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MINERAL RESOURCES OF MICHIGAN
WITH
STATISTICAL TABLES OF PRODUCTION
AND VALUE OF MINERAL PRODUCTS
FOR
1915 AND PRIOR YEARS.

WITH A TREATISE ON LIMESTONE RESOURCES
R. A. SMITH.

PREPARED UNDER THE DIRECTION OF
R. C. ALLEN
DIRECTOR, MICHIGAN GEOLOGICAL AND
BIOLOGICAL SURVEY

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LETTER OF TRANSMITTAL.

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

Gov. Woodbridge N. Ferris.
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 21, Geological Series 17, the fifth of a series of annual statements of the production and value of the mineral products of Michigan, with a special article by R. A. Smith on Limestone Resources.

Very respectfully,
R. C. ALLEN,
Director.

PART I. METALLIC MINERALS.

THE MICHIGAN COPPER INDUSTRY IN 1915.

WALTER E. HOPPER.

GENERAL REVIEW.

The production of the Michigan copper mines during the year 1915 was the largest in the history of the industry. According to the figures of the U. S. Geological Survey, the total refined copper produced amounted to 238,956,410 pounds, as compared with 158,009,748 pounds in 1914 and with 231,112,228 pounds in 1912, the record production previous to 1915.

There was mined and milled in the Lake Superior district 12,334,699 tons of ore-producing concentrates, containing 265,283,378 pounds of copper, or a recovery of slightly above one per cent of copper from the ore. A portion of the concentrates produced was not smelted in 1915. At an average price of 17.5 cents per pound, the copper output of Michigan in 1915 had a value of about $41,800,000. The copper mines also produced in 1915, 585,933 ounces of silver, valued at $297,068.

At the beginning of the year practically all development and exploratory work was in a state of suspension and all the producing mines, with the exception of the Mohawk and Wolverine, were operating on a reduced scale of production and wages. The conditions at the close of the year were in marked contrast to those at the beginning of the year. At the close of 1915 all producing mines were increasing production as rapidly as possible and practically all non-producing mines were again in operation. The large increase in total production and the renewed activity in development and exploratory work were due directly to the large consumption and to the high price received for copper sold.

Among the notable achievements of the year may be mentioned the remarkable increase in yield of refined copper per ton of ore stamped and the decided lowering of the cost per pound of copper produced. Both of these are due to various improvements in mining practice, the introduction of new mining and milling machinery and especially to a closer selection and better sorting of ore underground.

The one-man drill and the Carr bit have doubled the output per miner of a few years ago. A close study of the breaking of ore underground and the introduction of lighter and more efficient drilling machines have resulted during the last five years in a saving of over $2,000,000 to the mining companies, and, at the same time, the workmen have benefited by over $1,000,000. The use of the low-pressure steam turbine has increased and Ahmeek, Champion and Isle Royale installed this equipment during 1915. Regrinding is now done at many of the mills and steel balls have replaced the flint

pebbles in the Hardinge mills. The Calumet & Hecla began the treatment of tailings from its large pile of over 35,000,000 tons of stamp sand and results have been excellent. A large recovery of copper is being made at a very low cost. The leaching plant now in the process of construction will probably be in operation before the close of 1916. At the Copper Range mines the use of waste stamp sand for filling stopes has been increased. This sand fill makes possible a more complete extraction and thorough exploration of the lode.

With improved conditions in the copper market wages were increased until they are now the highest ever known in the district. The managements felt that the employees, because of their loyalty and efficiency, should share in the existing prosperity due to the higher price of copper. The employees of the Calumet & Hecla and its subsidiaries received as a premium the wages forfeited under the reduced rate of pay from September 1, 1914 to May 1, 1915. Contract work and bonus systems make it possible for the efficient men underground to earn almost double the basic rate. On May 1 wages at the Quincy mine were restored to the basis existing prior to September 1914, which was the highest rate ever paid employees, but with the advance in the price of copper, wages were increased about seven and one-half per cent December 1, and another advance of seven and one-half per cent will take effect March 1, 1916, making 15 per cent in all.

EXPLORATION AND DEVELOPMENT WORK.

The great demand and high price for copper stimulated interest in exploration and development work during 1915.

The Houghton Copper Company, the South Lake and the New Arcadian sent ore to the mills during 1915. The White Pine has been a steady producer on a limited scale since April. All of these are new producers.

At the northern end of the district Keweenaw continued exploration of the Ashbed lode on the Phoenix property, and a mill test will be made during the summer of 1916.

On the Cliff lands in Keweenaw county seven diamond drill holes were put down to explore the Ashbed lode, the Calumet conglomerate and the Osceola amygdaloid.

Mayflower and Old Colony continued their exploration of the Mayflower lode by diamond drilling and the latter will soon be in a position to start a shaft to develop the mineral deposit which has been so persistent in each hole drilled.

Algomah resumed exploration work in April. The mine was unwatered and sinking of the shaft resumed in June. The shaft is sinking towards the point where the Lake, South Lake and Algomah properties join.

Diamond drilling at the Contact was successful in locating in two holes the Wyandot No. 8 lode. Where cut, the lode possesses all the favorable characteristics of other commercially mineralized beds of the district.

Cherokee resumed exploration work during the summer of 1915. Numerous cross-trenches and pits revealed an amygdaloid lode, showing such promising mineralization, as to warrant the installation of a plant sufficient to sink an exploring shaft to a depth of 500 to 700 feet. This work will probably commence in the spring of 1916.

Indiana carried on an unsuccessful search on the 600 foot level for No. 2 drill hole, which showed a rich deposit of copper. Drifting in search of the deposit is now under way at the 1,150 and 1,400 foot levels.

Naumkeag continued exploratory work and the results show that there is a shoot of copper bearing ground in the northern part of the property which undoubtedly is worthy of development in depth.

North Lake operated continuously throughout the year. Three very promising looking amygdaloid lodes, all carrying copper, were exposed. These probably correspond to the South Lake lodes Nos. 1, 2 and 3. The shaft is now being sunk to the 800 foot level.

New Arcadian continued development work on the New Arcadian lode, and also found No. 8 conglomerate to be well mineralized on the 900 foot level. Results were very encouraging.

Exploratory work at the New Baltic consisted of trenching and diamond drilling for the purpose of definitely locating the outcrop of the New Arcadian lode and No. 8 conglomerate. The results of the diamond drill work were very favorable.

Onondaga resumed exploration of its lands within the Nonesuch basin. A series of drill holes finally located the Nonesuch lode, and further work will consist of drilling to find some mineralized portion of the lode on the company's lands.

The most extensive and perhaps the most interesting exploratory work of the year was done in the Porcupine Mountain district, Ontonagon county. The White Pine Extension was organized in July to explore and develop lands west of the White Pine and Nonesuch mines. An extensive diamond drilling campaign was begun in the spring of the year and results were so encouraging that a shaft is now being sunk to develop a large area of the Nonesuch formation.

The Michigan resumed operations in July after a suspension of all active mining operations for a period of nearly six years.

CONSTRUCTION WORK.

Construction work, which was discontinued throughout the district, in August 1914, was resumed at many of the mines and mills in the spring of 1915.

Work at the Calumet & Hecla leaching plant was resumed in April. T he building is enclosed and work on the tank and piping is well under way. Part of the plant

probably will be ready for operation in the summer of 1916.

Ahmeek expended $175,943.29 for construction. The concrete foundation for a new steel shaft and rockhouse at No. 2 shaft was completed and the erection of the steel work will commence in March 1916. At the mill two additional stamps were installed and put in commission during the year.

Allouez spent $19,037.01 for construction. Two brick fireproof dries are being built, one at each shaft.

Isle Royale rebuilt the stamp-mill at a cost of $130,987.33 over the $100,358 insurance collected on the old mill

Osceola spent $82,074.22 for new construction at all branches. Of this amount $15,212.87 was for new work at the stamp-mill.

At the Tamarack recrushing plant the building proper is finished and floors and launders are being put in. All the necessary machinery has been ordered, with the exception of the Hardinge mills. Tamarack expended $31,791.55 for construction.

At the White Pine considerable work was done on surface and at the stamp-mill and $351,438.07 was spent for construction.

New construction at the mines and mills of the Copper Range Consolidated cost $161,587.23 during 1915. The major part of this expense was made to secure greater quantities of power at a favorable cost. A low-pressure turbine was installed at the Champion mill, and a transmission line constructed from the mills to the mines.

Franklin expended $14,139.92 for construction at mine and mill. Houghton Copper spent $8,111.49 for construction of a rockhouse and a railroad connection. Quincy spent $25,382.04 for construction at the mine, and Victoria spent $9,252.81 for construction at mine and mill.

Total construction work at the Mohawk amounted to $43,373.44, which includes the cost of a new steel rock-house at No. 5 shaft.

The erection of a modern steel rockhouse was started at the South Lake. Total cost of construction for the year was $7,779.65.

DIVIDENDS.

Ten companies paid dividends in 1915. Calumet & Hecla paid out $5,000,000; Champion $3,100,000; Copper Range $1,182,003; Ahmeek $1,650,000; St. Mary's $1,280,000, and Osceola $1,057,650. The total amount paid out in dividends during 1915 was $15,189,653.

Assets were increased in many cases, and only six companies out of a total of 47 ended the year with a balance of liabilities.

MINE CASUALTIES.

The report of the Houghton county mine inspector showed a total of 34 casualties for the year ending Sept. 30, 1915. The total number of men employed was 16,005 and the proportion of casualties was 0.0021. The largest number of casualties was seven, at the Quincy and the Hecla Branch. Accidents from fall of rock appear to be the most numerous, 24 of the 34 being of this nature.

Considerable interest has been shown among mining men during the past year in the question of accidents in mines and their causes. The writer has read carefully the testimony of witnesses and the verdict of the jury in each of the 34 cases, as stated in the county mine inspector's report. In only eight cases out of the total of 34 can the accident be clearly attributed to carelessness on the part of the men killed. In these eight cases of apparent carelessness only two miners were killed, the others being timber-men, trammers and men doing minor jobs underground.

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

DETAILS OF OPERATIONS OF THE MINING COMPANIES IN 1915

Ahmeek Mining Company.

Mine location: Ahmeek, Keweenaw county.
General Manager: James MacNaughton.
Superintendent: S. Russell Smith.
Controlled by the Calumet & Hecla Mining Co.

During the year 1915 Ahmeek produced 21,800,492 pounds of refined copper, at a total cost per pound of 7.96 cents. This cost includes 0.10 cents per pound for refining anodes to save silver values. Of the 948,914 tons hoisted only 40 tons was discarded in the rock-house, showing a percentage of discard of 0.004. The pounds of refined copper per ton of ore treated was 23.0. The success of the operations for the year is indicated by a total payment to shareholders in dividends of $1,650,000.00. Assets were increased during the year by $614,882.15.

Shaft sinking was continued in three of the four operating shafts. The bottom of No. 1 shaft is below the 20th level. The 18th and lower levels will be driven north to No. 2 shaft, with a grade towards No. 1, in order to permit all ground opened by these levels to be trammed to No. 1 shaft, thereby increasing the tonnage tributary to it.

In the No. 2 shaft the mass copper fissure vein north of the shaft is now open for a total distance of 2,105 feet from the 9th to the 18th levels inclusive, with the exception of the 12th level, on which no drifting has been done, as a large mass of copper is being removed from the intersection of the fissure and lode. The recovery during the year from these openings has been 1,488,000 pounds of copper, at an average cost, exclusive of

smelting, of 1½ cents per pound. Mules are used for tramming with satisfactory results on several levels in both No. 1 and No. 2 shafts.

The erection of the steel work for a new rock-house at No. 2 shaft will commence in March 1916. This rock-house will be equipped with two 24-inch by 48-inch crushers, a poor rock crusher and a drop-hammer for treating mass copper. With the completion of this new rock-house the present central crushing plant will be used for treating ore from No. 1 shaft only.

Mining operations at shafts Nos. 3 and 4 were resumed in May. On the south side of No. 3 shaft, from the 11th to the 15th levels inclusive, a promising looking fissure vein has been found, but no drifting as yet has been done on it. All openings in No. 4 shaft have shown ore of average quality. Drop switches and transfer cars have been installed at shafts 3 and 4 and are working satisfactorily.

At the stamp-mill two additional stamps, Nos. 5 and 6, went into commission May 31 and August 31 respectively. The regrinding machinery for these units will be completed early in 1916. Stamp foundations and floors for stamps 7 and 8 are completed, the machinery has been ordered and both of these stamps should be in operation during the coming year. The low-pressure turbine is giving good results and, in addition to supplying the necessary power for Nos. 5 and 6 stamps, is selling about 600 kilowatts to the Calumet & Hecla Mining Co.

A dam and reservoir of 3,000,000 gallons capacity has been built above the Hungarian Falls to provide additional fire protection for the Ahmeek, Tamarack, Osceola and Lake Milling companies.

Two diamond drill holes were put down from surface to locate and test the Calumet conglomerate; one in the S. E. ¼ of the S. E. ¼ of Section 29, T. 57 N., R. 32 W, and the other in the N. W. ¼ of the N. E. ¼ of Section 32, T. 57 N., R. 32 W. In the first hole the conglomerate was found to consist of two feet of very hard, compact felsite conglomerate with a few flakes of copper near the top, underlain by one foot of soft, dark-red sediment.

In the second hole drilled the Calumet conglomerate consisted of three feet of shaly sediment above which were two inches of coarse sandstone bearing no copper. This second hole was continued through the Osceola amygdaloid, which was found to be 15 feet thick and carried very little copper at one point.

On May 1 the rate of wages was restored to that existing prior to the cut of September 1, 1914, and in June all employees received as a premium the wages forfeited under the reduced rate of pay from September 1, 1914, to May 1, 1915. On December 31, 1915, it was announced that a premium of 10% would be added to the wages of all employees of the company for the first six months in 1916. The directors felt that the employees, because of their loyalty and efficiency, should share in the existing prosperity due to the higher prices of copper.

Algomah Mining Company.

Mine location: Lake Mine, Ontonagon county.
Superintendent: Thomas Bennett.

After a period of idleness of over a year work was resumed in April, following a sale of delinquent stock which had been bid in by the company for non-payment of assessment.

Two hundred feet of drifting was done on the 40 foot level and a small stope put through to surface, in order to take out some of the ore lying between the first level and surface. This work was discontinued, however, after two months, as it proved unprofitable owing to the difficulty, without a suitable concentrating plant, of selecting by hand ore of sufficiently high grade (18%) to go direct to the smelter. The mine was then unwatered and shaft sinking resumed, which at the end of the year had reached a depth of 478 feet.

Shaft sinking will be continued during 1916. The shaft is sinking towards the point where the Lake, South Lake and Algomah properties join. It is believed by General Manager Edwards that at depth some of the lodes worked in the Lake and South Lake will be encountered on the Algomah property.

During the year 5,005 pounds of copper was sold at 18 cents per pound. The excess of liabilities on December 31, 1915, was $18,133.65.

Allouez Mining Company.

Mine location: Allouez, Keweenaw county.
General Manager: James MacNaughton.
Controlled by the Calumet & Hecla Mining Co.

Allouez treated 534.705 tons of ore during 1915, and the total production of refined copper was 10,043,459 pounds. The yield of refined copper per ton of ore treated was 18.78, and the total cost per pound was 9.31 cents.

The results of Allouez's operations for 1915 are very interesting when compared with the results of the three years previous to 1915. The total tons of ore treated, the total production of refined copper and the yield per ton of ore treated are all considerably higher than during the other three years. The mining expense per pound was reduced about two cents and the total cost per pound of 9.31 cents is a notable decrease.

The stopes tributary to No. 1 shaft were fully up to the average quality, and No. 2 shaft stopes were a little better than average in quality.

For increase in wages and premiums see Calumet & Hecla Mining Co.

Two dividends of $1.00 a share, amounting to $200,000.00, were declared during 1915. Assets were increased by $599,987.98.

Baltic Mining Company.

Mine location: Baltic, Houghton county.
General Manager: F. W. Denton.
Superintendent: Albert Mendelsohn.
Controlled by the Copper Range Consolidated Co.

The Baltic's operations for 1915 show a net profit of $949,965.40. The total production of refined copper was 12,028,947 pounds and this was sold at 17.40 cents per pound. The Baltic has $336,376.79 worth of copper on hand which is already sold and $232,939.06 worth of copper has been delivered and not paid for. The surplus of the company Dec. 31, 1915, was $1,440,576.25.

The improvements in the underground sorting of ore broken resulted in the remarkable yield per ton of ore stamped of 31.79 pounds. The cost per pound was 9.50 cents.

No. 2 shaft was the chief producer during the year 1915 and furnished about half of the total output for the year. The new ground opened in this shaft is good. A total of 54,240 cubic yards of stamp sand was run into the mine for fill.

Improved methods permit breaking and handling much leaner ground, and the sand fill makes possible more complete extraction and thorough exploration of the lode.

Calumet & Hecla Mining Company.

Mine location: Calumet, Houghton county.
General Manager: James MacNaughton.
Superintendent: John Knox.

During the year 1915 the C. & H. produced 72,613,320 pounds of refined copper, of which amount 71,030,518 pounds was produced by the mine and 1,582,802 pound s was recovered from the sand bank at Torch Lake. The recovery from 3,188,583 tons of ore treated from the mine was 22.28 pounds per ton. The total cost per pound of mine copper produced was 9.33 cents, and the price received for copper sold averaged 18.11 cents. Four dividends, amounting to $5,000,000, were paid during the year.

The Calumet conglomerate lode produced 51,738,588 pounds of copper, an average of 29.74 pounds per ton, at a total cost per pound of 8.69 cents. About 51 drills were at work during the year removing shaft pillars and cleaning up arches and the backs of old stopes. A total of 379,201 tons was obtained from this work. Not much change was found in the character of the openings in the Hecla and South Hecla branches.

The Osceola lode produced 19,291,930 pounds of copper, an average of 13.32 pounds per ton, at a total cost per pound of 9.71 cents. The openings on this lode continue to show about the same grade of ore. The product obtained from foot-wall stopes was about 31½ per cent of the total product of this branch.

No work was done on the Kearsarge lode during 1915. No work was done on the lands of the Manitou-Frontenac branch and no work of any kind was done at the St. Louis branch during the year.

At the mills all the 28 stamps are running, 17 on conglomerate and 11 on amygdaloid ore. Both the old and the new recrushing plants were in continuous operation during the year, except for an interruption of about seven weeks in July and August, due to the burning out of the turbine generator.

The results with pebble mills used in the new plant are so far superior to the Chilian mills in the old plant that it is intended to remodel the old plant. When this is completed there will probably be sufficient increased capacity to handle all the mill tailings and thus make all of the new plant available for sand bank tailings.

The comparative results for 1915 from the two plants on mill tailings are as follows:

	No. 1 Plant.	No. 2 Plant.	Both Plants.
Tons coarse tailings crushed	337,243	168,461	505,704
Pounds per ton in material treated	13.14	13.14	13.14
Pounds copper saved per ton	4.01	4.73	4.25
Pounds copper produced	1,352,869	796,858	2,149,727
Cost per pound, excluding smelting and selling	6.52c	4.36c	5.72c

The reclamation plant went into commission on a limited scale in June, but was interrupted by power trouble in July and August. Since September it has been running continuously, the number of mills in commission gradually increasing until full capacity was reached in December. At present there are 48 Hardinge mills in this plant regrinding sand bank tailings. This number will be increased by 16 Hardinge mills, now handling stamp-mill tailings, as soon as the old (No. 1) recrushing plant is remodeled to handle all tailings from the stamp-mills.

The reclamation plant consists of three units, namely, dredge, classifying house and conveyor, and No. 2 (new) recrushing plant. With three-quarters of the plant in commission, production at present is at the rate of 5,000,000 pounds of copper annually. The results from the operations of the reclamation plant are as follows:

Tons tailings treated	181,732
Pounds per ton in material treated	21.80
Pounds copper saved per ton	8.71
Pounds copper produced	1,582,802
Cost per pound, excluding smelting and selling	4.02c

Work on the erection of the leaching plant was resumed in April. The building is enclosed and work on the tanks and piping is well under way. The building contains eight sand tanks each 54 feet in diameter by 12 feet high with a capacity of 1,000 tons of sand. The cycle of operations proposed will require approximately 96 hours, so that the capacity of the plant will be 2,000 tons daily. The principal leaching agent will be ammonia and a contract for future requirements has been made with the

Semet-Solvay Co. of Syracuse. It is hoped to have part of the plant in operation early in the summer of 1916.

At the smelter a new furnace, equipped with a mechanical pouring device and with a capacity of about 1,750,000 pounds per month, will probably be ready for operation by June 1, 1916.

Owing to improved conditions in the copper market, on May 1 the rate of wages was restored to that existing prior to the cut of Sept. 1, 1914, and in June all employees received as a premium the wages forfeited under the reduced rate of pay from Sept. 1, 1914 to May 1, 1915. On Dec. 31, 1915, announcement was made that a premium of ten per cent would be added to the wages of all employees of the company for the first six months in 1916, it being considered proper, because of their loyalty and efficiency, that they should share in the existing prosperity due to the higher prices of copper.

The above statement of increased wages also applies to the following C. & H. subsidiaries:—Ahmeek, Allouez, Centennial, Isle Royale, Osceola and Superior.

Centennial Copper Mining Company.

Mine location: Calumet, Houghton county.
General Manager: James MacNaughton.
Controlled by the Calumet & Hecla Mining Co.

The gain from mining operations for the year 1915 was $142,439.81. Assets were increased by $248,483.81.

Centennial produced 2,347,500 pounds of refined copper, at a yield of 15.63 pounds per ton of ore treated. The total cost per pound, however, was 12.45 cents, the mining expense per pound being 11.21 cents.

No. 1 shaft is used entirely for transportation of men and material and no stoping or development work was done in that vicinity. To the north of No. 2 shaft openings showed average results. Some exceptionally good ground was encountered on the 31st and 32d levels. The drift on the 37th level which is being driven south to No. 1 shaft has shown copper at various points which warrant further inspection in the future.

No construction work was done during the year.

For increase in wages and premiums see Calumet & Hecla Mining Co.

Champion Copper Company.

Mine location: Painesdale, Houghton county.
General Manager: F. W. Denton.
Controlled by Copper Range Consolidated Company and St. Mary's Mineral Land Company.

Champion made a remarkable record in 1915. The total production was 33,407,599 pounds of copper at a yield of 36.17 pounds per ton of ore stamped. The cost per pound was 6.30 cents and the price received 17.40 cents, giving a profit per pound of 11.10 cents.

The tons of ore stamped, the pounds of copper produced and the yield of copper per ton were all much higher in 1915 than in any other year in the history of the company. After paying $3,100,000.00 in dividends, the suplus at the end of the year was $1,815,868.46, as compared with $1,206,819.44 at the end of 1914.

All openings made during the year showed average values. The advisability of drilling into the foot and hanging for parallel lodes is clearly proved by the opening of a large area of rich ground between Nos. 2 and 3 shafts, back in what was previously supposed to be the foot-wall.

As at the other Copper Range mines, stamp sand is used for fill, and during the year 220,920 cubic yards was run into the mine for this purpose.

The notable increase in yield per ton of ore stamped is due chiefly to better sorting. The product of the regrinding mills (estimated at about two pounds per ton) is another factor.

General Manager Denton states that the mine is in excellent condition and the outlook favorable.

Cherokee Copper Company.

Location of property: Between the Bohemia and King Philip properties.
Superintendent: H. W. Fesing.

The Cherokee owns about 800 acres of well timbered land. Outcrops are numerous, and a great deal of the overburden is light. The Copper Range Railroad and the Stratton Timber Railroad both traverse the property, making it very accessible.

Exploration work was resumed in the summer of 1915. Work was started in the S. W. ¼ of Section 2, T. 51 R. 37. Two amygdaloids were uncovered by cross-trenches but showed nothing of interest.

Work was then started in the N. W. ¼ of Section 2. The cross-sections and cores from several holes drilled in the summer of 1911 showed an amygdaloid carrying some heavy copper with a general strike of N. 45° E. A number of pits were sunk on this line of strike and four of these uncovered the amygdaloid.

Two of these pits (Nos. 10 and 18) gave very interesting results. In the S. E. ¼ of the N. W. ¼ of Section 2 the bed was exposed for a width of 46 feet. The foot was composed largely of a sludge of chrysocolla in which were found many nuggets of metallic copper. For the first 10 feet from the foot the bed carried considerable heavy copper; the rest had copper here and there, with a little stronger showing towards the hanging.

A second pit (No. 18) was started 50 feet southwest of the one described above. This was a well timbered pit, eight by nine, and was sunk seven feet in the bed. All the rock from this opening showed strong mineralization, and this will probably be the site for a deep exploratory shaft.

Boiler, compressor, hoist and pumps will be installed in the spring of 1916. A shaft will be sunk to explore at depth the mineralized lode exposed in the pits and trenches.

Balance of assets Dec, 31, 1915, was $39,791.62.

Cliff Mining Company.

Location of property: Keweenaw county.
General Manager: James MacNaughton.
Controlled by the Calumet & Hecla Mining Co.

The balance of assets was reduced to $24,113.49, the sum of $12,025.64 being expended for exploration and development work during 1915.

No work was done at the temporary shaft. Seven diamond drill holes, totalling 3,686 feet, were put down to complete the cross-section from the Greenstone bluff to the most easterly part of the company's property.

Five holes, totalling 2,141 feet of drilling, were put down in Section 25 T. 58 N. R. 32 W. to explore the Ashbed lode. The lode in these drill holes was found to vary from 25 to 32 feet in thickness, being practically barren in two of the holes and carrying fine copper, not in commercial quantity, in the other three. Just above the Ashbed there is a bed of silicious sandstone varying from one inch to 18 inches in thickness, which also carries a little very fine copper.

The West lode is from six to nine feet thick and is separated from the main Ashbed lode by a bed of trap about 36 feet thick. In character it is very similar to the Ashbed, and carries a little copper. At the top of the West lode there is a well-defined slide.

Two holes, totalling 1,545 feet, were drilled in Section 1, T. 57 N. R. 32 W. to explore the Calumet conglomerate and Osceola amygdaloid lodes. One of these holes cut both lodes. The Calumet conglomerate was found to be a dark red, clayey to shaly sediment, 3½ feet thick and practically barren of copper.

The Osceola amygdaloid in this same hole looked encouraging, being 13½ feet thick, four feet of which carried a little copper. The overburden was too deep for trenching at the outcrop of the lode, so another hole was drilled. This revealed a very poor looking bed, scarcely recognizable as the Osceola, 20 feet thick, with very little copper. The showing was not considered sufficiently good to warrant further work at this point.

Contact Copper Company.

Location of property: Elm River, Houghton county.
Superintendent: George S. Goodale.

The operations of the Contact during 1915 consisted of further exploration of the property by diamond drilling. Four holes were drilled, showing a total of 5,271 feet for the year.

In two of these holes the Wyandot No. 8 lode was definitely located at depths of 450 and 950 feet from the outcrop. The last hole drilled in this preliminary section should cut the lode at about 1,550 feet in depth.

The drilling during 1915 furnished sections of the lode at depth from the outcrop of 450 feet, 950 feet and 1900 feet, corresponding roughly to what would ordinarily be the 3d level, 8th level and 17th level respectively in a shaft.

The lode where cut appears to be a big, strong amygdaloid, at least, 50 feet in thickness. Supt. G. S. Goodale states as follows: "The reasonable certainty that we have established the true identification of this bed, and its favorable and promising character for a mineralized formation, taken together with its promising disclosure of mineralization in other underground developments, leads me to feel that the results of our work for the year are very satisfactory."

The company had on hand Jan. 1, 1916, a balance of $18,948.96 in cash.

Copper Range Consolidated Company.

Mine office: Painesdale, Houghton county.
General Manager: F. W. Denton.
Controls Copper Range Co., Baltic Mining Co., Trimountain Mining Co., and Atlantic Mining Co., and owns half of Champion Copper Co.

Various improvements in mining practice and the introduction of new mining and milling machinery resulted in a yield of copper per ton much higher, and a reduction in cost per pound much lower than ever previously obtained by the company. The total production of 37,035,642 pounds is 3,895,345 pounds larger than the best previous production in the history of the company.

The average yield of copper per ton for 1915 was 32.50 pounds, and the cost per pound 8.06 cents. Both of these are new records for the company. These improvements at the same time prolong the life of the mines; the lode is made more productive per unit of area, and results similar to or better than those of 1915 may be expected under average conditions.

While the great increase in the company's production in 1915 was due chiefly to the increase from the Champion mine, all the properties of the Copper Range are now in excellent physical condition, and at the close of 1915 the reserves of developed stoping ground in the mines were greater than at the beginning of the year.

A total of $161,587.23 was spent for new construction at the mines and mills.

The net earnings of the company for 1915 were $9.00 per share. A dividend of $3.00 per share was paid on December 15, and the balance added to working capital.

The new sales office in New York, opened Jan. 1, 1915, has been a great success. Savings in commissions have been considerable over the previous arrangement. A surplus of several million pounds of unsold copper and the entire product of 1915 was all disposed of during the first ten months of the year. The average selling price of 17.404 cents per pound does not include the sales made during the last two months of the year.

The New Jersey company, which formerly held the shares of the Copper Range Consolidated operating

companies, was dissolved Oct. 8, 1915. It is probable that the Baltic Mining Co. and the Trimountain Mining Co. will also be dispensed with during 1916.

Franklin Mining Company.

Mine location: Demmon, Houghton county.
Superintendent: Enoch Henderson.

During 1915 Franklin produced 1,314,969 pounds of refined copper, which was sold at an average price of 19.83 cents per pound. Production began in April and increased gradually to 250,000 pounds of refined copper in December.

Franklin's operations during 1915 were confined to the development of the Allouez conglomerate and the driving of the exploratory crosscut on the 32d level.

Because of the limited openings in the conglomerate it was possible to work only a small number of men during the first half of the year. A crosscut was driven from the No. 1 amygdaloid shaft 540 feet to cut the Allouez conglomerate on the 27th level. This level was connected with the 37th level by a rock chute with a loading bin at its bottom to permit dumping ore on all the conglomerate levels. In August the installation of the electric haulage transfer system to transfer ore from the bottom of the chute in the conglomerate on the 37th level to No. 1 amygdaloid shaft was completed. This electric haulage has a carrying capacity greater than the hoisting capacity of No. 1 amygdaloid shaft which it serves. Drift-stoping on all conglomerate levels was then started and was continued with a steadily increasing production to the end of the year.

There was no underground selection or sorting of ore as there were no worked out stopes to permit of discard. Out of a total of 151,269 tons hoisted, 29,251 tons was discarded in the rock-house. This discard was principally trap and footwall sandstone.

One of the most interesting points of Franklin's operations during 1915 was the easterly exploratory crosscut on the 32d level. This was driven 2,638 feet to a total distance of 4,000 feet from the hanging of the Pewabic amygdaloid. Two conglomerates, the Calumet and the Kearsarge, and 23 amygdaloids, including the Osceola amygdaloid, were exposed. Both conglomerates, the Osceola amygdaloid and 13 of the others were found to be barren. Seven of the remaining beds carried copper in small quantities and two carried sufficient copper to warrant drifting.

The opening work of the year put in sight new reserves of average value conglomerate ore amounting on Dec. 31, 1915 to 600,000 tons.

Production for 1916 up to 250,000 pounds per month has been sold for better than 25 cents per pound. Every effort is being made towards increasing production, and No. 2 conglomerate shaft will probably be reopened in the summer of 1916.

After remaining idle since July 24, 1913, the Franklin stamp-mill was overhauled and stamping of custom ore was resumed on March 29th. Since the first of August four heads have been in almost constant operation, stamping Franklin ore and custom ore from several other mines.

The surplus at the end of the year was $30,022.43.

Hancock Consolidated Mining Company.

Mine location: Hancock, Houghton county.
General Manager: John L. Harris.

Mining operations were resumed in March. The Hancock was one of the first companies to suspend operations in August 1914 because of the European war.

The total production of refined copper for the year was 871,124 pounds, of which 443,417 pounds was sold at an average price of 18.578 cents per pound.

The development work of the year was confined principally to drifting on lodes intersected at depth in No. 2 shaft at the 39th, 44th, 49th and 53d levels. Stoping was done in the upper levels on lodes Nos. 3 and 9 and in the lower levels on lodes 4 and 8.

The general average of the ground mined in the upper workings was low grade. The development work at and below the 39th level exposed more promising copper bearing formations than in the upper workings.

General Manager Harris states that since operations were resumed last March a decided change for the better seems to have taken place in the lower workings, and from present indications further development work should show satisfactory results.

On the 30th level south there seems to be a very heavy slide fault, which north of the main crosscut is on the hanging wall contact which it follows for quite a distance. To the south there is a decided change; the physical appearance is entirely different from that on the north side, although showing copper for practically the entire distance.

Considerable stoping has been done some distance south of the main crosscut on a reddish trap zone, from 6 to 8 feet thick, carrying considerable copper in the form of small grains up to walnut size, with occasional small slabs of copper in the seams. There appears to be no well defined foot or hanging wall; the copper occurs in the zone about parallel to the dip of the regular amygdaloid beds.

Considerable interest has been shown in the agreement between the Hancock and the Quincy Mining Co. for the joint operation of the Quincy No. 7 shaft. The details of this agreement as stated by Pres. John D. Cuddihy are as follows:

"An agreement, for five years, was entered into with the Quincy Mining Company in August for the joint operation of their No. 7 shaft, which was, heretofore, sunk to the 71st level to the boundary line of the Hancock property; drifts extended south and rock extracted within its ground up to the boundary line in the lower levels.

"The Pewabic lode in the territory of the Quincy Company south of No. 7 shaft and the territory of the Hancock Company being so accessible to this shaft, it was deemed advisable to join in the operation of the shaft in order to quickly gain access to the ground beyond the Hancock-Quincy boundary, and as it would require several years to sink and equip a subsidiary shaft to our No. 2 shaft into our territory near the Quincy boundary, the advantage to the Hancock Company^ in gaining access to this ground, at once, enables us to extend openings into our own territory, so that the subsidiary shaft from the bottom of No. 2 shaft to the 71st level can be sunk and raised at the same time from several levels, and, consequently, much time gained and money saved in equipping it to carry on operations in our own territory below the bottom level (71st) tributary to No. 7 shaft.

"About 75 acres of ground in the east half of the S. E. ¼ of section 22, and a very small area in the N. E. ¼ of the N. E. ¼ of section 27 was sold to the Quincy Mining Company for $191,250.00; also the sale of a 160 foot strip, about 1100 feet long, along the Hancock-Quincy boundary south of No. 7 shaft for $35,000.00.

"In this ground, a pillar is to be left during the life of the agreement to prevent caving or destruction of the workings of either company.

"We are to have the right to use No. 7 shaft of the Quincy Mining Co. for one-half of the time, or 12 hours each day, and pay one-half the cost of operation and one-half the cost of maintenance, with the provision that it may be increased another one-half upon payment of proportionate increase in rental if the Quincy Company should offer the additional time and Hancock Company is willing to accept it; a division of the cost of operation and maintenance of surface plant, including rock-house hoisting engine, etc.; a fixed charge per ton for transporting rock from rock-house to stamp-mill of the Quincy Company on Torch Lake; lease of one stamp head at the Quincy mill; a provision that the Quincy Company shall operate the head for the benefit of the Hancock Company and charge the Hancock Company for the operation the average cost of operation per stamp head for the entire mill.

"The mineral produced by the Hancock Company through the Quincy mill is to be smelted at the Quincy Smelting Works under a smelting contract agreed upon."

The Hancock has also purchased a sufficient amount of stock in the Lake Milling, Smelting and Refining Co. to entitle it to have ore which will be hoisted from shafts, other than Quincy No. 7, treated in the mills owned by that company.

Houghton Copper Company.

Mine location: North of the Superior mine, Houghton county.
Superintendent: R. R. Seeber.

In May a right of way for railroad connections was acquired and early in June a spur connecting the shaft with the tracks of the Superior Copper Co. was finished. Shipments then began from the stock-pile accumulated during development work and continued until September. The stock-pile contained about 8,140 tons, in addition to which 6,517 tons was shipped from underground work. The total product of refined copper was 156,766 pounds and the yield per ton of ore stamped was 10.69 pounds.

The yield of 10.69 pounds per ton was considerably poorer than was anticipated, so it was decided inadvisable at present to sink the shaft any deeper. The shaft-house was equipped with a rock crusher, motor and a small rock-bin, and underground work resumed in September.

Several good bunches of copper were encountered in the drift south of the shaft on the 620 foot level. The winze to the 1,020 foot level was continued down 92 feet. The first 20 feet of this winze showed a lode well charged with heavy copper; for the next 75 feet a roll of the foot-wall cut out the lode; below this trap the lode showed considerable heavy copper again. At the 12th level a crosscut will be run to the West lode.

Balance of assets Dec. 31, 1915 was $24,763.49.

Indiana Mining Company.

Mine location: Indiana, Ontonagon county.
Superintendent: Thomas Bennett.

The work at the Indiana during 1915 was confined almost entirely to an endeavor to locate the "well-known" No. 2 drill hole at the 600 foot level, with the object of exploring it from that point to the bottom and thereby determining the exact position of the rich deposit of copper cut by the drill at 1,441 to 1,492 feet.

A chamber approximately 100 feet in diameter was opened around the theoretical position of No. 2 drill hole at the 600 foot level, but the hole was not found.

Late in the year it was decided to discontinue the search at the 600 foot level and to proceed directly to look for the deposit itself at the 1,150 and 1,400 foot levels. The shaft was unwatered to the bottom, and drifting in search of the deposit is now under way at these two levels.

A geological examination of the drill cores and openings was made by Prof. A. C. Lane in August. Prof. Lane's general conclusion is that the much desired deposit lies a short distance east of the shaft at the 1,400 level and is a rather ragged aplite or felsite dike with a steep hade, about 12° to 18° more or less, at right angles to the dip of the beds, and that this dike is heavily charged with copper especially at the contact.

Prof. Lane, also advises further exploration above No. 8 conglomerate in the horizon of the South Lake lodes.

The balance of assets at the close of the year was $14,574.35.

Isle Royale Copper Company.

Mine location: Houghton, Houghton county.
General Manager: James MacNaughton.
Superintendent: James E. Richards.
Controlled by the Calumet & Hecla Mining Co.

The operations of the Isle Roy ale during 1915 resulted in a profit of $498,277.41. A total of 9,342,106 pounds of refined copper was obtained from the treatment of 680,270 tons of ore, an average of 13.7 pounds per ton. The total cost per pound refined copper was 14.94 cents which includes the expense of rebuilding the stamp-mill, reopening No. 1 shaft and sinking No. 7 shaft. These extraordinary expenditures totalled $183,293.35, or nearly two cents per pound. The mining expense was 10.56 cents per pound.

The reopening of No. 1 shaft was resumed in April. Hoisting ore from stopes on the 7th to the 12th levels inclusive started in August. From the 14th level to the bottom the shaft is filled with water which is now being removed. In December two drills were started drifting in the West lode and four stoping on the Isle Royale lode.

At the No. 2 shaft three drifts were extended north of the shaft in the West lode, a little over one-half of the ground opened containing copper. The drifts south of the shaft were in the Isle Royale lode, and about half of the ground contained copper.

At the No. 4 shaft about three-fourths of the ground opened contained copper. The 3d and 10th levels north have been connected to the old Huron mine workings.

At the No. 5 shaft 80 per cent of the ground opened contained copper, and at the No. 6 shaft about two-thirds of the ground developed showed copper.

At No. 7 shaft sinking from surface was resumed in May. The shaft was sunk about 40 feet in the lode by the end of the year. As soon as the concrete shaft-collar is completed, sinking will be resumed.

Isle Royale transported 211,964 tons of Superior ore at seven cents per ton and received $14,837.48. This reduced the cost of transporting Isle Royale ore over its own tracks to 3.17 cents per ton.

The first unit in the new stamp-mill went into commission June 7, just 5½ months after the old mill was completely destroyed by fire. The second unit was placed in commission July 9 and the third August 26. The mill has been in continuous operation since its completion and is now handling 2,000 tons daily. The cost of rebuilding the stamp-mill was $130,987.33 over the $100,358 insurance collected on the old mill

Wilfley tables have been installed throughout the mill for the finished product and for the slimes. A Hardinge mill is being erected to regrind the richer of the coarse products. A low-pressure steam turbine of 600-kilowatts capacity has been installed and all mill machinery is now motor driven.

Mining operations were not interrupted during the rebuilding of the mill. Most of the ore was sent to the Lake Milling Company's plant at Point Mills, and when the capacity of this mill was exceeded, a part of the ore was handled at the Franklin mill and a part at the Tamarack mill.

Isle Royale invested $144,035.67 in Lake Milling, Smelting and Refining Company stock and there are two units at the Point Mills plant stamping Isle Royale ore when furnished.

For increase in wages and premiums see Calumet & Hecla Mining Co.

Keweenaw Copper Company.

Location of property: Keweenaw county.
General Manager: W. J. Uren.

No work was done on the lands of this company during 1915.

During the year additional shares of stock of the Phoenix Consolidated Copper Co. were exchanged for shares of the Keweenaw Copper Co.

For statement of mining operations see Phoenix Consolidated Copper Co.

Lake Copper Company.

Mine location: Lake Mine, Ontonagon county.
General Manager: E. W. Walker.

Work at the Lake mine was resumed in April 1915, following a two-year shut-down on account of labor troubles and the war. The mine was filled with water up to about the 6th level, so bailing was started on May 12 and was continued until June 22, when the 11th level, the lowest in the mine, was reached. The mine was found to be in very good condition and little work was required to resume active mining operations.

Active production began late in July and the total output of refined copper for the year ending April 30, 1916 was 1,581,071 pounds. The yield of refined copper per ton of ore stamped was 26.42, and the price received was 20.149 cents per pound. The ore was treated at the Trimountain mill until that mill was destroyed by fire in March. The ore is now being stamped at the Baltic mill.

Careful sorting has about doubled the yield of copper per ton of ore stamped and the increase in the cost of mining has not been great. The production for the year came from all levels in the mine with the exception of the 11th, where the work was confined to crosscutting in both the hanging and foot walls to locate the copper-bearing portions of the lode and to determine the width of the lode. Most of the ore came from the main Lake lode, with a small amount from the East lode. Supt. E. W. Walker states that "on the whole, the results have been quite satisfactory, and it seems reasonable to expect that the mine can continue to operate at a profit, especially with an increase in output."

Lake Milling, Smelting & Refining Company.

This company now has six heads at mill No. 1, Point Mills, and two heads at mill No. 2, formerly the little Tamarack mill, Hubbell.

An adjustment was made between Allouez and Centennial to make their holdings of stock of this company more nearly conform to their stamping requirements, the Allouez Mining Co. paying the Centennial Copper Mining Co. $109,516.05 for 10,000 shares of stock of the Lake Milling Co.

The present holdings of Lake Milling stock are as follows:

Allouez Mining Co.	36,164 shares
Centennial Copper Mining Co.	16,164 shares
Hancock Consolidated Mining Co.	10,000 shares
Isle Royale Copper Co.	18,836 shares
Superior Copper Co.	18,836 shares

At the No. 1 mill, Point Mills, No. 1 head went into commission July 13 and is handling Hancock ore. Very little other construction work was done during the year. Capacity will probably be increased by means of rolls in the near future and additional power will be required.

The No. 2 mill, Hubbell, handles all the Centennial ore in one unit, the other unit being used for Allouez. Construction work for two new heads has been started. One head is to be built south and one north of the present mill and these will be known as Nos. 1 and 4. The stamps will be Norberg Compound and the wash equipment similar to that of the present units.

Additional fire protection has been provided by building a dam and reservoir above Hungarian Falls.

La Salle Copper Company.

Mine location: South of Osceola, Houghton county.
General Manager: James MacNaughton.
Controlled by the Calumet & Hecla Mining Co.

The mine was closed down early in August, 1914, on account of the war. In the spring of 1915 preparations were begun for resuming mining. The water in No. 1 shaft was lowered to below the 15th level and in No. 2 shaft to the bottom. Ore shipments to the Franklin mill began July 13.

At the No. 1 shaft the mining during 1915 consisted of stoping on three levels and a little drifting on one. The copper content of the ground was variable, the average being rather low.

At No. 2 shaft mining operations consisted of driving openings on both sides of the shaft on three levels and stoping on one to the north. In general the ore is better than at No. 1 shaft. Preparations have been made to resume sinking this shaft, as soon as possible.

On Dec. 31, 1915 it was announced that a premium of 10 per cent would be added to the wages of all employees for the first six months in 1916.

Operations during 1915 resulted in a decrease of assets of $15,522.25. The total production for the year was 782,493 pounds of refined copper, but the yield of copper per ton of ore treated was only 9.67 pounds.

Mass Consolidated Mining Company.

Mine location: Mass, Ontonagon county.
Superintendent: E. W. Walker.

Mass produced during 1915 a total of 4,638,452 pounds of refined copper, at a total cost per pound, of 14.37 cents. The copper was sold at 18.363 cents per pound. The yield of copper per ton of ore stamped was 14.35. The gain in cash assets during the year was $167,473.95.

The main Butler lode produced 227,628 tons and the Evergreen lode 62,083 tons. The north Butler, south Butler, Ogima, Knowlton and No. 3 lodes were also producers.

Development work was carried on in both "B" and "C" shafts, and there are now sufficient reserves on the Butler lode alone to last for at least three years at the present rate of extraction. Production was increased to the capacity of the mine and milling facilities.

On the 8th level at "B" shaft a crosscut was run in the footwall of the Evergreen lode to intercept the lodes which have been opened up at the South Lake property. Some very good ground was found in places.

Considerable stoping has been done on the Butler footwall lode in some of the lower levels. In several places the mineralization is of commercial value, and it is hoped that at greater depth it may prove to be of still greater value.

The old Evergreen workings above the 6th level are being drained of water, which will make available a considerable amount of very good ground.

Developments throughout the mine during 1915 have shown up ground equal to that of former years and in some instances considerable improvement is shown. Production will be further increased during 1916.

Mayflower Mining Company.

Location of property: East of Kearsarge and Wolverine mines, Houghton county.
Superintendent: George S. Goodale.

The work on the Mayflower property during 1915 was a continuation, of the investigation of the geological conditions affecting the Mayflower lode.

One diamond drill was operated in hole No. 41 and the total footage drilled for the year was only 822 feet.

Hole No. 41 is located farther west than the other holes and should intersect the Mayflower lode much deeper than encountered elsewhere. To a depth of 1,857 feet

the drill passed through firm and undisturbed ground; from this point to a depth of 2,569 feet a succession of crushed and shattered strata was encountered, which made drilling very difficult and progress slow. Drilling was interrupted for nine months by the loss of the drilling bit.

The St. Louis conglomerate was developed from 1,834 to 1,857 feet and was found to be dipping at a flatter angle at this depth.

Balance of assets Dec. 31, 1915 was $52,990.74.

Michigan Copper Mining Company.

Mine location: Rockland, Ontonagon county.
Superintendent: Samual Brady.

After a suspension of all active mining operations for a period of nearly six years, work was resumed at the Michigan in July.

An old incline shaft, which had been sunk to a depth of about 225 feet upon the hanging side of the Butler lode, was sleeted for enlargement from 5 x 8 to 8 x 14, with a view of ultimate enlargement to one 8 x 20 should the results of the explorations justify it. The work of enlarging and sinking this shaft, known as "E" shaft, was started early in September, and it is intended to continue the shaft on a dip of 49° to a depth of 603 feet, from which level it is proposed to crosscut the formation both north and south for extended distances to prove the value of the known copper-bearing lodes of that locality.

Strong lines of shearing were found crossing the formation at acute angles with the general strike and carrying more or less copper in contact, with the Butler lode. While the work was in contact with the hanging side of the Butler formation, upon the foot side of the shaft the Butler lode was found to be marked by a crossing some 10 feet wide, which was well charged with barrel copper and stamp rock. This crossing, the strike of which was approximately at a right angle to that of the Butler lode, indicated an entirely different and independent line of mineralization from that following the lines of shearing. At a point near the 5th level where the line of the shaft seemed to penetrate the hanging of the Butler lode for a short distance, the lode was found to be well charged with copper.

Crosscutting and testing the formation from the 603 foot level will probably be started about the middle of May 1916.

Mohawk Mining Company.

Mine location: Mohawk, Keweenaw county.
Superintendent: Theo. Dengler.

Mohawk had a very satisfactory year in 1915. Operations showed an increase of over two pounds of refined copper per ton of ore stamped and a notable decrease in the cost of production, compared with results of 1914. The total product of refined copper was 15,882,914 pounds, at a yield per ton treated of 19.15 pounds. The total cost per pound including construction was 7.48 cents. A total of $43,373.44 was expended for construction, and two dividends, amounting to $600,000.00, were made during the year. The net profit for the year was $1,511,575.73.

At No. 1 shaft efforts are now being directed toward extensive sinking and drifting for increased production to compensate in part for the ultimate elimination of No. 2 shaft. The openings in general in this shaft indicate the necessity of considerable underground selection of many stretches of ground.

No. 2 shaft is in process of elimination. No. 3 shaft was discontinued early in the year.

At No. 4 and No. 5 shafts all drifting during the year showed a very fair mineralization. The new steel rock-house at No. 5 shaft was completed and put into commission December 20.

At. No. 6 shaft the drifting as a whole has shown fair mineralization. Work in this shaft has been directed chiefly toward drifting and sinking in preparation for an ultimate increased capacity to offset the elimination of Nos. 2 and 3 shafts. As this shaft increases in production the operating shafts will be reduced to four in number, the combined output of which will be ample to supply the mill.

The scale of wages was advanced an average of 15 per cent over that in force in January 1915 and since June 1915 all employees have received a bonus of 5 per cent on their earnings. For the month of January 1916 all employees will receive a bonus of 10 per cent on their earnings.

Naumkeag Copper Company.

Mine location: Houghton, Houghton county.
Superintendent: Sidney S. Lang.

The exploratory work of the Naumkeag during 1915 was confined to the workings from the Dakotah Heights adit, which is at the north end of the property, just south of the county road.

President J. Park Charming states that "the exploration up to date shows that there is a shoot of copper bearing ground in the northern part of the property which undoubtedly is worthy of development in depth, but this should not be done until the whole possible copper formation has been explored on the adit level."

New Arcadian Copper Company.

Mine location: East of Quincy mine, Houghton county.
General Manager: Robert H. Shields.
Mining Engineer: H. W. Fesing.

Development operations were continued without interruption during 1915 and were conducted along the lines of the previous year. Mineralization of the New Arcadian lode has been proven for a depth of 1,250 feet and for a length of 1,100 feet.

During the year three mill tests were made at the Franklin mill. The number of tons of ore treated was

3,845 and the yield 79,209 pounds of refined copper, or 20.62 pounds per ton. The copper was sold at an average price of 17.856 cents per pound.

The development work of the year consisted of sinking No. 1 shaft from the 900 foot level to the 1,250 foot level; continuing the east crosscut on the 900 foot level to expose No. 8 conglomerate; cross-cutting east from the shaft to the lode at the 1,050 and 1,250 foot levels; drifting north and south on the 250, 900, 1,050 and 1,250 foot levels, and a limited amount of stoping on the different levels. Work was also started at the proposed site of No. 2 shaft, about 1,850 feet south of No. 1 shaft, where a former exploratory shaft was continued in depth to 50 feet, at which depth crosscuts were driven east and west across the formation.

Mining Engineer H. W. Fesing states that the openings made during the year have shown persistence of mineralization in varying degree, both in lateral openings and in depth, while the points at which the little stoping has been done have shown ground of good grade.

No. 8 conglomerate was intercepted about 380 feet east of the New Arcadian amygdaloid in the east crosscut on the 900 foot level and where cut, the conglomerate was found to be mineralized to such an extent as to warrant further exploration.

In the lower crosscuts east from the shaft the lode was intercepted much sooner than in the levels above, indicating a flattening of the dip with depth. If this condition continues the shaft will cut the lode at a depth of about 2,000 feet.

The various crosscuts east from the shaft to the lode being worked have passed through a number of amygdaloids; one of these, encountered generally from 12 to 20 feet east of the shaft, is particularly strong looking, of good width and mineralized. In cutting the station at the 1,250 foot level this amygdaloid was found to be heavily mineralized and is worthy of further attention.

Prof. A. C. Lane visited the mine in August and reported as follows: "I am led to the interesting conclusion that your lode is very likely the Isle Royale lode of the Isle Royale mine, though it appears somewhat richer where you have opened it. If it continues as good as is exhibited on the 250 foot and 900 foot levels, I should judge that by mining the better portion of the lode you should be able to maintain the percentage of mineral shown in your mill runs (31 pounds to 34 pounds per ton).

“On the other hand, and this implies a correction in our previous report, I am sure it has nothing to do with the horizon opened in the old Arcadian, but is probably the horizon of the top of No. 101 (p. 449 of the Arcadian section)* which shows a trace of copper there, in thickness 269 feet, below the horizon then worked, which may now be worth examination.

"Conglomerate 8 seems to be entirely cut out by a slide fault in the Torch Lake section and some of the Oneco holes. The occurrence of a small area of copper rock in conglomerate 8 itself in your 900 foot cross-section raises the question whether to the north or where this fault cuts it off it will prove richest."

A special meeting of the stockholders of the company was held in February and unanimously confirmed the sale of 160 acres of its lands comprising the S. W. ¼ of section 9, 55-33, to the New Baltic Copper Co. for the sum of $40,000 cash and 14,000 shares of the capital stock of that company.

The present hoisting and machinery equipment is entirely inadequate and it has been decided to install a larger equipment which will provide for the exploration of the lode to a depth of at least 2,500 feet.

*Michigan Geological Survey, Publication 6, Volume I.

New Baltic Copper Company.

Location of property: East of Franklin mine, Houghton county.
General Manager: Robert H. Shields.

Exploratory work was begun in November on the N. W. ¼ of the N. E. ¼ of section 16, T. 55 N. R. 33 W., and consisted of trenching and diamond drilling for the purpose of definitely locating the outcrop of the New Arcadian lode and No. 8 conglomerate.

Hole No. 5 was drilled south 45° E. on a dip of 50° and was sunk to a depth of 481 feet, cutting the No. 8 conglomerate at 409 feet. The conglomerate was found to be fully 40 feet in width and the core showed mineralization. This is the same conglomerate which the New Arcadian found to be well mineralized some 4,000 feet south in their east crosscut on the 9th level. This hole No. 5 also cut an amygdaloid at a depth of 106 to 116 feet and the core showed considerable fine copper.

Hole No. 6 was started at the same point as No. 5, the dip, however, being vertical, and cut No. 8 conglomerate at a depth of 513 feet, where it was found to be 60 feet wide. The conglomerate was reached at a much shallower depth than was expected, indicating either a fault or a marked change in the dip. This hole passed through an amygdaloid at 203 to 212 feet, over two feet of which was well charged with shot copper.

Hole No. 7 was located 800 feet N. 45 W. of hole No. 5 and was drilled vertically. A well mineralized amygdaloid was cut at 271 feet, continuing for over 16 feet, and showing good mineralization for fully seven feet. Another amygdaloid was cut at a depth of 487 feet, continuing for ten feet, seven feet carrying copper and two feet very rich. This hole will be continued until it reaches No. 8 conglomerate.

The New Baltic purchased from the New Arcadian Copper Co. 160 acres of mineral land, adjoining the New Baltic property to the northwest, for $40,000.00 in cash and 14,000 shares of the capital stock of the company. This gives the New Baltic an area of about 400 acres on the dip of the New Arcadian lode.

The results of the diamond drilling and the favorable developments at the adjoining New Arcadian mine indicate a bright future for the New Baltic. It is the intention of the management to sink a shaft on the New Arcadian lode as soon as its outcrop is determined, and by lateral openings from this shaft to explore not only the New Arcadian lode but the whole western part of the property, which from the diamond drill explorations, is known to contain a number of mineralized beds, including No. 8 conglomerate.

North Lake Mining Company.

Mine location: Lake Mine, Ontonagon county.
General Manager: R. M. Edwards.
Superintendent: Thomas Bennett.

When work was resumed in May 1914 the crosscut at the 300 foot level was continued in order to cut the extension of the lodes being developed on the South Lake property. This crosscut, however, broke through into the overburden at 730 feet and it then became necessary to sink an inclined winze to a greater depth, before going ahead with the crosscut. The winze was sunk 200 feet on an incline of 30° and crosscutting was resumed at the 400 foot level.

During 1915 this crosscut to the northwest at the 400 foot level was extended 252 feet from the bottom of the winze. Three very promising looking amygdaloid lodes were cut and all three carried copper. It is believed that their probably correspond to the South Lake lodes Nos. 1, 2, and 3.

Only a small amount of opening was done on these lodes because the work again broke through into the overburden.

Shaft sinking was resumed in August and will be continued to the 800 foot level, at which depth the three copper bearing lodes will again be opened up by a crosscut. A crosscut will also be driven southeast at the 800 foot level to explore lodes known to exist in that direction.

Balance of liabilities Dec. 31, 1915 was $15,556.20.

Old Colony Copper Company.

Location of property: Calumet, Houghton county.
Superintendent: George S. Goodale.

The exploratory work on the Old Colony property during 1915 was a continuation of the diamond drill investigations of the Mayflower lode. A total of 8,319 feet was drilled during the year ending November 19, 1915.

Considerable crushed and disturbed ground was encountered in the holes and this condition retarded progress. In two of the holes the Mayflower lode was found to be mineralized with fine copper.

President H. F. Fay states that the company will soon be in a position to start a shaft to develop the mineral deposit which has been so persistent in each hole drilled.

Onondaga Copper Company.

The Onondaga Copper Company was organized April 22, 1912, to acquire and develop the mineral rights underlying about 10,000 acres of land situated in Ontonagon county, west of the Ontonagon river.

Diamond drilling was started in August, 1912, and was carried on continuously until September 21, 1914, when the work was suspended temporarily.

Five holes were drilled in section 14, T. 49 W. R. 42 N. Four of these holes were drilled practically at right angles to the formation and gave a continuous cross-section of the series in section 14 from the southeast corner to a large felsite outcrop in the northwest quarter of the section. The fifth hole was drilled northwesterly under the felsite to determine the contact and the possibility of mineralization at that point. The hole was drilled to a depth of nearly 2,000 feet, but failed to reach the contact.

The sixth hole was drilled in the S. E. ¼ of section 4, 49-42. Holes seven, eight and nine were then drilled, making a complete cross-section from the southeast corner of section 14 to the northwest corner of section 4. With the completion of the ninth hole September 21, 1914, drilling was suspended.

While some of the cores from this cross-section showed copper, none showed copper in commercial quantities.

In the spring of 1915 arrangements were made for the exploration of lands within the Nonesuch basin. Several miles of road were built through the woods to section 34, 50-43, and drilling was started there in July. This drilling was started near the northern boundary of the section and was continued by a succession of drill holes, each hole exploring the territory farther south, until finally a drill hole at the extreme southeast corner of the section passed through the Nonesuch lode at a depth of about 1,100 feet. This hole, however, did not show any copper values.

Pres. R. C. Pryor, who is directing the exploration work, is encouraged by the determination of the location of the lode and hopes by further drilling to find some mineralized portion of the lode on the company's property.

Balance on hand Feb. 1, 1916 was $46,585.10.

Osceola Consolidated Mining Company.

Mine location: Osceola, Kearsarge and Tamarack, Houghton county
General Manager: James MacNaughton.
Superintendent: Frank H. Haller.
Controlled by the Calumet & Hecla Mining Co.

Osceola had a very successful and profitable year in all three branches during 1915. Dividends were declared amounting to $1,057,650.00 and the assets were increased by $553,210.20. The total production was 19,731,472 pounds of refined copper, at a yield of 14.5 pounds per ton of ore treated. The total cost per pound

refined copper was 10.03 cents. During the year $82,074.22 was expended for new construction at all branches.

Osceola Branch:

The Osceola branch made a better showing in 1915 than for a long time past, in fact, it made a fair profit for the first time in six years or more. An excellent grade of ore was found in the extreme south workings and the operating cost was lowered considerably. The Osceola branch has a promising future.

The best showing in the mine in recent years was opened up over 2,500 feet south of No. 6 shaft on the 42d level and the three levels above. Development work was pushed on these levels all through the year and at present half the regular product is obtained from that territory. The ground along the southern boundary will be opened up as rapidly as possible.

A diamond drill hole was started horizontally in the hanging wall of the Osceola lode at a point 2,750 feet south of No. 6 shaft on the 42d level to explore for and determine the character of the Calumet conglomerate lode. The drill passed through the Calumet amygdaloid at 200 feet without showing any copper and continued through various other amygdaloids and traps. The drill hole passed through the Calumet conglomerate at a horizontal distance of 712 feet from the Osceola lode, where it was found to be a dark, fine-grained sandstone only a few feet thick and barren of copper.

The construction work at No. 3 shaft, interrupted in August 1914, was resumed in the spring of 1915. The plant at this shaft was put into condition for service; several of the old levels are being opened up and equipped with tracks and tram cars; some ore is being hoisted for shipment to the mill. If milling facilities permit, No. 3 shaft should yield a substantial product during 1916.

Osceola branch produced 3,882,069 pounds of refined copper at a cost per pound, excluding mill construction, of 12.34 cents.

North Kearsarge Branch:

This branch had a very successful and profitable year and is in good shape to make even a better showing in 1916. When the production from South Kearsarge begins to lessen, North Kearsarge can make up the loss in tonnage. While the ore may not be as rich, tonnage costs will be nearly as low.

The production of refined copper was 7,886,579 pounds and the cost per pound, excluding, mill construction, was 10.99 cents.

Improvements in drill steel, drilling machines and methods brought about an increased rate of stoping at No. 4 shaft, which helped to reduce costs quite materially during 1915. It is expected that these improvements will continue to show good results as fast as they can be put into effect elsewhere in the mine, and that the cost per ton in 1916 will be somewhat less than the best showing made thus far.

The new ground opened by drifting in No. 1 shaft is rather above the average for that shaft. The workings at No. 4 shaft are improving with depth. The whole plant and shaft at No. 3 was completely overhauled and put in good condition. This shaft could be put in commission on short notice and could be made to produce a substantial tonnage if stamping facilities were available.

South Kearsarge Branch:

This branch made the largest production in its history in 1915. Costs per ton were lower than in any previous year except 1911, when wages were much lower than during 1915. It has not yet become necessary to reduce production because of exhaustion of reserve mining areas, and the recovery of copper per ton of ore treated has not lessened to any great extent.

The production of refined copper was 7,962,824 pounds, at a yield per ton of 16.72 pounds. The cost per pound, excluding mill construction, was 7.77 cents.

Mining the pillars of No. 2 shaft at the bottom level (16th) was started in June. This ground will be mined out rapidly during the next few years and will yield about 250,000 tons. The estimated reserves at this time, exclusive of the shaft pillars, are about 450,000 tons. In May the upper levels between the two shafts began to cave and continued moving for several months. The surface of the ground over an area of about two acres subsided from two to ten feet and communication between the shafts was blocked all the way down to the 15th level.

For increase in wages and premiums at Osceola Consolidated see Calumet & Hecla Mining Co.

Phoenix Consolidated Copper Company.

Mine location: Between Phoenix and Eagle River, Keweenaw county.
General Manager: W. J. Uren.

Development work on the Ashbed lode was continued during 1915. No. 1 shaft was sunk 537 feet and the total depth is now 1,415 feet. Total openings for the year amounted to 8,598 feet.

Drifting along the hanging wall opened up fair copper ground. In April an exploratory crosscut was started southerly across the lode on the 6th level west. The lode is wide and before reaching the footwall good copper ore was found. Drifting along the footwall was started in June and has shown fair to good copper values. Towards the latter part of the year the 7th and 8th levels east reached this footwall portion of the lode and have been in fair to good copper ore.

For drainage and ventilation an old adit about 1,100 feet east of No. 1 shaft was reopened. The mouth of this adit is near the village of Eagle River, and years ago it was driven south about 3,100 feet to connect with workings on the Ashbed lode.

There are two vertical shafts “A" and “B" on this adit, and in order to connect between the shafts the adit south of "A" shaft was driven to a point 56 feet from the adit north of “B" shaft by the end of the year.

The stamp-mill will be overhauled and a mill test made during the summer of 1916.

Quincy Mining Company.

Mine location: Hancock, Houghton county.
General Manager: Charles L. Lawton.

Quincy produced 22,054,813 pounds of refined copper during 1915, and realized a profit on silver of $11,829.08. The business income for the year was $1,873,674.69, and a total of $880,000.00 was paid in dividends.

The ground developed by the opening work was of about the usual quality and the mine as a whole did very well throughout the year. The extreme north end produced a low grade ore at times but the central portion of the mine, throughout No. 6 shaft workings, was particularly good. The showing of ore at the bottom of the mine in the new openings, with the exception of two low-grade drifts south of No. 2 shaft, is better than for several years.

No. 7 shaft was repaired for the purpose of handling both Quincy and Hancock ore.

No. 2 shaft produced the lowest tonnage and the lowest grade of stamp-rock but the largest amount of mass copper, so that the combined recovery of refined copper per ton of ore stamped was the highest of all the shafts. There are three branches of the Pewabic lode being mined in this shaft, all producing the different grades of ore that make up the general average. When the lode is rich in mass copper and barrel work, the stamp-rock is generally of lower tenor and vice versa.

In the No. 6 or Pewabic shaft, three branches of the Pewabic lode are being mined, and a small amount of work is being done on the Mesnard epidote lode. The openings from this shaft developed copper ground better than the average of the mine as a whole. The extension of some of the old upper levels developed ground that averages with the best Stamp rock of the mine.

In the No. 8 or Mesnard shaft, four branches of the Pewabic lode were mined during the year, though only three are active at present. The shaft produced a fair grade of ore throughout the year.

No. 9 shaft, which is bottomed at a depth of about 2,900 feet, has remained idle, except for the pumping of water on the third and fourth levels.

Air blasts were more or less numerous throughout the year, but were not very serious or of great magnitude. Greater attention was paid to building the rock-rib-packs at the top and bottom of the stopes, above and below each level, and these packs have restricted and curtailed the extension and effect of the air blasts, and have permitted a higher extraction from the lode.

At the stamp-mills a great deal of repair and betterment work was done. Twenty-four small type bull jigs were installed in No. 1 mill and 12 have been ordered for No. 2 mill. Three more Sturtevant rolls were installed at No. 1 mill, making four rolls now in operation in each of the mills. Two 36 inch by 8 foot Hardinge ball mills have been ordered, one to be installed in each mill.

The smelter was very busy throughout the year, especially during the latter half, owing to the increase in custom work, and is now running pretty well up to its capacity.

About 80 acres of mineral land was purchased from the Hancock Consolidated Mining Company for $226,250.00. This ground will be mined at depth from shifts 2 and 7. See Hancock Cons. Mining Co.

On May 1 wages at the mine were restored to the basis existing prior to September 1914, which was the highest rate ever paid employees, but with the advance in the price of copper wages were increased about 1½ per cent December 1, and another advance of about 7½ per cent will take effect March 1, 1916.

South Lake Mining Company.

Mine location: Greenland Junction, Ontonagon county.
General Manager: R. M. Edwards.
Superintendent: Thomas Bennett.

During the year 1915 a mill test of 3,993½ tons of ore was made at the Franklin mill. This ore came from the drifts on all the lodes opened and several trial stopes on lodes Nos. 1, 2 and 3. The mineral was smelted at the Michigan Smelter and the net return of refined copper was 61,637 pounds, or 15.4 pounds per ton.

No. 1 lode on the 300 foot level has probably shown the most even mineralization, while lodes Nos. 2 and 4 on the 600 foot level have shown the richest ore.

The long crosscut south on the 600 foot level was continued 428 feet. The crosscut on the 300 foot level was extended north to cut the Butler lode, which overlies No. 1 lode about 300 feet at right angles to the formation.

The Butler lode was encountered at 415 feet from the hanging of No. 1 and the Butler hanging was reached at 506 feet. The Butler lode was found to be 91 feet thick horizontally and carried good copper values on both foot and hanging sides. Drifting along the hanging also showed good copper. The Butler lode will also probably be reached in the 600 foot crosscut south.

During the summer Prof. A. C. Lane made an examination of the various lodes opened. His conclusions were as follows:

"1st—That the lodes found dipping north in the 300 crosscut north of the shaft are the same as those found dipping south in the 600 crosscut south of the shaft.

"2nd—That one of these lodes, probably No. 2 in the 600 crosscut, or possibly a combination of No. 1 to No.

3, is the same as the lode mined by the Lake Copper Co., commonly known as the Lake lode.

"3rd—That the continuation of the 600 crosscut south should cut the Butler lode dipping south.

"4th—That the lodes south of the shaft are somewhat faulted by two sets of faults, while those north of the shaft are apparently undisturbed."

The erection of a modern steel rock-house will probably be completed by March 1, 1916, when production will begin and will be increased as rapidly as possible.

Excess of quick assets Dec. 31, 1915 was $16,958.11.

St. Mary's Mineral Land Company.

Agent: F. W. Nichols, Houghton.

St. Mary's enjoyed a very prosperous year in 1915, due to the record production of the Champion mine, half of which is owned by St. Mary's.

A total of $1,550,000 was received in dividends from the Champion, and St. Mary's distributed $8.00 per share to its stockholders.

No sales of mineral ground were made during the year. Oak and pine only on 760 acres were sold for $3,300.00 and surface rights on 20 acres for $300.00.

The real property of the company Dec. 31, 1915 consisted of 93,012.69 acres, besides the mineral rights to 14,132.96 additional acres.

Superior Copper Company.

Mine location: South of Isle Royale mine, Houghton county.
General Manager: James MacNaughton.
Superintendent: Ocha Potter.
Controlled by the Calumet & Hecla Mining Co.

Superior made a gain of $245,017.27 from mining operations during 1915. The purchase of 18,836 shares of the Lake Milling, Smelting & Refining Company's stock for $240,000.00 and the assessment of $5,615.17 account the same company, however, resulted in a decrease in assets of $597.90.

From 212,051 tons of ore treated, 3,866,484 pounds of copper was obtained, an average of 18.23 pounds per ton. The total cost per pound was 12.29 cents.

At No. 1 shaft the ground broken has shown enough copper to warrant shipment to the mill, although the copper is very fine, almost no mass being found.

The only development work on the Superior lode was on the 16th level south, where 216 feet was driven, about half of this distance being in stoping ground of below average quality.

Stoping reserves on the Superior lode were lessened rather than increased during the year. Development work is now being pushed to the limit.

At the No. 2 shaft the 18th level was extended north 580 feet, but no ground worth stoping was found.

For increase in wages and premiums see Calumet & Hecla Mining Co.

Tamarack Mining Company.

Mine location: Calumet, Houghton county.
General Manager: James MacNaughton.
Superintendent: John T. Been.
Controlled by the Calumet & Hecla Mining Co.

The operations of the Tamarack for 1915 show a great improvement over those of 1914. As much ore as possible was extracted, to take advantage of the high price of copper, without carrying on development work.

The total production of refined copper was 3,888,150 pounds and the yield per ton 17.9 pounds. The total cost per pound refined copper was 17.07 cents and the price received was 19.10 cents per pound. Assets were increased during the year by $308,987.72.

The mining operations during the year consisted of 285 feet of drifting on the Osceola amygdaloid in No. 2 shaft and 590 feet of drifting on the 20th level south in No. 3 shaft.

No. 1 shaft was used exclusively for pumping. In No. 5 shaft the 29th level crosscut between this shaft and No. 2 was cleaned out and timbered, it being necessary to keep this line of communication between the two shafts so that it could be used in case of accident. The total depth of No. 5 shaft is 5,308.5 feet from surface.

At the recrushing plant the building proper is finished and floor and launders are being put in. All necessary machinery has been ordered, with the exception of the Hardinge mills, which have been delayed pending experiments now being made.

Trimountain Mining Company.

Mine location: Trimountain, Houghton county.
General Manager: F. W. Denton.
Superintendent: Richard Bowden.
Controlled by the Copper Range Consolidated Co.

Trimountain produced during 1915 a total of 8,302,896 pounds of refined copper at a yield per ton of 23.75 pounds. The total cost per pound was 9.53 cents and the price received was 17.404 cents per pound, giving a profit per pound of 7.88 cents.

Openings made during 1915 showed no marked change from the past two or three years. The higher yield of copper per ton stamped was due to improvement in underground handling of ore broken.

No. 1 shaft, which was abandoned as a working shaft several years ago, will be used as a chute to take waste stamp sand underground for fill.

The management expects further improvement in results.

Victoria Copper Mining Company.

Mine location: Victoria, Ontonagon county.
Superintendent: George Hooper.

Victoria produced 1,499,695 pounds of refined copper in 1915, which is 13,453 pounds better than for the year 1914. No large increase was possible, owing to the limited capacity of the hoist and shaft and the necessary work on the new shaft. The new shaft and the new hoist will more than double the present hoisting capacity. The net profit for the year was $45,799.80.

On May 16, 1915 wages were again restored to the former scale paid before the reduction in September 1914.

Little development work was done during 1915 due to the low stage of water the first part of the year and the fact that attention was directed to raising the new compartment of the shaft the latter part of the year. In the last six months of the year, however, the copper content of ore was at least one pound per ton better than that of the past eighteen months.

Hoisting from the upper levels of the new compartment with a small temporary hoist, will probably begin in February 1916. This will increase tonnage as well as development, and, at the same time, raise the copper content per ton and decrease the cost of production.

White Pine Copper Company.

Mine location: White Pine, Porcupine Mountain District, Ontonagon county.
General Manager: James MacNaughton.
Superintendent: Thomas H. Wilcox.
Controlled by the Calumet & Hecla Mining Co.

Mining operations were carried on in 1915 at the No. 2 temporary vertical shaft and at the inclined shafts Nos. 3 and 4. The openings on the second level west of No. 2 shaft were rather poor. All other openings, when in the lode, showed fair to good values. Stoping was begun in April; about 16 per cent of the lode is left in place for stope pillars.

During the last eight months of the year 114,039 tons of ore was treated, yielding 2,824,145 pounds of refined copper, an average of 24.76 pounds per ton. The total cost per pound including construction was 16.64 cents.

The stamp-mill went into commission in April. The mill is making a recovery of approximately 67 per cent. The tailing losses are excessive, consisting partly of sulphides, but mostly of free flaky particles of native copper. The tailings are being saved and can be rehandled at a later date if it proves profitable to do so.

A railroad about one and three-quarters miles in length was built to connect the mine plant with the Chicago, Milwaukee and St. Paul Railroad.

A premium of ten per cent will be added to the wages of all employees for the first six months of 1916.

During 1915 there was expended for construction work $351,438.07.

White Pine ended the year with a balance of assets of $139,786.05.

White Pine Extension.

Mine location: S. E. ¼ of the N. E. ¼ of section 7, T. 50 R. 43.
Post-office: Ontonagon, Ontonagon county.
General Manager: Theo. Dengler.
Superintendent: Fred B. Close.

Operations of this new organization began about November 1, 1914, and were reviewed in the report on the Copper Industry for 1914 under the heading "Smith Explorations." The present company was organized in July 1915, and is now under the Stanton management.

The work during the last two months of 1914 was done in the S. E. ¼ of the S. E. ¼ of section 12, T. 50, R. 44. A test shaft was sunk 70 feet, a crosscut made into the formation for 40 feet and 15 feet of drifting done. The results of this work were very favorable and extensive diamond drilling was planned for the year 1915.

Diamond drilling was started in the early spring of 1915 and during the year a large area of land was explored. This drilling was done in section 7, 50-43 and in sections 12, 13 and 14, 50-44.

The remarkable showing of copper in several of these drill cores and the very satisfactory assays warranted the sinking of a shaft to develop and mine this rich section of the copper district. The sinking of a shaft was started in the S. E. ¼ of the N. E. ¼ of section 7, 50-43. The shaft is vertical and is sinking in the footwall of Outer Conglomerate.

The Nonesuch formation on the property of the White Pine Extension has a thickness of 550 to 600 feet. The strike is about N. 56½ °E., but to the eastward swings more to the east. The dip at the test shaft in section 12 is about 58°. The dip steepens towards the east; at the present sinking shaft it is about 80° to the southeast, and at the east end of the property it is practically vertical.

The Nonesuch formation is composed of gray to black shales and gray grits and sandstone. The upper part is chiefly brown shale; the lower sandstones are coarser and usually conglomeratic. The copper-bearing horizons are in the lower part of the formation and in the two lower shale belts. Between the shale belts there is a sandstone. Some of the shale is carbonaceous, and there is more copper in the darker beds. The values are principally sulphides, chalcocite, with some chalcopyrite and bornite.

The upper lode is a banded shale 20 feet thick. This is a fine silicious rock, and the copper occurs near the bottom of the shale belt where the shale is darker in color. This dark portion is about two feet thick.

Below the banded shale there is usually a thin grit, two to six feet in thickness. Below this grit is No. 1 shale,

about six to twenty feet thick. Below the No. 1 shale is a coarse sandstone, No. 1, which varies in thickness from four to ten feet. Below this coarse sandstone is No. 2 shale, usually four to six feet thick. Below the No. 2 shale is No. 2 sandstone which grades down into the Outer Conglomerate. No. 1 and No. 2 sandstone are usually conglomeratic.

Crosscuts will be driven from the shaft to the copper-bearing portions of the formation. Plans are being considered for the erection of a mill in the near future.

Winona Copper Company.

Mine location: Winona, Houghton county.
Superintendent: R. R. Seeber.

Work at the Winona was resumed early in May, when unwatering of the mine was commenced. Some copper was produced in June and since then production has been gradually increased to about 200,000 pounds of refined copper per month.

The tributing arrangement ran from October 15, 1914 to June 1, 1915, with satisfactory results to the company as well as to the tributors.

The total production of refined copper for 1915 was 1,722,638 pounds. The yield of copper per ton of ore stamped was 16.79 pounds. The average price of copper sold was 17.4 cents per pound, which includes two and one-half months' production of tributors in 1914.

King Philip No. 1 shaft-house, which was destroyed by fire two years ago, is being replaced. This work will probably be completed in May and will enable Winona to increase its output some 35 per cent.

Balance of assets Dec. 31, 1915 was $223,324.11.

Wolverine Copper Mining Company.

Mine location: Kearsarge, Houghton county.
Superintendent: Theo. Dengler.

Wolverine continued normal output. A total of 7,250,866 pounds of refined copper was produced during the year ending July 1, 1915. The yield per ton stamped was 18.23 pounds and the total cost per pound 8.43 cents. Sales of copper, however, were made while the copper market was low and only 12.81 cents per pound was received. One dividend, amounting to $240,000.00, was paid in April.

About 44.6 per cent of the total ore hoisted was obtained with Jackhammer machines, cutting out along the foot in old and more recent stopes. Openings during the year showed fair mineralization, but much of the ground will require selection underground.

Supt. Dengler states that "the condition of the property both on surface and underground, as well as at the mill, make it reasonable to assume that operations for the coming year will show little change as compared with the past fiscal year."

Wyandot Copper Company.

Mine location: Winona, Houghton county.
Superintendent: Frank L. Van Orden.

Work at the Wyandot was resumed April 6, 1915. The mine was unwatered and actual mining started early in July. Drifts were extended north and south on the 9th level. The shaft was sunk to the 10th level and drifting taken up at that point. The results of the stoping were very encouraging and there is now a stockpile of about 2,000 tons which should yield very good returns.

The stoping has demonstrated that the mineralization is not confined to a narrow zone immediately adjacent to the footwall of the lode but is found in places to be 16 feet wide. The ore is very rich in places.

A stamp-mill test of the stockpile will be made in the spring of 1916, and if the mill test meets present expectations the winze will be converted into a permanent shaft, making a surface connection through the overburden by means of a three-compartment vertical drop shaft.

Treasury assets, including cash and assessments due, are sufficient to continue development work along present lines for another two years.