15,329	27,718	89,506	577,747
		69,435	77,960	99,219	121,010	367,624
116,633	220,106	160,511	91,370	93,453	187,070	1,483,639
				102,511	156,528	259,039
50,439	75,702	176,634	73,832	102,294	136,645	904,587
						846,905
						65,192
200,142	171,493	160,818	176,274	262,382	174,992	373,765
			27,081	53,155	81,842	2,371,468
						162,078
8,323		16,650	63,411	242,049	236,302	2,092
						116,299
	3,750	48,395	5,972		35,948	569,461
749	12,377			19,361	30,470	94,065
1,919	40,417	40,322	25,584		12,890	62,957
89,450	83,528	43,649			53,691	121,132
110,084	187,584	149,309	172,720	108,218	138,881	744,102
						904,486
1,115,514	1,736,516	1,943,560	1,453,403	2,181,694	2,795,862	17,888,532

†Iron Trade Review reports 132,779 tons shipped 1915.

‡Iron Trade Review reports 155,711 tons shipped 1915.

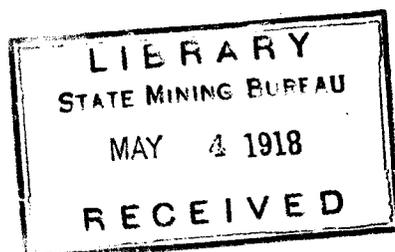
§Iron Trade Review reports 99,050 tons shipped 1915.

Total for Iron River district 1915, Iron Trade Review 2,182,934 tons.

MINERAL RESOURCES OF MICHIGAN.

SUMMARY OF IRON ORE SHIPMENTS FROM MICHIGAN RANGES. (GROSS TONS.)

	1903 and prior years.	1904	1905	1906	1907
Marquette.....	69,074,846	2,767,242	4,086,943	3,935,293	3,907,955
Gwinn.....	642,907	76,461	129,079	166,894	380,118
Menominee.....	31,563,402	1,712,800	2,741,169	2,953,131	2,498,784
Crystal Falls.....	8,093,686	917,969	1,174,366	1,395,910	1,631,484
Iron River.....	2,096,091	284,273	337,973	568,469	589,946
Gogebic.....	34,555,808	2,042,398	3,215,352	3,113,981	3,093,083
Metropolitan.....	164,323	4,737			13,913
Calumet.....	38,913			15,773	51,646
Total.....	146,229,876	7,805,880	11,684,432	12,149,451	12,166,929
	1908	1909	1910	1911	1912
Marquette.....	2,214,782	3,983,436	3,840,129	2,614,881	3,406,646
Gwinn.....	199,850	272,736	552,597	346,104	510,398
Menominee.....	1,254,110	1,991,108	1,674,447	1,421,840	1,538,746
Crystal Falls.....	629,602	1,425,261	1,206,592	1,254,135	1,304,739
Iron River.....	630,745	1,152,076	1,001,960	1,115,514	1,736,966
Gogebic.....	2,348,626	3,402,415	3,652,918	2,102,322	3,883,011
Metropolitan.....	9,123	24,933	26,462	33,758	12,468
Calumet.....	15,222				35,387
Total.....	7,302,060	12,251,965	11,955,105	8,898,554	12,428,361
	1913	1914	1915	1916	Total
Marquette.....	3,487,993	2,340,326	3,778,098	4,694,669	114,137,545
Gwinn.....	302,573	199,027	358,811	642,388	4,779,946
Menominee.....	1,680,620	1,156,452	1,355,289	1,871,747	55,423,645
Crystal Falls.....	1,172,948	535,457	1,241,187	1,491,421	23,474,757
Iron River.....	1,943,560	1,453,403	2,181,694	2,795,862	17,888,532
Gogebic.....	3,847,398	3,150,609	4,591,040	7,316,885	80,315,846
Metropolitan.....	9,251				298,868
Calumet.....	18,976				175,917
Total.....	12,463,319	8,835,274	13,506,119	18,812,972	296,495,056



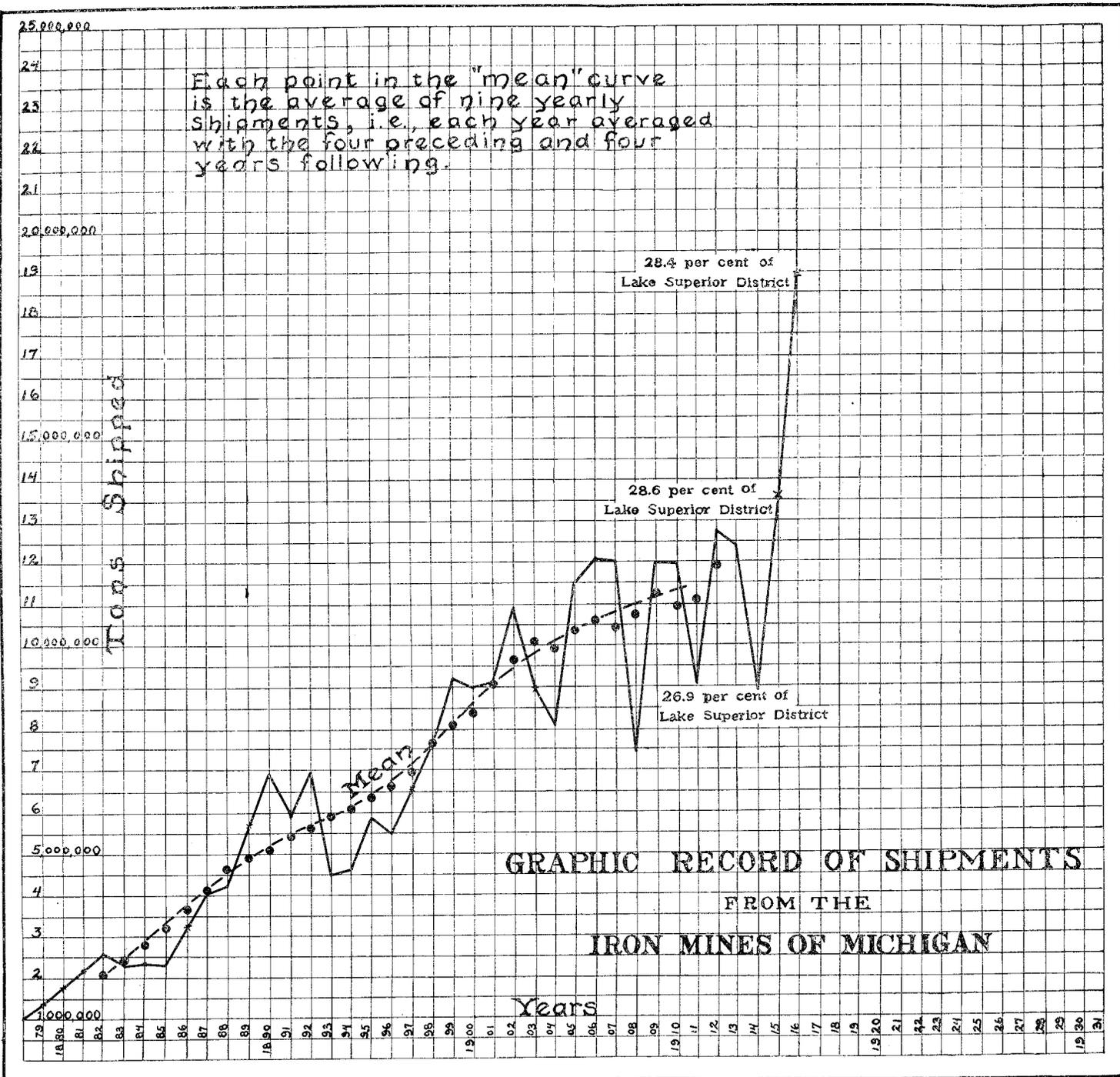


Fig. 3.

SUMMARY

Marquette
Gwinn
Menominee
Crystal F

Iron River
Gogebic
Metropolitan
Calumet

Tot

Marquette
Gwinn
Menominee
Crystal F

Iron River
Gogebic
Metropolitan
Calumet

Ma
Gw
Me
Cr

Ir
G
M
C

SHIPMENTS OF IRON ORE FROM MICHIGAN RANGES BY COUNTIES.
(GROSS TONS.)

County.	1903 and prior years.	1904	1905	1906	1907
Gogebic.....	34,555,808	2,042,398	3,215,352	3,113,981	3,093,083
Iron.....	10,189,777	1,202,242	1,512,339	1,964,379	2,221,430
Dickinson.....	31,766,538	1,717,537	2,741,169	2,968,904	2,564,343
Marquette.....	68,962,760	2,817,195	4,175,605	4,097,111	4,154,288
Baraga.....	744,993	26,508	39,967	5,076	133,785
Total.....	146,229,876	7,805,880	11,684,432	12,149,451	12,166,929

County	1908	1909	1910	1911	1912
Gogebic.....	2,348,626	3,402,415	3,652,918	2,102,322	3,883,011
Iron.....	1,260,347	2,577,337	2,208,552	2,369,649	3,041,705
Dickinson.....	1,278,455	2,016,041	1,700,909	1,465,598	1,585,601
Marquette.....	2,305,366	3,888,055	4,236,311	2,871,116	3,864,401
Baraga.....	109,266	368,117	156,415	89,642	53,943
Total.....	7,302,060	12,251,965	11,955,105	8,898,327	12,428,361

County	1913	1914	1915	1916	Total
Gogebic.....	3,836,739	3,150,609	4,591,040	7,316,885	80,315,846
Iron.....	3,116,508	1,988,860	3,422,881	4,287,283	41,363,289
Dickinson.....	1,708,847	1,156,452	1,355,289	1,871,747	55,898,430
Marquette.....	3,753,023	2,494,029	4,018,294	5,297,050	116,910,747
Baraga.....	37,543	45,324	118,615	40,007	2,006,744
Total.....	12,452,660	8,835,274	13,506,119	18,812,972	296,495,056

[AVERAGE NUMBER OF MEN EMPLOYED IN THE IRON MINES OF MICHIGAN IN 1916 BY COUNTIES.

	Gogebic	Iron	Dickinson	Baraga	Marquette
Total employed in producing mines = 17,544.....	6,496	4,275	2,364	73	4,336
Total in idle mines and explorations = 455...	10	230	none	none	215
Total = 17,999*....	6,506	4,505	2,364*	73	4,551*

*Indiana mine in Dickinson County not reported. Empire mine in Marquette County not reported.

LIST OF THE ACTIVE IRON MINES OF MICHIGAN

Name of mine.	Location.				First ship- ment.	No. of men employed 1916.	Depth, 1916, Feet.
	County.	Section.	Twp.	Rge.			
MARQUETTE RANGE:							
American and Boston	Marquette.	32	48	28	1880	294	1,620
Breitung Hematite No. 1	Marquette.	8	47	26	1903	140	960
Breitung Hematite No. 2	Marquette.	8	47	26	1907	90	640
Cambria	Marquette.	35	48	27	1875	122	978
Champion	Marquette.	31,32	48	29	1867	.....	1984
Chase	Marquette.	3	47	28	1913	.....	351
Cliff Shaft	Marquette.	9,10	47	27	1887	336	987
Empire	Marquette.	19	47	26	1907	*	200
Gwinn	Marquette.	28	45	25	1914	181	1,009
Hartford (Cambria No. 2)	Marquette.	36	48	27	1889	.....	.....
Himrod (see Mary Charlotte)	Marquette.	7	47	26	1914	.....	640
Imperial	Baraga.	25	48	31	1890	1	185
Isabella	Marquette.	29,32	47	26	1915	151	702
Jackson	Marquette.	1	47	27	1846	.....	.....
Lake and Moro	Marquette.	10	47	27	1892	284	591
Lake Sally	Marquette.	14	47	27	1915	8	.....
Lake Superior (Hard Ore)	Marquette.	9,10	47	27	1858	319	1,080
Lake Superior (Soft Ore)	Marquette.	10	47	27	1858	7	820
Lake Angeline (Angeline)	Marquette.	15	47	27	1864	26	615
Lloyd (see Morris)	Marquette.	6	47	27	1911	.....	808
Lucy (with Jackson)	Marquette.	6,7	47	26	1878	.....	.....
Maas	Marquette.	31	48	26	1907	220	1,100
Maitland (Volunteer)	Marquette.	30	47	26	1907	.....	506
Mary Charlotte	Marquette.	8	47	26	1903	275	640
Morris and Lloyd	Marquette.	1	47	28	1912	291	860
Moro with Lake	Marquette.	10	47	27	1881	.....	.....
Negaunee	Marquette.	5,6	47	26	1887	358	1,086
Ohio	Baraga.	22	48	31	1882	72	250
Portland	Baraga.	26	48	31	1896	.....	.....
Queen Group	Marquette.	5	47	26	1888	212	1,010
Republic	Marquette.	7	46	29	1872	269	2,150
Richmond	Marquette.	28	47	26	1896	85	.....
Rolling Mill	Marquette.	7	47	26	1872	86	786
Salisbury	Marquette.	15	47	27	1872	123	941
Volunteer	Marquette.	30	47	26	1871	93	506
Washington (Barron)	Marquette.	11	47	29	1865	10	875
SWANZY DISTRICT:							
Austin	Marquette.	20	45	25	1907	53	364
Princeton	Marquette.	18,20	45	25	1872	8	782
Stegmiller	Marquette.	17	45	25	1909	59	300
Stephenson	Marquette.	20	45	25	1907	236	562
MENOMINEE RANGE:							
Aragon	Dickinson.	8,9	39	29	1889	349	1,355
Chapin	Dickinson.	25,30	40	31,30	1880	720	1,501
Cyclops & Norway (Penn Grip)	Dickinson.	5	39	29	1878	.....	355
East Vulcan (Penn Group)	Dickinson.	10,11	39	29	1877	756	1,400
Indiana	Dickinson.	27	40	30	1915	*	85
Loretto	Dickinson.	7	39	28	1893	183	800
Millie (Hewitt)	Dickinson.	31	40	34	1881	1	312
Munro	Dickinson.	6	39	29	1903	40	170
Pewabic	Dickinson.	32	40	30	1890	249	941
West Vulcan, Curry & Brier Hill	Dickinson.	9,10	39	29	1879	.....	1,770
Clifford and Traders	Dickinson.	20	40	30	.....	66	143

*Not reported.

†Undeveloped.

1916, WITH LOCATION, OWNERSHIP, ETC.

Number or name of level.	Operators.	Address of Home Office.
20th	American Boston Mining Co.	1300 Leader-News Building, Cleveland, Ohio.
9th	Breitung Hematite Mng. Co.	Marquette, Mich.
6th	Breitung Hematite Mng. Co.	Marquette, Mich.
5th	Republic Iron & Steel Co.	Youngstown, Ohio.
35rd	Champion Iron Co.	Wolvin Building, Duluth, Minnesota.
3rd	Cleveland Cliffs Iron Co.	Ishpeming, Mich.
10th	Cleveland Cliffs Iron Co.	Ishpeming, Mich.
2nd	Empire Iron Co.	Rector Building, Chicago, Illinois.
8th	Cleveland Cliffs Iron Co.	Ishpeming, Mich.
.....	Republic Iron & Steel Co.	Youngstown, Ohio.
6th	Mary Charlotte Mng. Co.	Marquette, Mich.
4th	Cleveland Cliffs Iron Co.	Ishpeming, Mich.
1st	Cascade Mining Co.	Hibbing, Minn.
.....	Cleveland Cliffs Iron Co.	Ishpeming, Mich.
5th	Cleveland Cliffs Iron Co.	Ishpeming, Mich.
.....	Jones & Laughlin Ore Co.	Pittsburg, Penn.
1080 L	Oliver Iron Mining Co.	Wolvin Building, Duluth, Minn.
820 L	Oliver Iron Mining Co.	Wolvin Building, Duluth, Minn.
9th	Pittsburg & Lake Angeline Iron Co.	Cleveland, Ohio.
3rd	Cleveland Cliffs Iron Co.	Ishpeming, Mich.
.....	Cleveland Cliffs Iron Co.	Ishpeming, Mich.
3rd	Cleveland Cliffs Iron Co.	Ishpeming, Mich.
.....	Cleveland Cliffs Iron Co.	Ishpeming, Mich.
3rd	Volunteer Ore Co.	1400 Alworth Bld., Duluth, Minn.
6th	Mary Charlotte Mining Co.	Marquette, Mich.
4th	Cleveland Cliffs Iron Co.	Ishpeming, Mich.
.....	Cleveland Cliffs Iron Co.	Ishpeming, Mich.
9th	Cleveland Cliffs Iron Co.	Ishpeming, Mich.
6th	Niagara Iron Mining Co.	North Tonawanda, N. Y.
.....	Niagara Iron Mining Co.	North Tonawanda, N. Y.
1010 L	Oliver Iron Mining Co.	Wolvin Bldg., Duluth, Minn.
2150 L	Cleveland Cliffs Iron Co.	Ishpeming, Mich.
.....	Richmond Iron Co.	1300 Leader-News Bldg., Cleveland, Ohio.
8th	Jones & Laughlin Ore Co.	3d Ave. & Try St., Pittsburg, Pa.
19th	Cleveland Cliffs Iron Co.	Ishpeming, Mich.
5th	Volunteer Ore Co.	1400 Alworth Bldg., Duluth, Minn.
10th	Washington Iron Co.	Marquette, Mich.
.....	Cleveland Cliffs Iron Co.	Ishpeming, Mich.
6th	Cleveland Cliffs Iron Co.	Ishpeming, Mich.
6th	Cleveland Cliffs Iron Co.	Ishpeming, Mich.
2nd	American Mining Co.	Western Reserve Building, Cleveland, Ohio.
5th	Cleveland Cliffs Iron Co.	Ishpeming, Mich.
.....	National Tube Works Co.	Frick Bldg., Pittsburg, Pa.
14th	Chapin Mining Co.	Wolvin Bldg., Duluth, Minn.
17th	Penn Iron Mining Co.	1703 Morris Bldg., Philadelphia, Pa.
.....	Penn Iron Mining Co.	1703 Morris Bldg., Philadelphia, Pa.
1st	Thomas Furnace Co.	Milwaukee, Wis.
8th	Loretto Iron Co.	1400 Fulton St., Chicago, Ill.
3rd	Dessau Mining Co.	Care B. J. Clergue, Montreal, Que.
2nd	Munro Iron Mining Co.	55 Erie Co. Bank Bldg., Buffalo, N. Y.
8th	Pewabic Co.	910 Wells Bldg., Milwaukee, Wisconsin.
18th	Penn Iron Mining Co.	1703 Morris Bldg., Philadelphia, Pa.
1st	Antoine Ore Company	Republic Building, Youngstown, Ohio.

LIST OF THE ACTIVE IRON MINES OF MICHIGAN.

Name of mine.	Location.				First ship-ment.	No. of men employed 1916.	Depth, 1916, feet.
	County.	Section.	Twp.	Rge.			
CRYSTAL FALLS DISTRICT:							
Amasa Porter	Iron	22, 33	44	33	1916	85	400
Bristol	Iron	19	43	32	1892	200	1,060
Carpenter	Iron	31	43	32	1914	246	330
Dunn-Richards	Iron	1	42	33	1887	98	1,623
Genesee (with Tobin)	Iron	29, 30, 31	43	32	1902		
Great Western	Iron	21	43	32	1882	1	1,257
Hemlock	Iron	4	44	33	1891	5	1,015
Judson	Iron	13	42	33	1914	158	300
Michigan (with Hemlock)	Iron	9	44	33	1893		1,015
Odgers	Iron	30	43	32	1916	125	150
Ravenna	Iron	19	43	32	1911	49	350
Tobin	Iron	30	43	32	1901	254	1,335
Warner	Iron	9	44	33	1915	59	740
IRON RIVER DISTRICT:							
Baker-Tully	Iron	31	43	34	1909	285	548
Balkan	Iron	13	42	33	1915	137	232
Baltic	Iron	7	42	34	1901	242	533
Bates	Iron	19	43	34	1915	96	850
Bengal	Iron	36	43	35	1913	186	280
Berkshire	Iron	6	42	34	1908	70	365
Caspian	Iron	1	42	35	1903	363	292
Chatham-Riverton	Iron	35	43	35	1907	178	925
Chicago	Iron	26	43	34	1911	109	712
Cortland	Iron	34	43	35	1912		405
Cottrell	Iron	1	42	35	1915	56	265
Davidson No. 1	Iron	23	43	35	1912	70	450
Davidson No. 2	Iron	14	43	35	1912	78	240
Fogarty (see Baltic)	Iron	1	42	35	1907		365
Forbes	Iron	14	43	35	1913	117	275
Hiawatha	Iron	35	43	35	1893	101	1,029
Homer	Iron	22, 23	43	35	1915	154	350
Osana (James)	Iron	23	43	35	1907	117	428
Dober Isabella (Riverton)	Iron	1, 35, 36	42, 43	35	1898	96	1,000
Rogers	Iron	29	43	34	1914	139	330
Tully (see Baker)	Iron	36	43	35	1910		438
Virgil	Iron	24	43	35	1912	46	273
Wauseca	Iron	23	43	35	1910	48	398
Wickwire	Iron	35	43	35	1911	23	313
Youngs	Iron	12	42	35	1905	106	575
Zimmerman	Iron	7	42	34	1908	178	350
GOGEBIC RANGE:							
Anvil	Gogebic	14	47	46	1887	4	1,663
Asteroid	Gogebic	13	47	46	1906	136	1,130
Ashland	Gogebic	22	47	47	1885	150	1,900
Brotherton	Gogebic	9	47	45	1886	103	1,157
Castile	Gogebic	10	47	45	1906	155	1,770
Colby and Ironton	Gogebic	16	47	46	1884	760	1,314
Davis, Geneva, Royal,		17, 18					
Puritan	Gogebic	19, 20	46	47	1886	398	1,754
Eureka	Gogebic	13	47	46	1890	240	1,950
Ironton (see Colby)	Gogebic	17	47	46	1886		
Keweenaw	Gogebic	11	47	46	1914	116	1,663
Mikado	Gogebic	18	47	45	1895	65	1,131
Newport and Bonnie	Gogebic	24	47	47	1886	880	2,168
Norrrie-Aurora Group	Gogebic	22, 23	47	47	1884	1,845	1,676
Palms	Gogebic	14	47	46	1912	464	1,663
Plymouth	Gogebic	18	47	45	1916	161	*
Puritan (see Davis)	Gogebic	17	47	46	1886		
Sunday Lake	Gogebic	10	47	45	1885	210	1,391
Tilden	Gogebic	15	47	46	1891	241	1,526
Wakefield	Gogebic	16, 17	47	45	1913	452	*
Yale	Gogebic	16	47	46	1901	116	1,757

*Open pit.

1916, WITH LOCATION, OWNERSHIP, ETC.—Concluded.

Number or name of level.	Operators.	Address of Home Office.
11th	Bristol Mining Co.	Wade Building, Cleveland, Ohio.
4th	Nevada Mining Co.	Duluth, Minnesota.
1st	Hollister Mining Co.	1300 Leader-News Bldg., Cleveland, Ohio.
13th	Corrigan, McKinney Co.	Wickliffe, Ohio.
16th	Corrigan, McKinney Co.	Wickliffe, Ohio.
14th	Hemlock River Mining Co.	Cleveland, Ohio, Western Reserve Bldg.
3rd	Judson Mining Co.	First National Bank Bldg., Chicago, Illinois.
.....	Hemlock River Mining Co.	Cleveland, Ohio, Western Reserve Bldg.
1st	Hudson Iron Mining Co.	Wickliffe, Ohio.
2nd	Hollister Mining Co.	1300 Leader News Bldg., Cleveland, Ohio.
13th	Corrigan, McKinney Co.	Wickliffe, Ohio.
7th	Hemlock River Mining Co.	Cleveland, Ohio, Western Reserve Bldg.
4th	Corrigan, McKinney Co.	Wickliffe, Ohio.
1st	Balkan Mining Co.	Cleveland, Ohio, Western Reserve Bldg.
7th	Verona Mining Co.	Cleveland, Ohio, Western Reserve Bldg.
850 L	Bates Iron Co.	New York City, 25 Broad St.
2nd	Verona Mining Co.	Cleveland, Ohio, Western Reserve Bldg.
4th	Brule Mining Co.	76 Wade Building, Cleveland, Ohio.
3rd	Verona Mining Co.	Cleveland, Ohio, Western Reserve Bldg.
9th	Brule Mining Co.	76 Wade Bldg., Cleveland, Ohio.
7th	Munro Mining Co.	55 Erie Co. Bank Bldg., Buffalo, N. Y.
4th	Wickwire Mining Co.	Buffalo, N. Y.
3rd	Oliver Iron Mining Co.	Duluth, Minn., Wolvin Bldg.
450 L	Davidson Ore Mining Co.	403 White Bldg., Buffalo, N. Y.
2nd	Davidson Ore Mining Co.	403 White Bldg., Buffalo, N. Y.
4th	Verona Mining Co.	Western Reserve Bldg., Cleveland, Ohio.
2nd	Jones & Laughlin Ore Co.	3d Ave. & Try St., Pittsburg, Pa.
9th	Munro Mining Co.	55 Erie Co. Bank Bldg., Buffalo, N. Y.
2nd	Buffalo Iron Mining Co.	Buffalo, N. Y., Station B.
4th	Mineral Mining Co.	910 Wells Bldg., Milwaukee, Wis.
10th	Oliver Iron Mining Co.	Wolvin Bldg., Duluth, Minn.
1st	Munro Iron Mining Co.	55 Erie Co., Bank Bldg., Buffalo, N. Y.
4th	Corrigan, McKinney Co.	Wickliffe, Ohio.
2nd	Wickwire Mining Co.	Buffalo, N. Y.
4th	Mineral Mining Co.	910 Wells Bldg., Milwaukee, Wis.
4th	Wickwire Mining Co.	Buffalo, N. Y.
5th	Huron Iron Co.	Iron River, Mich.
4th	Spring Valley Iron Co.	Wellston, Ohio, Jackson Co.
11th	Newport Mining Co.	First National Bank Bldg., Milwaukee, Wis.
12th	Castile Mining Co.	76 Wade Bldg., Cleveland, Ohio.
25th	Hayes Mining Co.	808 1st National Bank Bldg., San Jose, Cal.
21st	Brotherton Iron Mining Co.	Western Reserve Bldg., Cleveland, Ohio.
17th	Castile Mining Co.	76 Wade Bldg., Cleveland, Ohio.
19th	Corrigan, McKinney Co.	Wickliffe, Ohio.
18th	Oliver Iron Mining Co.	Wolvin Bldg., Duluth, Minn.
19th	Castile Mining Co.	76 Wade Bldg., Cleveland, Ohio.
.....	Corrigan, McKinney Co.	Wickliffe, Ohio.
11th	Newport Mining Co.	First National Bank Bldg., Milwaukee, Wis.
16th	Verona Mining Co.	Western Reserve Bldg., Cleveland, Ohio.
19th	Newport Mining Co.	First National Bank Bldg., Milwaukee, Wis.
23rd	Oliver Iron Mining Co.	Wolvin Bldg., Duluth, Minn.
11th	Dunn Iron Mining Co.	First National Bank Bldg., Milwaukee, Wis.
.....	Coates & Tweed	Duluth, Minnesota.
.....	Oliver Iron Mining Co.	Wolvin Bldg., Duluth, Minn.
23rd	Sunday Lake Iron Co.	Western Reserve Bldg., Cleveland, Ohio.
23rd	Oliver Iron Mining Co.	Wolvin Bldg., Duluth, Minn.
1757 L	Wakefield Iron Co.	1300 Leader-News Bldg., Cleveland, Ohio.
	Lake Superior Iron & Chemical Co.	Penobscot Bldg., Detroit, Mich., F. W. Blair, Receiver.

IRON ORE RESERVES OF MICHIGAN.

Range.	1911 ¹		1913 ²		1914 ³	
	Developed. Tons.	Prospective. Tons.	Developed. Tons.	Prospective. Tons.	Developed. Tons.	Prospective. Tons.
Gogebic county.....	18,296,721	13,308,279	23,813,191	7,754,388	23,765,158	21,113,192
Iron county: (Iron River District) (Crystal Falls District).....	7,634,687	25,689,155	13,249,683	47,536,233	13,337,913	45,045,227
Menominee: (Dickinson county).....	9,082,750	2,567,700	9,682,994	3,100,458	11,062,700	2,129,950
State.....	71,542,900	98,038,202	81,437,902	109,920,354	81,261,238	116,208,087
Total.....	169,581,102		191,358,256†		197,469,325*	

¹Of date Jan. 1, 1914 in addition to which there was in stock 4,954,830 tons of ore, making a grand total of 202,424,155 tons.
²Of date Jan. 1, 1913 in addition to which there was in stock 4,366,349 tons of ore, making a grand total of 195,724,605 tons.
³Estimated by C. K. Leith for Board of State Tax Commissioners.
[†]Estimated by C. K. Leith and R. C. Allen for Board of State Tax Commissioners.
^{*}Estimated by R. C. Allen and O. R. Hamilton for Board of State Tax Commissioners.

IRON ORE RESERVES OF MICHIGAN.—Continued.

Range.	1915 ³		1916 ³		1917 ³	
	Developed. Tons.	Prospective. Tons.	Developed. Tons.	Prospective. Tons.	Developed. Tons.	Prospective. Tons.
Gogebic county.....	33,764,457	12,838,990	32,181,415	25,743,175	29,458,730	16,289,986
Iron county: (Iron River District) (Crystal Falls District).....	19,258,369	42,961,778	17,332,239	40,935,494	15,274,255	42,217,450
Menominee: (Dickinson county).....	10,134,241	1,701,540	8,035,306	1,671,055	7,506,771	2,710,080
Marquette: (Baraga county) (Marquette county).....	28,629,708	50,235,260	30,655,677	49,239,115	47,509,118	46,130,241
State.....	91,786,775	107,737,568	88,204,637	117,588,839	99,748,874	107,347,757
Total.....	199,524,343‡		205,793,476**		207,096,631***	

³Of date Jan. 1, 1914 in addition to which there was in stock 4,954,830 tons of ore, making a grand total of 202,424,155 tons.
[†]Of date Jan. 1, 1915 in addition to which there was in stock 6,596,195 tons of ore, making a grand total of 206,150,538 tons.
^{**}Of date Jan. 1, 1916 in addition to which there was in stock 5,608,465 tons of ore, making a grand total of 211,401,941 tons.
^{***}Of date Jan. 1, 1917 in addition to which there was in stock 5,132,243 tons of ore, making a grand total of 212,228,974 tons.
[‡]Estimated by R. C. Allen and O. R. Hamilton for Board of State Tax Commissioners.

APPRAISED VALUE OF MICHIGAN IRON MINES.¹

Range.	Previous appraisals.					
	1911	1912	1913	1914	1915	1916
Gogebic.....	\$28,338,100	\$27,226,300	\$25,849,873	\$34,067,028	\$34,377,792	\$34,210,394
Iron county: (Iron River District) (Crystal Falls District).....	15,018,475	15,359,664	20,978,709	21,275,945	20,856,919	20,977,257
Menominee: Dickinson county.....	7,427,500	7,240,625	6,641,925	6,413,063	5,906,443	5,758,461
Baraga county.....	34,745,000	31,270,500	29,063,714	29,216,139	28,616,453	29,791,496
Marquette county.....						
State.....	\$85,529,075	\$81,097,089	\$82,534,221	\$91,572,115	\$89,757,607	\$90,737,608

¹Ten per cent cut from 1911 assessment (approximate figure).
²By Board of State Tax Commissioners.

APPRAISED VALUE OF MICHIGAN IRON MINES.¹—Continued.

	1917 appraisal.		Combined value of mine and ore in stock	Total tonnage in mine and in stock Jan. 1, 1916.	Assessed value per ton.
	Mine.	Ore in stock.			
Gogebic.....	\$28,420,805	\$5,867,345	\$34,288,150	\$46,710,999	.73405
Iron county: (Iron River District) (Crystal Falls District).....	16,607,727	5,385,241	21,992,968	59,117,778	.37201
Menominee: Dickinson county.....	4,161,904	1,654,873	5,816,867	10,591,146	.54921
Marquette: Baraga county.....	23,806,834	6,286,089	30,092,923	95,809,051	.31409
Marquette county.....					
State.....	\$72,997,360	\$19,193,548	\$92,190,908	\$212,228,974	.43439

¹By Board of State Tax Commissioners.

VALUE OF MICHIGAN IRON ORE SHIPMENTS 1916 FROM REPORT OF APPRAISER OF MINES TO BOARD OF STATE TAX COMMISSIONERS 1916.¹

Range.	Gross receipts.	**Beyond the Mine charges.	Net receipts f. o. b. at the mine.	Shipment. Tons. 1916.	Value per ton f. o. b. mine 1916.	Value per ton f. o. b. mine 1915.
Gogebic—Gogebic county.....	\$27,337,652 08	\$7,554,431 09	\$19,783,220 99	7,321,273	\$2,70215	\$2,24461
Iron River..... } Iron county.....	12,375,501 47	3,628,949 44	8,746,552 03	4,266,827	2,04989	1,85211
Crystal Falls..... } Dickinson county.....	6,374,944 57	1,595,035 70	4,779,908 87	1,827,585	2,61542	2,06583
Menominee—Dickinson county.....	16,583,255 69	4,008,607 10	12,574,648 59	5,210,366	2,41339	1,88601
Marquette..... } Baraga county.....						
State of Michigan.....	\$62,671,353 81	\$16,787,023 33	\$45,884,330 48	\$18,626,051	\$2,46344	\$2,02060

*Includes: 1. Rail freight.
2. Boat freight.
3. Cargo insurance.
4. Lower lake analyses.
5. Selling commissions.

¹From report of Appraiser of Mines to Board of State Tax Commissioners 1917.
*Of which the Lake Superior District produced 63,960,956 tons, or 85 per cent of the total.
Tonnage mined during 1916 is given by U. S. G. S. as 75,167,672 gross tons
of which Minnesota mined 48,585,422 tons.
Michigan mined 18,971,016 tons.
Alabama mined 6,747,901 tons.
Wisconsin mined 1,504,518 tons.
New York mined 1,542,507 tons.
All other states mined 3,110,308 tons.
Total..... 75,167,672 tons.

1916 U. S. Production = 75,167,672 gross tons.
Valued at \$181,902,274 or average price of \$2.34 per ton. Shipments 77,870,553 gross tons.

COSTS, PROFITS, LOSSES AND ASSESSMENTS, IRON MINES OF THE MARQUETTE RANGE, MARQUETTE COUNTY, MICH.
Compiled by the Appraiser of Mines for the Board of State Tax Commissioners from reports by the operators.

	1906. Per ton.	1907. Per ton.	1908. Per ton.	1909. Per ton.	1910. Per ton.	1911. Per ton.
Cost of Mining.						
1. General office expenses.....	\$0 08148	\$0 11454	\$0 06125	\$0 05057	\$0 05898	\$0 08027
2. Fire insurance.....	.07846	.11416	.06121	.04739	.05768	.08403
3. Employers liability insurance.....	.00075	.00044	.00564	.00397	.00398	.00395
4. Taxes.....	.00037	.00042	.00544	.00378	.00321	.00328
5. Depreciation.....	.....	.....	.00441	.00339	.00510	.01152
6. Mining.....	.05630	.06870	.00439	.00339	.00509	.05109
7. Exploration and development.....	.05567	.06863	.08099	.08026	.07564	.15103
8. Construction.....	.....	.....	.07922	.07867	.07471	.14034
9. Total cost at mine.....	.....	.....	.09942	.09080	.05200	.08064
10. Rail freight.....	1.33839	1.40609	1.52434	1.50437	1.38800	1.56820
11. Boat freight.....	1.32326	1.40609	1.51431	1.50317	1.37501	1.48329
12. Cargo insurance.....	.06841	.09228	.09939	.07166	.06095	.08208
13. Analysis at lower lake ports.....	.05708	.08664	.09939	.06369	.05389	.07039
14. Selling commissions.....	.08579	.10932	.02212	.06509	.06347	.07106
15. Total "Beyond the Mine" cost.....	.06654	.10932	.05813	.05813	.06347	.07061
	1.63112	1.79137	1.87556	1.87008	1.72044	2.01223
	1.58438	1.78526	1.88550	1.84893	1.68613	1.96943
Beyond the Mine Cost.						
10. Rail freight.....	26842	27659	29435	29444	29841	29228
11. Boat freight.....	26842	27659	29435	29427	29841	29228
12. Cargo insurance.....	49696	48986	44747	46945	48197	52936
13. Analysis at lower lake ports.....	.00140	.00192	.00021	.00082	.00088	.00113
14. Selling commissions.....	.00047	.00031	.00022	.00069	.00069	.00113
15. Total "Beyond the Mine" cost.....	.00915	.01198	.01629	.01873	.01852	.02515
	.77640	.78066	.75864	.78410	.80007	.82774
	.77640	.78066	.75854	.78402	.80007	.81466

COSTS, PROFITS, LOSSES AND ASSESSMENTS, IRON MINES OF THE MARQUETTE RANGE, MARQUETTE COUNTY, MICH.

Compiled by the Appraiser of Mines for the Board of State Tax Commissioners from reports by the operators.

	1906. Per ton.	1907. Per ton.	1908. Per ton.	1909. Per ton.	1910. Per ton.	1911. Per ton.
Beyond the mine cost.— <i>Con.</i>						
16. Total cost of delivery.....	\$2.40752	\$2.57203	\$2.65620	\$2.65427	\$2.52951	\$2.63020
17. Royalties.....	2.36078	2.56582	2.64404	2.63295	2.48620	2.58409
	1.2239	1.3238	.21741	.18385	.31752	.24763
	1.13669	1.24044	.20704	.17744	.20591	.24036
18. Total cost of delivery to operator.....	2.52991	2.70441	2.87361	2.83812	2.74753	2.87783
	2.48317	2.69830	2.85108	2.81039	2.69211	2.82445
Profit and Loss.						
19. Receipts from sale of ore.....	3.37320	3.77856	3.80000	3.51487	3.70991	3.59091
20. Profit or loss to operator.....	.84329	1.07415	.92369	.67675	.90288	.71308
21. Total profit (operator's profit or loss plus royalty and depreciation).....	.89003	1.08027	.94892	.70448	1.01780	.76646
22. Assessed valuation per ton by Board of State Tax Commissioners.....	1.01242	1.21265	1.25538	.97272	1.23339	1.06035
	1.01242	1.21265	1.25538	.97272	1.23339	1.06035

a. Total of all operations.

b. Total of all operations excluding non-producers.

Note.—All items in 1906 and 1907 figured on basis of tons shipped, tons mined not available.

In all other years items 1 to 9 inclusive figured on tons mined, items 10 to 17 inclusive and item 19 on tons shipped.

COSTS, PROFITS, LOSSES AND ASSESSMENTS, IRON MINES OF THE MARQUETTE RANGE, MARQUETTE COUNTY, MICH.—*Concluded.*

Compiled by the Appraiser of Mines for the Board of State Tax Commissioners from reports by the operators.

	1912. Per ton.	1913. Per ton.	1914. Per ton.	1915. Per ton.	1916. Per ton.	1917. Per ton.
Cost of Mining.						
1. General office expenses.....	\$0.09194	\$0.06932	\$0.07754	\$0.05827	\$0.06977	.....
	.08885	.06680	.07091	.05686	.06857	.....
2. Fire insurance.....	.00388	.00357	.00435	.00378	.00292	.....
	.00370	.00341	.00380	.00343	.00272	.....
3. Employer's liability insurance.....	.01135	.01850	.01824	.02069	.01841	.....
	.11435	.01840	.01824	.02069	.01827	.....
4. Taxes.....	.13837	.11820	.12630	.13616	.11330	.....
	.13837	.11820	.12630	.13616	.11330	.....
5. Depreciation.....	.08570	.06817	.14911	.13074	.10877	.....
	.08570	.06817	.14911	.13074	.10877	.....
6. Mining.....	1.45260	1.45000	1.31975	1.13464	1.26114	.....
	1.45260	1.45000	1.31975	1.13464	1.26114	.....
7. Exploration and development.....	.04982	.06080	.07520	.06322	.08823	.....
	.07015	.08205	.03720	.06322	.08823	.....
8. Construction.....	.04906	.04476	.15827	.05274	.17690	.....
	.04906	.04476	.15827	.05274	.17690	.....
9. Total cost at mine.....	1.95512	1.87401	1.92951	1.61115	1.68130	.....
	1.95512	1.87401	1.92951	1.61115	1.68130	.....
Beyond the Mine Cost.						
10. Rail freight.....	26284	30700	28232	29818	30783	.....
	23578	30367	27765	29818	30783	.....
11. Boat freight.....	20048	38732	31371	32504	43619	.....
	20838	38262	30677	32504	43619	.....
12. Cargo insurance.....	.00191	.00117	.00091	.00127	.00176	.....
	.00191	.00117	.00091	.00127	.00176	.....
13. Analysis at lower lake ports.....	.00094	.00463	.00411	.00375	.00432	.....
	.00094	.00463	.00411	.00375	.00432	.....
14. Selling commissions.....	.01477	.02128	.00411	.01375	.01923	.....
	.01477	.02128	.00411	.01375	.01923	.....
15. Total "Beyond the Mine" cost.....	57987	73142	61854	63699	76933	.....
	57478	71251	60541	63697	76920	.....

COSTS, PROFITS, LOSSES AND ASSESSMENTS, IRON MINES OF THE MARQUETTE RANGE, MARQUETTE COUNTY, MICH.—*Concluded.*
 Compiled by the Appraiser of Mines for the Board of State Tax Commissioners from reports by the operators.

	1912. Per ton.	1913. Per ton.	1914. Per ton.	1915. Per ton.	1916. Per ton.	1917. Per ton.
Beyond the Mine Cost.— <i>Con.</i>						
16. Total cost of delivery.....	\$2.53501	\$2.50543	\$2.54805	\$2.24814	\$2.45063	
17. Royalties.....	2.48616	2.58045	2.42833	2.21098	2.41676	
	a	1917	21773	18120	19079	
	b	18478	18469	17913	18575	
18. Total cost of delivery to operator.....	2.72618	2.78764	2.76578	2.42934	2.64142	
	a	2.67034	2.71514	2.64555	2.39011	
	b					
Profit and Loss.						
19. Receipts from sale of ore.....	2.90551	3.15906	2.82446	2.52302	3.17105	
20. Profit or loss to operator.....	17933	37142	58868	93668	52963	
	a	23437	17891	13291	56854	
21. Total profit (operator's profit or loss plus royalty and depreciation).	45664	63180	42552	38753	82627	
	a	50305	69664	42278	85902	
22. Assessed valuation per ton by Board of State Tax Commissioners.....		.34464	.35034	.34913	.30090	\$0.31409

a. Total of all operations.
 b. Total of all operations excluding non-producers.
 Note.—All items in 1906 and 1907 figured on basis of tons shipped, tons mined not available.
 In all other years items 1 to 9 inclusive figured on tons mined, items 10 to 17 inclusive and item 19 on tons shipped.

COSTS, PROFITS, LOSSES AND ASSESSMENTS, IRON MINES OF THE GOGEBIC RANGE, GOGEBIC COUNTY, MICH.
 Compiled by the Appraiser of Mines for the Board of State Tax Commissioners from reports by the operators.

	1906. Per ton.	1907. Per ton.	1908. Per ton.	1909. Per ton.	1910. Per ton.	1911. Per ton.
Cost of Mining.						
1. General office expense.....	\$0.07006	\$0.06827	\$0.07218	\$0.06973	\$0.05213	\$0.08225
2. Fire insurance.....	.06808	.06734	.07092	.06901	.05119	.08225
3. Employers' liability insurance.....	.00256	.00256	.00431	.00378	.00415	.00708
	a	.00218	.00419	.00374	.00413	.00708
	b		.00379	.00495	.00664	.02721
4. Taxes.....	.05509	.05834	.06429	.00379	.00664	.02721
	a	.05486	.05809	.07432	.07565	.19711
	b	.00648	.00898	.07387	.07522	.19711
5. Depreciation.....	1.21186	1.2328	1.2199	1.4554	1.2335	1.5555
	a	1.22906	1.37212	1.46021	1.38712	1.32950
	b	.08821	.08133	.08133	1.12984	1.43033
6. Mining.....	.20230	.22745	.24725	.19922	.08334	.20058
	a	1.64046	1.86100	2.05535	2.01451	2.20339
	b	1.63497	1.84194	2.04676	1.91483	2.22039
7. Exploration and development.....	.39625	.39142	.39280	.39047	.39285	.37326
8. Construction.....	.73723	.73122	.64708	.63825	.70098	.73326
9. Total cost at mine.....	7.3733	7.3122	6.4708	6.3825	7.0098	7.48302
Beyond the Mine Cost						
10. Rail freight.....						
11. Boat freight.....						
12. Cargo insurance.....						
13. Analysis at lower lake ports.....						
14. Selling commissions.....	.03915	.03933	.04572	.00373	.00210	.00138
	a	.03915	.04572	.05470	.00210	.00138
	b	1.17263	1.16197	1.08560	1.05470	.03548
15. Total "Beyond the Mine" cost.....	1.17263	1.16197	1.08560	1.08565	1.14707	.89604

MINERAL RESOURCES OF MICHIGAN.

COSTS, PROFITS, LOSSES AND ASSESSMENTS, IRON MINES OF THE GOGEBIC RANGE, GOGEBIC COUNTY, MICH.—Continued.
Compiled by the Appraiser of Mines for the Board of State Tax Commissioners from reports by the operators.

	1906.	1907.	1908.	1909.	1910.	1911.
	Per ton.	Per ton.	Per ton.	Per ton.	Per ton.	Per ton.
Beyond the Mine Cost.—Con.						
16. Total cost of delivery.....	{ a b	\$3. 02297 3. 00391	\$3. 14095 3. 13236	\$3. 10406 3. 00438	\$2. 97092 2. 06953	\$3. 11643 3. 11643
17. Royalties.....	{ a b	36805 36788	43373 43741	43323 43080	42650 42568	32288 32277
18. Total cost of delivery to operator.....	{ a b	3. 18714 3. 17548	3. 45670 3. 43740	3. 57847 3. 56977	3. 53720 3. 43527	3. 39742 3. 43521
Profit and Loss.						
19. Receipts from sale of ore.....		4. 05982	4. 73564	4. 07636	4. 69212	3. 87255
20. Profit or loss to operator.....	{ a b	887965 884333	1. 27893 1. 24815	41896 42706	51907 61109	43223 43353
21. Total profit (operator's profit or loss plus royalty and depreciation).....	{ a b	1. 24721 1. 25869	1. 72163 1. 74070	1. 1784 1. 21752	1. 8465 1. 84564	3. 1107 3. 1107
22. Assessed valuation per ton by Board of State Tax Commissioners.....	{ a b					3. 43521 3. 43521

a. Total of all operations.
b. Total of all operations excluding non-producers.
Note.—All items in 1906 and 1907 figured on basis of tons shipped, tons mined not available.
In all other years items 1 to 9 inclusive figured on tons mined, items 10 to 17 and item 19 on tons shipped.

STATISTICAL TABLES—IRON ORE.

COSTS, PROFITS, LOSSES AND ASSESSMENTS, IRON MINES OF THE GOGEBIC RANGE, GOGEBIC COUNTY, MICH.—Continued.
Compiled by the Appraiser of Mines for the Board of State Tax Commissioners from reports by the operators.

	1912.	1913.	1914.	1915.	1916.	1917.
	Per ton.	Per ton.	Per ton.	Per ton.	Per ton.	Per ton.
Cost of Mining.						
1. General office expenses.....	{ a b	\$0. 06157 0.05763	\$0. 06841 0.06837	\$0. 05757 0.05757	\$0. 07140 0.07138	
2. Fire insurance.....	{ a b	00593 00526	00517 00506	00514 00514	00345 00345	
3. Employer's liability insurance.....	{ a b	01913 02207	02667 02652	01998 01998	01893 01893	
4. Taxes.....	{ a b	13478 13478	14182 14182	16451 16451	11574 11574	
5. Depreciation.....	{ a b	11307 11307	09045 09045	16340 16340	11412 11412	
6. Mining.....	{ a b	1. 19161 1. 19161	1. 37673 1. 37673	1. 00294 1. 00294	1. 13900 1. 13900	
7. Exploration and development.....	{ a b	12864 12864	23965 23377	16489 16489	14048 14048	
8. Construction.....	{ a b	04681 04681	18114 18114	13189 13189	12036 12036	
9. Total cost at mine.....	{ a b	1. 70154 1. 70154	2. 13630 2. 07685	1. 94400 1. 93032	1. 60941 1. 58558	
Beyond the Mine Cost.						
10. Rail freight.....	{ a b	38032 38032	44526 44520	40792 40762	48369 48369	
11. Boat freight.....	{ a b	46717 46717	55204 55200	43081 43081	54064 54064	
12. Cargo insurance.....	{ a b	00075 00132	00132 00097	00136 00136	00153 00153	
13. Analysis at lower lake ports.....	{ a b	00222 00222	00248 00248	00289 00289	00336 00336	
14. Selling commissions.....	{ a b	04801 04801	05374 05374	04889 04889	05261 05261	
15. Total "Beyond the Mine" cost.....	{ a b	89847 89847	1. 05484 1. 05477	89405 89405	1. 03183 1. 03183	

MINERAL RESOURCES OF MICHIGAN.

Compiled by the Appraiser of Mines for the Board of State Tax Commissioners from reports of the operator.

	1912. Per ton.	1913. Per ton.	1914. Per ton.	1915. Per ton.	1916. Per ton.	1917. Per ton.
Beyond the Mine Cost.— <i>Con.</i>						
16. Total cost of delivery	\$2.60001	\$3.19174	\$2.80553	\$2.66406	\$2.64124	
17. Royalties	2.60001	3.13162	2.79115	2.66280	2.61741	
	26506	30459	31961	29208	32184	
	20445	30275	31882	29154	32067	
18. Total cost of delivery to operator	2.86507	3.49633	3.12514	2.95614	2.96308	
	2.86446	3.43437	3.10997	2.95434	2.93808	
Profit and Loss.						
19. Receipts from sale of ore	3.30027	4.11367	3.32800	3.13869	3.73400	
20. Profit or loss to operator	45520	61734	20386	18255	77092	
21. Total profit (operator's profit or loss plus royalty and depreciation)	45581	67930	21993	18435	79592	
22. Assessed valuation per ton by Board of State Tax Commissioners	81333	1.04837	62292	69757	1.23663	
	81333	1.10799	63656	69883	1.26040	
		81887	75715	71260	74478	\$0.73405

a. Total of all operations.
b. Total of all operations excluding non-producers.
Note.—All items in 1906 and 1907 figured on basis of tons shipped, tons mined not available.
In all other years items 1 to 9 inclusive figured on tons mined, items 10 to 17 and item 19 on tons shipped

COSTS, PROFITS, LOSSES AND ASSESSMENTS, IRON MINES OF THE MENOMINEE RANGE, DICKINSON COUNTY, MICH.

Compiled by the Appraiser of Mines for the Board of State Tax Commissioners from reports of the operators.

	1906. Per ton.	1907. Per ton.	1908. Per ton.	1909. Per ton.	1910. Per ton.	1911. Per ton.
Cost of Mining.						
1. General office expenses	\$0.06131	\$0.07640	\$0.06687	\$0.04570	\$0.04250	\$0.06026
2. Fire insurance	06115	07604	06655	04570	04250	05975
3. Employers liability insurance	00098	00114	00768	00551	00531	00701
4. Taxes	04875	06366	00758	00551	00531	00701
5. Depreciation	04844	06331	00341	00143	00605	00333
6. Mining	00528	00691	00341	00143	00605	00333
7. Exploration and development	98118	1.21721	00341	00143	00605	00333
8. Construction	07647	08296	00341	00143	00605	00333
9. Total cost at mine	1.3598	1.6885	1.1040	1.0260	1.0141	1.5691
	1.31688	1.61720	1.0967	1.0260	1.0141	1.5691
	1.30948	1.61642	1.16123	1.0260	1.0141	1.5691
			1.6404	1.4697	1.4071	1.2818
			1.20207	1.21584	1.26711	1.34760
			1.20110	1.21584	1.26711	1.34760
			1.3769	1.3863	1.3863	1.6300
			1.3769	1.3863	1.3863	1.6300
			1.9086	1.9095	1.9086	0.5983
			1.88392	1.71143	0.7037	0.5983
			1.87809	1.71143	0.7037	0.5983
						1.92632
						1.92290
"Beyond the Mine" Cost.						
10. Rail freight	32025	31908	30214	32006	30832	31708
11. Boat freight	34010	33683	37593	37786	39260	31544
12. Cargo insurance	00081	00063	37445	37786	39260	33087
13. Analysis at lower lake ports				00207	00205	00190
14. Selling commissions	01403	01336	00920	01645	02251	00010
15. Total "Beyond the Mine" cost	71259	71345	70049	76037	80337	82159
Unclassified	03740	04355	01322	04393	80337	68144
						67652
						00934

MINERAL RESOURCES OF MICHIGAN.

Compiled by the Appraiser of Mines for the Board of State Tax Commissioners from reports of the operators.

	1906.	1907.	1908.	1909.	1910.	1911.
	Per ton.	Per ton.	Per ton.	Per ton.	Per ton.	Per ton.
Beyond the Mine Cost.—Con.						
16. Total cost of delivery	\$2. 02947	\$2. 33065	\$2. 58441	\$2. 47180	\$2. 57546	\$2. 60776
17. Royalties	2. 02207	2. 32087	2. 57335	2. 47180	2. 57546	2. 59342
	22030	28256	23856	25538	30194	24478
	22030	28256	23856	25538	30194	24478
18. Total cost of delivery to operator	2. 24986	2. 61323	2. 82207	2. 72478	2. 87740	2. 82254
	2. 24246	2. 61245	2. 81181	2. 72478	2. 87740	2. 84420
Profit and Loss.						
19. Receipts from sale of ore	3. 13222	3. 89632	2. 93813	3. 32263	3. 49090	2. 79380
20. Profit or loss to operator	88236	1. 28300	11516	57293	61359	65864
21. Total profit (operator's profit or loss plus royalty and depreciation)	1. 10803	1. 57238	41866	67785	61359	65030
22. Assessed valuation per ton by Board of State Tax Commissioners	1. 11542	1. 57335	52611	67780	1. 05624	31551
			52611	99780	1. 05624	32266
						63752

a. Total of all operations
 b. Total of all operations excluding non-producers.
 Note.—All items in 1906 and 1907 figured on basis of tons shipped, tons mined not available.
 In all other years items 1 to 9 inclusive figured on tons mined, items 10 to 17 inclusive and item 19 on tons shipped.

STATISTICAL TABLES—IRON ORE.

COSTS, PROFITS, LOSSES AND ASSESSMENTS, IRON MINES OF THE MENOMINEE RANGE, DICKINSON COUNTY, MICH.—Continued.
 Compiled by the Appraiser of Mines for the Board of State Tax Commissioners from reports of the operators.

	1912.	1913.	1914.	1915.	1916.	1917.
	Per ton.	Per ton.	Per ton.	Per ton.	Per ton.	Per ton.
Cost of Mining.						
1. General office expenses	\$0. 06289	\$0. 04738	\$0. 06062	\$0. 06662	\$0. 05793	.....
2. Fire insurance	.06954	.04667	.05913	.06192	.05687	.....
3. Employers liability insurance	.00649	.00595	.00713	.00714	.00577	.....
4. Taxes	.00874	.00571	.00732	.00682	.00560	.....
5. Depreciation	.01074	.01829	.01805	.01670	.01807	.....
6. Mining	18124	16429	17651	17439	11639	.....
7. Exploration and development	17778	16248	17554	16385	11474	.....
8. Construction	15657	14160	12795	16388	16714	.....
9. Total cost at mine	1. 54642	1. 35000	1. 2795	1. 53066	1. 74530	.....
	1. 6610	1. 42176	1. 56472	1. 74277	1. 74464	.....
	1. 6610	1. 4462	1. 5022	1. 6856	.01630	.....
	1. 6598	1. 4462	1. 461	1. 6596	.01630	.....
	.07908	1. 5735	1. 3618	.0671	.03167	.....
	.07908	1. 5735	1. 3618	.0671	.03167	.....
	2. 21059	2. 10683	2. 24249	2. 14317	1. 99461	.....
	2. 18726	2. 09182	2. 23443	2. 11344	1. 99107	.....
"Beyond the Mine" Cost.						
10. Rail freight	.28654	.33679	.31258	.42076	.43243	.....
11. Boat freight	.27718	.33176	.31258	.42076	.43243	.....
12. Cargo insurance	.23061	.29336	.25476	.31763	.40788	.....
13. Analysis at lower lake ports	.00038	.00044	.00076	.00068	.00084	.....
14. Selling commissions	.00010	.00037	.00076	.00027	.00227	.....
15. Total "Beyond the Mine" cost	.01117	.00889	.00110	.00207	.02550	.....
	.00949	.01654	.01165	.02063	.02550	.....
	.58939	.72872	.61438	.72014	.87272	.....
	.57172	.71839	.61431	.70960	.87242	.....
Unclassified	.05408	.07939	.05353	.06960	.07412	.....

COSTS, PROFITS, LOSSES AND ASSESSMENTS, IRON MINES OF THE MENOMINEE RANGE, DICKINSON COUNTY, MICH.—Continued.
 Compiled by the Appraiser of Mines for the Board of State Tax Commissioners from reports of the operators.

	1912. Per ton.	1913. Per ton.	1914. Per ton.	1915. Per ton.	1916. Per ton.	1917. Per ton.
Beyond the Mine Cost.— <i>Con.</i>						
16. Total cost of delivery.....	\$2.79998	\$2.83555	\$2.85684	\$2.01334	\$2.86733	
17. Royalties.....	2.75898	2.81081	2.86774	2.88304	2.86854	
	19541	21612	18070	19852	24707	
	19313	21400	17810	18853	24513	
18. Total cost of delivery to operator.....	2.99530	3.05167	3.03754	3.11186	3.11440	
	2.95211	3.02487	3.02584	3.07157	3.10867	
Profit and Loss.						
19. Receipts from sale of ore.....	2.61715	3.08293	2.50720	2.88601	3.48817	
20. Profit or loss to operator.....	37824	93036	55034	27585	37377	
21. Total profit (operator's profit or loss plus royalty and depreciation).	33496	93116	51864	23556	37950	
	32628	30118	22206	07255	78798	
22. Assessed valuation per ton by Board of State Tax Commissioners.	.00282	.00622	.21296	.08498	.78534	
		.51957	.46544	.46981	.55020	\$0.54921

a. Total of all operations.
 b. Total of all operations excluding non-producers.
 Note.—All items in 1906 and 1907 figured on basis of tons shipped, tons mined not available.
 In all other years items 1 to 9 inclusive figured on tons mined, items 10 to 17 inclusive and item 19 on tons shipped.

COSTS, PROFITS, LOSSES AND ASSESSMENTS, IRON MINES OF THE IRON RIVER AND CRYSTAL FALLS DISTRICTS, MICH.
 Compiled by the Appraiser of Mines for the Board of State Tax Commissioners from reports by the operators.

	1906. Per ton.	1907. Per ton.	1908. Per ton.	1909. Per ton.	1910. Per ton.	1911. Per ton.
Cost of Mining.						
1. General office expenses.....	\$0.02142	\$0.03991	\$0.06483	\$0.05912	\$0.07662	\$0.09376
2. Fire insurance.....	.01914	.03893	.06270	.05847	.07328	.08936
3. Employers liability insurance.....	.00502	.00546	.00701	.00367	.00494	.00576
	.00439	.00539	.00597	.00334	.00449	.00492
4. Taxes.....	.01892	.01942	.00510	.00551	.00653	.00686
	.01634	.01937	.03398	.02133	.02625	.09472
5. Depreciation.....	.01089	.01409	.12240	.13189	.02502	.08124
	.01069	.01409	.12113	.13123	.11837	.15052
6. Mining.....	1.00419	1.05856	1.25692	98412	1.1837	1.21722
	.85729	.34431	1.22709	.98017	1.17976	1.20463
7. Exploration and development.....	26340	48955	10211	10502	25900	20459
	14520	18955	10211	07084	13150	17734
8. Construction.....	24793	30177	24661	11833	17559	10170
	20844	25780	23143	11135	14882	07781
9. Total cost at mine.....	1.57137	1.78346	1.96529	1.42899	1.84706	1.87503
	1.34229	1.58363	1.81934	1.38182	1.68742	1.79168
"Beyond the Mine" Cost.						
10. Rail freight.....	.88136	.39229	.37714	.38548	.38549	.36687
	.88134	.39229	.37714	.38548	.38549	.35260
11. Boat freight.....	.96819	.57313	.37474	.43736	.47241	.32513
	.96814	.57313	.37474	.43736	.47241	.30924
12. Cargo insurance.....				.00079	.00114	.00070
				.00079	.00074	.00058
13. Analysis at lower lake ports.....				.05009	.00074	.00058
				.05009	.00074	.00058
14. Selling commissions.....	.08732	.08288	.09856	.07241	.07734	.06752
	.08732	.08288	.09856	.07241	.07734	.06752
15. Total "Beyond the Mine" cost.....	1.03679	1.04830	.85044	.90113	.93712	.76980
	1.03679	1.04830	.85044	.90113	.93712	.72707

COSTS, PROFITS, LOSSES AND ASSESSMENTS, IRON MINES OF THE IRON RIVER AND CRYSTAL FALLS DISTRICT, MICH.—Continued.

Compiled by the Appraiser of Mines for the Board of State Tax Commissioners from reports by the operators.

	1906. Per ton.	1907. Per ton.	1908. Per ton.	1909. Per ton.	1910. Per ton.	1911. Per ton.
Beyond the Mine Cost.— <i>Con.</i>						
16. Total cost of delivery	\$2 60824	\$2 83176	\$2 81573	\$2 33012	\$2 78418	\$2 68583
17. Royalties	2 37908	2 63103	2 66078	2 28205	2 62454	2 51875
	20623	27628	25170	23845	27167	23104
	19862	27032	24005	23202	24874	22370
18. Total cost of delivery to operator	2 81447	3 10804	3 06743	2 56857	3 05583	2 86697
	2 57770	2 90225	2 90083	2 51497	2 87328	2 74245
Profit and Loss.						
19. Receipts from sale of ore	3 10194	3 95240	3 01281	3 27907	3 66809	2 80477
20. Profit or loss to operator	28747	84436	95462	71050	61224	92700
21. Total profit (operator's profit or loss plus royalty and depreciation)	52424	1 05015	10298	76410	79481	15232
22. Assessed valuation per ton by Board of State Tax Commissioners	50459	1 13473	31948	1 08084	1 09228	40006
	73375	1 33456	46416	1 12735	1 16192	52634
						44666

a. Total of all operations.

b. Total of all operations excluding non-producers.

Note.—All items in 1906 and 1907 figured on basis of tons shipped, tons mined not available.

In all other years items 1 to 9 inclusive figured on tons mined, items 10 to 17 and item 19 on tons shipped.

COSTS, PROFITS, LOSSES AND ASSESSMENTS, IRON MINES OF THE IRON RIVER AND CRYSTAL FALLS DISTRICTS, MICH.—Continued.

Compiled by the Appraiser of Mines for the Board of State Tax Commissioners from reports by the operators.

	1912. Per ton.	1913. Per ton.	1914. Per ton.	1915. Per ton.	1916. Per ton.	1917. Per ton.
Cost of Mining.						
1. General office expenses	\$0 07995	\$0 08637	\$0 11919	\$0 06907	\$0 05838	
2. Fire insurance	07587	07266	11035	06581	09470	
3. Employers liability insurance	00486	00733	00616	00512	00410	
4. Taxes	01008	00647	00533	00462	00410	
5. Depreciation	00962	02012	02950	01887	01872	
6. Mining	08153	09690	13931	11820	08266	
7. Exploration and development	06482	08180	11463	10118	10720	
8. Construction	11376	12853	13560	09768	10414	
9. Total cost at mine	1 10252	1 18226	1 29722	09748	1 0509	
	1 26915	1 4967	1 26056	1 1334	1 13965	
	16993	28649	31585	91659	1 0768	
	19837	30065	21772	13915	07648	
	11781	18762	19341	08803	11567	
	1 86122	2 10865	2 26082	1 48878	08231	
	1 63211	1 81136	2 05625	1 40896	1 45903	
"Beyond the Mine" Cost.						
10. Rail freight	37014	42886	44558	43875	42851	
11. Boat freight	36538	41676	41958	42901	42871	
12. Cargo insurance	23496	27170	26330	27286	26375	
13. Analysis at lower lake ports	23310	26135	24332	26601	26345	
14. Selling commissions	00028	00092	00097	00113	00140	
15. Total "Beyond the Mine" cost	00046	00227	00319	00309	00370	
	06269	06675	03355	00291	00370	
	06150	08415	04882	05622	05342	
	66853	78054	76659	65436	65048	
	66072	73522	71558	75419	85048	

COSTS, PROFITS, LOSSES AND ASSESSMENTS, IRON MINES OF THE IRON RIVER AND CRYSTAL FALLS DISTRICTS, MICH.—Continued.
 Compiled by the Appraiser of Mines for the Board of State Tax Commissioners from reports by the operators.

	1912. Per ton.	1913. Per ton.	1914. Per ton.	1915. Per ton.	1916. Per ton.	1917. Per ton.
Beyond the Mine Cost.— <i>Con.</i>						
16. Total cost of delivery.....	{ a \$2,52975	\$2,86919	\$3,02741	\$2,26076	\$2,34961	
17. Royalties.....	{ b 2,29283	2,54658	2,77178	2,15915	2,30354	
	{ a 22019	28898	28250	2777	29443	
	{ b 21170	22626	25786	21077	28215	
18. Total cost of delivery to operators.....	{ a 2,74994	3,15817	3,30991	2,51097	2,64404	
	{ b 2,50453	2,77284	3,02984	2,37592	2,58769	
Profit and Loss.						
19. Receipts from sale of ore.....	2,61385	3,00108	2,63985	2,62411	2,90039	
20. Profit or loss to operator.....	13609	15709	67706	11321	25635	
21. Total profit, operator's profit or loss plus royalty and depreciation.....	{ a 10932	22824	30570	2431	31270	
	{ b 19786	26042	35806	4618	66226	
22. Assessed valuation per ton by Board of State Tax Commissioners.....	43259	57758	61293	55569	69899	
		34512	35776	32927	35185	\$0,37201

a. Total of all operations
 b. Total of all operations excluding non-producers.
 Note.—All items in 1906 and 1907 figured on basis of tons shipped, tons mined not available.
 In all other years items 1 to 9 inclusive figured on tons mined, items 10 to 17 and item 19 on tons shipped.

COSTS, PROFITS, LOSSES AND ASSESSMENTS, MICHIGAN IRON MINES.

Compiled by the Appraiser of Mines for the Board of State Tax Commissioners from the reports of the operators.

	1906. Per ton.	1907. Per ton.	1908. Per ton.	1909. Per ton.	1910. Per ton.	1911. Per ton.
Cost of Mining.						
1. General office expenses.....	\$0,06368	\$0,08084	\$0,06619	\$0,05704	\$0,05792	\$0,08406
2. Fire insurance.....	.06206	.08021	.06539	.05563	.06652	.08177
3. Employer's liability insurance.....	.00190	.00206	.00579	.00409	.00419	.00545
	.00174	.00200	.00550	.00394	.00407	.00517
4. Taxes.....	.04807	.05599	.00415	.00399	.00599	.01280
	.04731	.05583	.07330	.06869	.06968	.01258
5. Depreciation.....	.00481	.00636	.07222	.06704	.06898	.15022
	.00481	.00636	.12127	.12421	.10092	.14592
6. Mining.....	1,16233	1,29348	1,2043	1,2497	1,0092	1,2972
	1,14413	1,28889	1,40644	1,30734	1,31023	1,2575
7. Exploration and development.....	1,0683	1,14406	1,40057	1,30143	1,30544	1,39408
	.08433	.11399	.12097	.09864	.13937	1,38582
8. Construction.....	1,5695	1,8758	1,0066	.07897	1,1135	1,4150
	1,4374	1,7959	1,5741	1,1996	.09994	.08838
9. Total cost at mine.....	1,54457	1,77037	1,95555	1,0275	0,8804	0,8261
	1,48812	1,72687	1,92386	1,73872	1,78824	2,01689
"Beyond the Mine" Cost.						
10. Rail freight.....	.33341	.33639	.34304	.34590	.34547	.31765
11. Boat freight.....	.33340	.33639	.34244	.34404	.34547	.31266
12. Cargo insurance.....	.53102	.53428	.48666	.49555	.53537	.37546
	.53101	.53428	.48638	.49555	.53537	.37108
13. Analysis at lower lake ports.....	.00066	.00080	.00006	.00150	.00182	.00159
	.00015	.00012	.00009	.00114	.00182	.00159
14. Selling commissions.....	.03078	.03221	.03933	.00239	.00114	.00109
	.03078	.03221	.03933	.04023	.03920	.03950
15. Total "Beyond the Mine" cost.....	90564	91318	87169	89295	93426	73681
Unclassified.....	.00964	.00938	.00251	.00738	.01126	.00152

COSTS, PROFITS, LOSSES AND ASSESSMENTS, MICHIGAN IRON MINES.—Continued.
 Compiled by the Appraiser of Mines for the Board of State Tax Commissioners from reports of the operators.

	1906. Per ton.	1907. Per ton.	1908. Per ton.	1909. Per ton.	1910. Per ton.	1911. Per ton.
"Beyond the Mine" Cost.—Con.						
16. Total cost of delivery.....	\$2 45023	\$2 68355	\$2 82724	\$2 67691	\$2 72950	\$2 75370
	{ a 39376	{ a 64005	{ a 70451	{ a 62081	{ a 67518	{ a 70740
	{ b 22560	{ b 26862	{ b 30007	{ b 28448	{ b 30409	{ b 29209
17. Royalties.....	22434	26750	29479	27457	30409	27765
18. Total cost of delivery to operator.....	2 67583	2 95217	3 12731	2 96139	3 02740	3 03159
	{ a 2 61810	{ a 2 90755	{ a 3 08030	{ a 2 90438	{ a 2 97150	{ a 2 96495
	{ b 2 61810	{ b 2 90755	{ b 3 08030	{ b 2 90438	{ b 2 97150	{ b 2 96495
Profit and Loss.						
19. Receipts from sale of ore.....	3 44813	4 08242	3 56079	3 59276	3 97701	3 34723
20. Profit or loss to operator.....	77230	1 13025	63137	63137	94952	33174
21. Total profit (operator's profit or loss plus royalty and depreciation).....	83003	1 17487	47149	68838	1 00551	38238
22. Assessed valuation per ton by Board of State Tax Commissioners.....	1 00271	1 40523	85482	1 04006	1 35543	73259
	{ a 1 06918	{ a 1 44873	{ a 88671	{ a 1 08702	{ a 1 40243	{ a 76539
	{ b 1 06918	{ b 1 44873	{ b 88671	{ b 1 08702	{ b 1 40243	{ b 76539

a. Total of all operations
 b. Total of all operations excluding non-producers.
 Note.—All items in 1906 and 1907 figured on basis of tons shipped, tons mined not available.
 In all other years items 1 to 9 inclusive figured on tons mined, items 10 to 17 inclusive and item 19 on tons shipped.

COSTS, PROFITS, LOSSES AND ASSESSMENTS, MICHIGAN IRON MINES.—Continued.
 Compiled by the Appraiser of Mines for the Board of State Tax Commissioners from reports of the operators.

	1912. Per ton.	1913. Per ton.	1914. Per ton.	1915. Per ton.	1916. Per ton.	1917. Per ton.
Cost of Mining.						
1. General office expenses.....	\$0 07639	\$0 06700	\$0 08053	\$0 06163	\$0 06625	.....
	{ a 07408	{ a 06275	{ a 07648	{ a 05995	{ a 06580	.....
	{ b 00543	{ b 00531	{ b 00541	{ b 00491	{ b 00369	.....
2. Fire insurance.....	00494	00503	00502	00465	00361	.....
	{ a 01325	{ a 01909	{ a 02369	{ a 01964	{ a 01872	.....
	{ b 01312	{ b 01945	{ b 02305	{ b 01959	{ b 01863	.....
3. Employer's liability insurance.....	12900	12216	14066	14311	10613	.....
	{ a 12330	{ a 11623	{ a 13310	{ a 13784	{ a 10212	.....
	{ b 10969	{ b 11088	{ b 12370	{ b 15006	{ b 12569	.....
4. Taxes.....	10750	10815	12009	14570	12444	.....
	{ a 130084	{ a 135877	{ a 20482	{ a 07526	{ a 22652	.....
	{ b 29085	{ b 35494	{ b 28172	{ b 07070	{ b 22384	.....
5. Depreciation.....	15305	16383	19263	12908	08571	.....
	{ a 12452	{ a 12771	{ a 15829	{ a 12305	{ a 08549	.....
	{ b 10014	{ b 19552	{ b 17592	{ b 09034	{ b 12500	.....
6. Mining.....	07357	13872	16110	08551	10337	.....
	{ a 18879	{ a 2 04346	{ a 2 03936	{ a 1 67403	{ a 1 63292	.....
	{ b 1 81107	{ b 1 93298	{ b 1 95886	{ b 1 64699	{ b 1 60286	.....
7. Exploration and development.....	32962	38361	36805	38349	39717	.....
	{ a 32606	{ a 37900	{ a 36085	{ a 38129	{ a 39717	.....
	{ b 32031	{ b 39878	{ b 32625	{ b 34823	{ b 45780	.....
8. Construction.....	32874	39425	31974	34653	45780	.....
	{ a 00096	{ a 00107	{ a 00092	{ a 00149	{ a 00149	.....
	{ b 00095	{ b 00106	{ b 00091	{ b 00120	{ b 00149	.....
9. Total cost at mine.....	00114	00288	00306	00310	00360	.....
	{ a 00112	{ a 00282	{ a 00300	{ a 00308	{ a 00360	.....
	{ b 03668	{ b 03930	{ b 03609	{ b 03737	{ b 04117	.....
10. Rail freight.....	03619	03837	03457	03683	04117	.....
	{ a 70524	{ a 83669	{ a 73882	{ a 77340	{ a 90123	.....
	{ b 69950	{ b 82665	{ b 72352	{ b 76893	{ b 90117	.....
11. Boat freight.....	00663	01105	00445	.....	.....	.....
	{ a 32962	{ a 38361	{ a 36805	{ a 38349	{ a 39717	.....
	{ b 32606	{ b 37900	{ b 36085	{ b 38129	{ b 39717	.....
12. Cargo insurance.....	32031	39878	34625	34823	45780	.....
	{ a 32874	{ a 39425	{ a 31974	{ a 34653	{ a 45780	.....
	{ b 00096	{ b 00107	{ b 00092	{ b 00149	{ b 00149	.....
13. Analysis at lower lake ports.....	00095	00106	00091	00120	00149	.....
	{ a 00114	{ a 00288	{ a 00306	{ a 00310	{ a 00360	.....
	{ b 03668	{ b 03930	{ b 03609	{ b 03737	{ b 04117	.....
14. Selling commissions.....	03619	03837	03457	03683	04117	.....
	{ a 70524	{ a 83669	{ a 73882	{ a 77340	{ a 90123	.....
	{ b 69950	{ b 82665	{ b 72352	{ b 76893	{ b 90117	.....
15. Total "Beyond the Mine" cost.....	00663	01105	00445	.....	.....	.....
	{ a 32962	{ a 38361	{ a 36805	{ a 38349	{ a 39717	.....
	{ b 32606	{ b 37900	{ b 36085	{ b 38129	{ b 39717	.....
Unclassified.....	.....	.....	.....	.....	.....	.....

"Beyond the Mine" Cost.

COSTS, PROFITS, LOSSES AND ASSESSMENTS, MICHIGAN IRON MINES.—*Concluded.*
 Compiled by the Appraiser of Mines for the Board of State Tax Commissioners from reports of the operators.

	1912. Per ton.	1913. Per ton.	1914. Per ton.	1915. Per ton.	1916. Per ton.	1917. Per ton.
<i>"Beyond the Mine" Cost.—Con.</i>						
16. Total cost of delivery.....	\$2.59303	\$2.88015	\$2.77818	\$2.44743	\$2.53415	.....
17. Royalties.....	2.51156	2.75963	2.68238	2.41592	2.50403	.....
	22255	23390	26407	23872	27134	.....
	21800	23582	25783	23136	26648	.....
18. Total cost of delivery to operator.....	2.81558	3.13405	3.04225	2.68615	2.80549	.....
	2.72956	2.99545	2.94021	2.64728	2.77051	.....
Profit and Loss.						
19. Receipts from sale of ore.....	2.92708	3.41137	2.92249	2.70402	3.36144	.....
20. Profit or loss to operator.....	11150	27752	11976	10787	55505	.....
	19760	41592	41772	14674	59093	.....
21. Total profit (operator's profit or loss plus royalty and depreciation).	44374	64210	27001	49665	95298	.....
22. Assessed valuation per ton by Board of State Tax Commissioners.....	52309	75989	36020	52380	98185	.....
	.....	43561	45237	43546	42923	\$0.43439

a. Total of all operations.
 b. Total of all operations excluding non-producers.
 Note.—All items in 1906 and 1907 figured on basis of tons shipped, tons mined not available.
 In all other years items 1 to 9 inclusive figured on tons mined, items 10 to 17 inclusive and item 19 on tons shipped.

PART II. NON-METALLIC MINERALS.

R. A. SMITH.