ANNUAL REPORT

OF THE

COMMISSIONER

OF

MINERAL STATISTICS

OF THE

STATE OF MICHIGAN,

FOR 1881.

BY AUTHORITY.

LANSING:
W. S. GEORGE & CO., STATE PRINTERS AND BINDERS.
1882.

OFFICE OF COMMISSIONER OF MINERAL STATISTICS,
Marquette, Michigan, August, 1882.

HON. DAVID H. JEROME, *Governor of Michigan:*

SIR:—Herewith, in compliance with law, I have the honor to submit the annual report of the Commissioner of Mineral Statistics, for 1881.

It has been the aim to make the report as full and accurate as possible, and thus to include a description of all the mines in the State, with such details of product, methods of working, cost of production, etc., as are reliable and could be obtained. In this connection very full statistical information will be found in that portion of the report relating to the copper mines. Generally, in the copper district, the mining agents manifested an entire willingness to afford any information desired, and, in some instances, access was freely given to the company's books for this purpose.

The work has been done by Prof. C. D. Lawton, whose education and experience as a Mining Engineer, and connection with the preparation of previous reports, and with the earlier geological survey, eminently qualify him for the important task which he has performed.

Prof. Lawton has visited all of the copper, iron, and coal mines, gypsum and slate quarries in the State that are working, and has also examined and described many other localities were mines are being opened, and to which public interest is directed.

Sectional maps of many of the copper mines are included in the report, and have been marked up to January 1st, 1882.

The statistical tables will be found at the close of this volume. To them has been added a table showing the production of gypsum in the State for previous years down to the close of 1881, and also will be found a valuable table prepared by Dr. S. S. Garrigues, State Salt Inspector, showing, in like manner, the salt production of the State. The table showing the coal production has been made more complete than heretofore.

I have reported to the Auditor General of the State the amount of copper, iron ore, and coal, subject to a specific tax, produced by each mining company.

I am, very respectfully, your obedient servant,

CHAS. E. WRIGHT,
Commissioner.

GYPSUM.

GYPSUM QUARRIES.

The gypsum deposits of Michigan, that are readily workable, are limited to a few localities, but fortunately they are at those points of sufficient extent and accessibility to suffice for all the demands that may be made upon them in the future. These beds, justly estimated among the most valuable of our mineral resources, belong to the carboniferous limestone series of the lower peninsula, but are not found to occur in the regular order of superposition, except in restricted districts; in many other places, having the same geological level, no indications of it are found. The most extensive of our known deposits of this mineral are found in the vicinity of Grand Rapids, in Kent county, in the western part of the State, and in the vicinity of Alabaster Point, in Iosco county, in the eastern margin of the State. At each of these localities is found a succession of thick beds of gypsum commencing near the surface, and aggregating many feet in depth. Plaster beds are also frequently met with in boring for salt, and in other borings where no beds were found, as in the Saginaw valley, its presence was detected by the large quantity of the gypsum, while the water held in solution a matter which, in such a connection, is very noticeable, from the fact that if the water, saturated with this mineral, is not shut off their pipes will become incrusted with it, and in a short time will be obstructed. Gypsum, in this form, was struck in the vicinity of Bay City at a depth of 700 feet, and at Kawkawlin the gypsum horizon was reached at about 400 feet below the surface. In the central portion of the peninsula no rock exposures of gypsum have been found, and neither here nor in the south part of the State have any gypsum deposits been discovered. This is a matter of small regret, however, since the deposits already known are sufficient to supply the demand for prepared gypsum were this demand to increase a hundred fold.

In the quarries of Smith, Bullard & Co., at Alabaster, the upper gypsum bed has a thickness of 16 feet, and borings which they have made at this point develop the existence of lower lying beds of an equal value, the second occurring but a few feet below the superficial bed. Commencing a few miles south from Alabaster point, along the shore of Lake Huron, may be observed the plaster beds which lie next above those found at the latter locality, and which rise above the surface, in bluffs, to the height of 20 feet to 30 feet. The product has not the purity, however, of that obtained at the Alabaster quarries. Near the head-waters of the Aux Gres river, extending west from Alabaster for nearly forty miles, gypsum is found near the surface of the soil; also to the north and to the south, and in many places in this vicinity are found large

beds of rich gypsum; but it is at Grand Rapids that the product for consumption is principally obtained. Here the deposit is found to the south from the city a distance of about six miles, extending beyond the village of Grandville, and lying on both sides of the Grand river and beneath it, extending over an area of eight or ten square miles and lying from 2 feet to 70 feet beneath the surface. In this region the upper superficial bed has a thickness of 6 feet to 8 feet, and lies directly beneath the soil; then occurs a seam of soft slate about 1 foot in thickness, followed by a bed of pure gypsum 12 feet in thickness. The gypsum obtained either at Grand Rapids or at Alabaster does not vary materially in appearance or in quality. It is found of various shades of color, gray, brown, red, yellow, white, and mottled, like castile soap.

The prevailing colors are white, rose colored, and gray. Specimens are found made up of white and rose-colored crystals that are indeed very beautiful.

There have been many analyses made which substantially agree in fixing the the composition of the Michigan gypsum at

Sulphuric acid	46 pounds in 100 pounds.
Lime	33 pounds in 100 pounds.
Water of crystallization	21 pounds in 100 pounds.

Gypsum is formed wherever sulphuric acid comes in contact with carbonate of lime, and is also formed by the mutual decomposition of sulphuret of iron and limestone. In the arts it is generally known under the name of plaster of Paris, from the fact that extensive deposits of this mineral were early known to occur in the region of this city, in France, and the material was applied to many of the uses for which it is adapted. Alabaster is a pure granular form of this rock; pure alabaster is of a delicate white color and fine grain, and is susceptible of a fine polish. It was used by the ancient Greeks and Romans for the purpose of being wrought into ornamental forms. It is said to have been very extensively made into pots and boxes for perfumes, etc., in the vicinity of Alabastron, between the Red Sea and the river Nile, near which city the stone, in ancient times, was obtained, and from which it derived its name.

The ancient Greeks and Romans also understood its use as stucco, in the finishing of walls and in making casts. The *selenite* or crystalline forms, that present a mica-like cleavage into thin, semi-transparent planes, are said to have been early used instead of glass.

For its uses as stucco the gypsum must first undergo the process of calcination, which consists in first grinding the rock, reducing it to a fine powder, and then heating in kettles until the water is driven off. In the process of heating or "boiling" the material is kept constantly stirred, which, together with the escaping moisture, causes the mass to assume the bubbling appearance of boiling water. When the ebullition, due to escaping steam, ceases, the calcination is completed, though it may be subjected to a far higher degree of temperature without thereby lessening its ability to set. In France it is used for making floors as well as walls. In forming the paste or cement the process is simply one of restoring the moisture which has been expelled, and thus calcined gypsum rapidly absorbs moisture from the air and loses its value as a plaster; care has therefore to be taken to secure it from the air in packages that are rendered as impervious as may be, to the air. For the purpose of economy in saving the heat, and still more to prevent the escape and waste of

the powdered plaster, the kettles are enclosed in a chamber which is provided with suitable apparatus for absorbing, etc., the process of the calcination. In the Grand Rapids mills the arrangements for calcining are very elaborate and complete. When the calcining is completed, by raising a lever a gate is raised which opens an aperture in the side of the kettles adjacent to the bottom, through which the plaster escapes into a hopper-shaped bin, from which it passes into elevators that carry it up to the bolt, in which it is revolved, the sifted particles dropping upon and sliding down one or more inclined hollow sheet iron pans that are kept filled with water, a constant stream of cold water being directed into one of the upper corners of each pan and passed out from the lower corner upon the opposite side. The water bears away the heat of the sheet iron plates, which in turn absorbs the heat from the plaster, thus rendering it sufficiently cool to allow it to be passed into the chest, or along the carrying belts into the warehouse, or down the spouts into the barrels or bags in which it is conveyed to market.

With the exception, perhaps, for the purpose of making casts, the stucco from Grand Rapids is equal to any in the market. The claim which is made is probably a just one, that for finishing walls, etc., it is nowise inferior to the Nova Scotia product. It has recently been introduced to take the place of lime for both plain and ornamental plastering, and with excellent results, judging from the appearance of the walls which have been made of it and the rapid increase of its use for this purpose. The advantage of this kind of wall is, that when the material is good and the work is well done it is not liable to crack or crumble, or fall off, and is susceptible of a high polish. The beautiful frescoes in Italy, that for ages have challenged the admiration of the world, are upon the walls of stucco.

But the chief use to which gypsum is now devoted is of more modern origin and cannot be ascribed to the ancients. Its application to agriculture is the outgrowth of modern investigation, and it is by reason of its effects, which experience has proved to be so efficacious in promoting the fertility of our soils and the prosperity and happiness of the husbandman, that the rich and ample deposits of this valuable mineral in our State become of so much importance.

That plaster promotes the growth of very many plants in a great variety of soils is a fact too well established to need a moment's consideration; but in Michigan experience has shown that it is especially effective; its importance is so great as to render it almost the basis of successful agriculture. Taking into consideration our climate, our varied timber soils, so well adapted to clover and to wheat, the system of farming that prevails which includes wheat and clover among the most prominent of our products—it is more than probable that under such conditions as do exist that it is only by the free use of plaster that farming industry can be rendered fully prosperous. The abundance of our gypsum, its accessibility, and consequent cheapness cause it to become more and more freely used, and its efficacy in stimulating the growth of clover, which proves to be one of the most valuable of fertilizers as well as excellent for forage, enables the farmers of this State to maintain the fertility of their soil very easily and cheaply, even under a system which, without the abundant and free use of gypsum, would be ruinous.

Gypsum enters into the composition of grasses, potatoes, turnips, and many other plants, but it is probable it is not due to the fact that it enters as an ingredient into these plants that its manurial value is to be attributed. Its

action is secondary; the sulphuric acid which it largely contains acts, in a measure, as a disintegrator of the soil, of its mineral elements, putting it into conditions available for plant use. Aside from this, clover, somehow, possesses the power of supplying the soil with ammonia. A soil which a chemical analysis may show to be entirely deficient in ammonia will be found to be more or less fully supplied with this important compound after it has grown a crop of clover.

The most valuable constituent of a soil is nitrogen, an element which constitutes four-fifths of the atmosphere which we breathe, and which enters largely into the composition of the most valuable and nutritious of our vegetables. Those vegetables are the most nourishing to the animal system which contain it in the largest proportion, and those soils are the most productive which contain the proper amount of nitrogen in the requisite form to be taken up by the roots of plants, and nitrogen usually exists in the soil in the form of ammonia, a combination of nitrogen and hydrogen, the lightest of known substances, and one of the constituents of water, in the proportion of one part of the former with three parts of the latter. Both analysis and experience prove that clover, by supplying ammonia to the soil, instead of exhausting it, as most plants do, renders it richer. If the clover produced the ammonia from the soil in which it grew—used up that already contained in it—the soil might be weakened by thus perpetually using up those of its elements by which the ammonia was formed, but observation has shown that the clover obtains its ammonia from the atmosphere either by direct absorption, or by obtaining the nitrogen by absorption through its leaves from the atmosphere, and the requisite amount of hydrogen from the water taken up in the soil through its rootlets; then decomposing the water the free hydrogen unites with the nitrogen obtained from the atmosphere, thus forming within the plant the ammonia which it afterwards gives to the soil through the decay of its leaves, stems, and roots. Thus it is probable that the most important constituent of a fertile soil, which may be supplied in the growth of clover, is not abstracted by the plant from the soil itself, but that the plant derives it from the atmosphere and, arranging it, gives it to the soil in the form to be readily taken up by subsequent vegetation. That a soil grows constantly richer in productive qualities by growing large crops of clover, though crops of grain are taken from it in regular rotation, is a fact which the experience of many of the best farmers has proven. Hon. George Geddes, of Onondaga county, N. Y., one of the best practical farmers in America, has land which has been cropped for over 80 years, and has never received any other fertilizer than frequent dressings of plaster applied to growing clover, and this land, he states, is more productive to-day than when first put under the plow. No other manure has been used than clover and plaster. Thirty years ago his farm was visited by Prof. F. W. Johnston, a distinguished agricultural chemist of England, who expressed the opinion that his system would surely destroy his land; he thought that poorer land would have given out long before, and believed his must ultimately; but Mr. Geddes states that the same land is more productive than it was when visited by Prof. Johnston and he made his disparaging comments, and all the time the same system has been invariably adhered to. Such a result could not be obtained in any available way than by the use of gypsum applied to produce abundant crops of clover.

Leguminous plants, such as peas, also supply ammonia to the soil, probably by acting as a mulch and keeping the soil moist and open; in the same manner clover doubtless acts, when heavy and lying in contact with the ground; the moisture hastens the decomposition of the under leaves of the clover, which in decaying give off hydrogen in the nascent state, in which condition it has a strong affinity for nitrogen, which it obtains from the air and with which it unites, forming ammonia that is rapidly absorbed by the moist earth.

But regardless of theory the fact remains that clover enriches the soil by supplying it with ammonia drawn from the atmosphere, and that plaster promotes the growth of clover in a wonderful manner. Thus it would seem that any soil may be rendered productive by growing clover, and nearly all soils, by a liberal use of plaster, may be made to grow clover.

It is probable, also, that plaster tends to increase the moisture of the surface of the ground, acting as above mentioned regarding the clover, in acting as a mulch, *i. e.* the moisture hastens decomposition of vegetable matter near the surface and in the ground. This matter, in decaying, gives off free hydrogen, which in turn unites with the free nitrogen in the atmosphere, forming ammonia, which is absorbed by the ground. Other plants besides clover are greatly stimulated in growth by the application of plaster, but in the clover we have in addition to its value for hay and pasture its use as the cheapest of all known fertilizers. Land plaster was prepared at Grand Rapids in the early settlement of that section, and has since continued to be manufactured with increasing facilities. A crude little mill was erected not far from the site of the mills of the present Grand Rapids Plaster Company, in 1845, by R. E. Butterworth, which was run by water, when the first plaster was ground. The farmers in the vicinity began using it, and gradually customers came in from greater distances, and thus the territory to be supplied soon widened, so that in the winter season, when good sleighing prevailed and after the facilities for grinding had been increased, teams came from long distances in the south part of the State and from Indiana in great numbers to Grand Rapids for the plaster. The plaster also began to be shipped to other points by boat via the Grand River, which is navigable from Lake Michigan to the plaster beds for light draft vessels.

Across the lake, in Wisconsin, a market was opened for the plaster; mills were erected there, and much of the product was supplied to them in the unground state. The shipping of the unprepared rock has all been done away with at Grand Rapids, for since the building of the immense mills and calcinal works and warehouses which they now have there, their facilities have become so elaborate and complete as to enable the companies to effect the preparation much more perfectly and cheaply than it can be done elsewhere, either of stucco or of land plaster. From Alabaster the rock direct from the quarry is shipped to several points in Michigan, Ohio, and Canada, to supply mills which prepare it for consumption.

The use of plaster upon the farms in this State has greatly increased, but it is doubtful if the merits of this valuable and now so easily to be obtained fertilizer are yet everywhere fully appreciated; its free use as an absorbent will be found to be greatly to the farmer's advantage, applied to the manure heap, to the barnyard and stable; it will absorb the escaping ammonia, and subsequently, in the decay of manure, after being spread upon the land, will relinquish it to the use of the growing plants.

Several railroads now concentrated at Grand Rapids, and these, together with the water communication afforded by Grand River into Lake Michigan,

furnish avenues for transportation to all portions of the State and country. From supplying the adjacent farms with a few tons annually of land plaster, the business has constantly radiated wider and wider until now it embraces the west and the southern States within the circle of the territory which draws from here its supply of gypsum. Car loads of land and calcined plaster are almost daily shipped to Omaha, St. Louis, Nashville, Louisville, New Orleans, or other points in the west and south. In the latter section of the country an important trade is springing up that bids fair to grow into a wide market for this commodity. Applications of plaster have been found to be very efficacious in promoting the growth of the cotton plant.

The gypsum deposits at Grand Rapids, in the quarries where they are worked, have a dip, slightly, to the northeast and east; the formation appears to roll, somewhat, though no faults are observable. Aside from what may be observed in the quarries, the extent of the gypsum deposits, as well as character and thickness of the rocks with which they are associated, is indicated by the results of a drill hole made by Messrs. Godfrey & Bro., at their quarry near the south line of the city limit, on the southeasterly side of the Grand River and near the mouth of Plaster Creek. This boring was made for the purpose of accurately determining the nature and thickness of the underlying rock beds, and careful examinations were made and a record kept of the results. The boring only extended to a depth of ninety-eight feet, and shows an aggregate thickness of fifty-seven feet of the plaster beds that were successively intercepted. The record is as follows, the boring having been made in 1876:

	Feet.		Feet.
Earth stripping	20	Gypsum	8½
Gypsum	8	Slate—shale	3½
Soft shale—slate	1	Gypsum	12½
Gypsum	12	Shale, or clay slate	1½
Shale, or clay slate	7	Gypsum	9½
Gypsum	6½		
Shale—clay slate	8	Total	98

Other borings have been made for salt and for the purpose of obtaining flowing wells, but generally no record was kept or the examinations were so loosely made that in most instances the data are not very reliable. The determinations above given were made by Mr. Freeman Godfrey, a gentleman of much intelligence and of long residence in this city, who also superintended the boring.

Thus far none but the two upper beds have been worked, and probably several generations will have succeeded one another before the necessity shall arise for resorting to the lower deposits for a supply of gypsum.

I have succeeded, with the assistance of the late Wm. Hovey, who, up to the time of his death in November last, had been agent of the Grand Rapids Company since 1860, and who was also familiar with what had been done here in this business prior to that period, and the Messrs. Godfrey, who have also been engaged in the plaster business during a long period, in compiling the statistics of the product of the quarries of Kent county up to the present time. A complete table of the statistics of the Grand Rapids Plaster Company will be found in connection with the description of that company's works, as will also be found the product for recent years of other companies in connection with the account of their quarries, etc. For the ten years prior to 1866 the total product of land plaster is estimated at 100,000 tons.

PRODUCT OF LAND PLASTER.

	Tons.		Tons.
1866	14,604	1875	27,019
1867	17,439	1876	29,131
1868	28,837	1877	40,000
1869	29,996	1878	40,000
1870	31,437	1879	44,667
1871	41,126	1880	48,070
1872	43,536	1881	32,720
1873	44,973		
1874	39,126	Total	652,680

The falling off in the product of 1881 was due to the severe winter and late spring that prevailed throughout the country, causing the farmers to be unusually behindhand in their work, and thus preventing them from obtaining their customary supply of plaster. The weather also obstructed the companies in the matter of shipping and promptly filling orders.

The manufacture of stucco or calcined plaster began about 1860, and up to 1868 the total number of barrels of stucco produced was about 80,000.

From 1868 to 1881 the total number of barrels of stucco manufactured was 1,076,656, as follows:

	Barrels.		Barrels.
1868	34,966	1876	64,386
1869	41,187	1877	55,000
1870	46,179	1878	48,346
1871	48,685	1879	50,800
1872	59,767	1880	106,004
1873	82,453	1881	112,813
1874	82,949		
1875	61,120	Total	1,076,655

A barrel of stucco weighs about 300 pounds. They reckon seven barrels to the ton.

For several years prior to 1880 a good deal of competition existed among the manufacturers of land and calcined plaster, particularly in the land plaster trade, which resulted in bringing the price down below the cost of production, causing the financial failure of some of the parties who were engaged in the business; this has naturally led to a reorganization of the plaster trade upon a basis that divides the entire production equably among those engaged in the manufacture. The price fixed upon each year is one that leaves a moderate profit to the producer, and treats all consumers alike.

The agreement entered into by the manufacturers fixes the price of land plaster, delivered into the general market, at $3.00 per ton at Grand Rapids. There is one exception to this price. Loren Day, representing the Wyoming quarry and mills—the Grange quarry, as it is sometimes called—sells in Michigan at $2.50 per ton. In the arrangement which he has made with the other companies he is allowed to sell, at this rate, only one-fifth of the total product of all the quarries; if his sales exceed the one-fifth of the product, he is to pay on the excess, fifty cents per ton, the amount to be proportioned and divided among the other companies. Considerable friction must naturally attend such a difference in price, but it is claimed that $3.00 per ton is as low as the plaster can be afforded. In this arrangement are also included Marsh & Co., of Ohio, and Smith, Bullard & Co., of Alabaster, Mich.

The price of the stucco is placed at $1.50 per barrel, and freight to Chicago is now 17 cents per barrel; formerly the freight was 45 cents, a great reduc-

tion, which shows the advantages which any manufacturing business possesses when provided with competing lines of transportation.

GRAND RAPIDS PLASTER COMPANY.

The Grand Rapids Plaster Company was organized in 1860, under the general laws of Michigan, with a capital stock of $125,000, divided into shares of $25 each. The company, however, began the work of mining and of grinding plaster rock in 1856, and up to the period of its organization as a corporation it had produced about 25,000 tons of land plaster and stucco. The product subsequently produced by this company since 1860 is shown in the following table, for each year, furnished to me by Mr. Hovey, the agent, from the books of the company:

Years.	No. of Tons Quarried.	No. of Tons Land Plaster.	No. Barrels Stucco.
1861	8,131	7,828	1,840
1862	9,223	9,223	4,357
1863	13,703	13,555	6,894
1864	15,059	13,260	10,785
1865	12,146	10,008	12,828
1866	9,424	6,546	17,268
1867	7,771	5,158	15,682
1868	9,421	5,842	21,477
1869	12,670	8,193	26,710
1870	10,502	7,231	19,624
1871	11,639	8,224	20,494
1872	17,081	13,333	22,491
1873	20,270	13,690	39,485
1874	15,365	8,803	39,376
1875	10,075	6,171	23,432
1876	8,510	5,411	18,298
1877	9,408	6,582	14,740
1878	10,440	8,286	12,925
1879	10,960	8,970	13,270
1880	15,525	12,000	23,500
1881	9,815	6,775	20,400
Totals	246,138	184,079	385,877

The location of the company's quarry and works is about one and one-half miles south of the city, on the northwest side of the Grand River, where the company owns one hundred and seventy-eight acres of land. The surface improvements, comprising the plaster mill, calcining works, extensive warehouses, etc., all of the most substantial kind and provided with every appliance for economical working and for producing the best material, were all consumed by fire in May, 1880. They have since been rebuilt, and the new structures and new works are in every respect equal to those which were destroyed. These buildings are situated just east of the bluff, which extends northerly and southerly, parallel with the river, which latter lies about 300 feet to the east. At the foot of the bluff two beds of gypsum are exposed, partly composed of white, and rose-colored granular gypsum with gray and mottled portions of the same material. There is mingled with it also some impurities, consisting of gray limestone cemented with brecciated gypsum which, when occurring, is rejected. Separating the gypsum from the slate

are thin seams of very pure translucent selenite. The mine is opened by three inclined shafts extending from the base of the bluff to the bottom of the mine. The underground workings extend about fifty rods from the mouth of the shaft, and comprise an area of about sixteen acres, worked out to a depth of 12 feet, leaving a roof of 8 feet of gypsum, with a superincumbent depth of earth of about 60 feet. The roof is supported by substantial pillars of the mineral, which are left about 30 feet apart and are about 16 feet in diameter; between these pillars the roof is secured by upright timbers 20 inches to 3 feet in diameter, of white oak, judiciously placed so as to insure perfect safety. So well has this matter been attended to that no fall of the roof has ever occurred in the mine, and no cracks or other indications of danger are anywhere observable. Between the gypsum bed, which is worked out, and the deposit, which forms the roof, is a stratum of friable slate-colored shale, 1 foot in thickness, and separating this from the two plaster beds above and below it is the thin seam of colorless selenite previously spoken of. This slaty bed is removed and left on the floor, as is also other refuse rock that it is deemed necessary to waste. The mine is dry and apparently free from dampness; not a drop of water finds ingress except the little which in rain fall, or arising from melting snow, runs down the shaft; this is drawn off into a sump and pumped out, as occasion requires. One or two leaks have been opened in the mine, but they have been effectually stopped. In one instance, a brick wall, built a few feet inside from the side of the wall where a serious leak had been opened, and the intervening space securely packed with clay, completely shut off the water, which has since given no trouble.

Tram roads extend to all parts of the mine which it is necessary to reach with the cars. Good wooden rails are used, laid with a gauge of three feet seven inches. The road is provided with switches and turn tables to change the direction of the cars as required, and contented-faced mules haul them to and fro over the railroads to and from the foot of the incline shaft, up and down which they are raised or lowered with a chain winding over a drum, connected with the engine. One of the skip roads terminates in the mill, on the floor where the crusher is placed, and another track runs out upon the surface of the ground and extends to the river. This road is used for running the carloads of rock from the mine to the boats, whenever gypsum is shipped in the unprepared state, as was formerly done to considerable extent, the rock going to supply mills in Wisconsin, where it was ground. The timbers necessary for supports in the mine, and other heavy materials are taken in or out on this track.

The method of mining pursued consists in taking down the rock from the roof half way to the bottom, and carrying forward this work of removal of the deposit for a considerable distance, the roof being supported by short stulls, which are afterwards taken away and are replaced by permanent supports. A bench or breast of gypsum, 6 feet high, is thus left, which in turn is stoped away, the selected rock removed to the surface, the timbers put into place and the bottom hauled up with the refuse. The rock is soft and easily drilled and blasted; powder is the only explosive employed, and the charges used are from three to five pounds. In this work of mining eleven miners only are kept constantly employed.

The quarry is lighted with gas, which is manufactured in the mine and conveyed to the lamps, in which it is burned, through rubber tubing. About eighteen barrels of gasoline are yearly consumed in manufacturing the gas for lighting this mine; these are kept, for safety, in tanks filled with water.

An examination of this subterranean quarry is simply a pleasant pastime. It is so easy to enter, so level and dry, so airy and comfortable, so free from impediments in traversing it, so well supported and devoid of danger, so full of interest, too, as an important practical industry, with enough of the unseen and mysterious to stimulate the imagination of the novice as to render a visit to this artificial cavern a delight to any who may be so fortunate as to enjoy the opportunity of making it.

The cars have a capacity of conveying about four tons of rock, and when drawn up into the mill the material is unloaded by being thrown, by the men, piece by piece, into the crusher, which breaks it up sufficiently fine for the pulverizer, a strong, iron coffee mill-like machine, which works by an upright iron shaft, and is placed on a level with the floor, directly beneath the vent of the crusher. In this it is broken up to a maximum size of a hickory nut, and is carried in the conveyors, precisely like those employed in flouring mills, to the hoppers of the grinding stone, which are French burrs, 42 inches in diamter, and of which there are four; two of which, only, are usually kept running, and these have a capacity of eleven tons per hour. This is the final reduction, as the stone pulverizes the material to the fineness necessary for land plaster or for subsequent calcination, for stucco. From the burrs the ground plaster is elevated in the closed conveyors and discharged upon a broad belt which moves horizontally, supported on small wooden rollers fixed at a few feet apart. The plaster is thus carried from the mill to the calcining building, with which it is connected by an elevated covered way. This carrying belt is made to discharge upon a similar belt running at right angles with it, which conveys the plaster to the long warehouse. If desired the belt is made to discharge so as to be drawn from a spout, extending down near to the floor in the room below, into bags for shipment. The cut-off is effected by giving a twist to the long carrying belt, causing the plaster to discharge at the point where the twist is made; by this means the plaster is caused to be deposited with any degree of uniformity upon the floor of the store room. At the extreme end of the conveyor is a spout directly over the scales, into which the plaster may be discharged, and thence drawn into a car, the car standing on the scales. The load is then run into the car standing upon the railroad track, which runs alongside the warehouse. The arrangements suffice for loading several cars at the same time, from the doors of the long warehouse, which open upon the track.

The plaster ground for stucco in the same manner passes into the building and is conveyed to the bin adjacent to the kettles, into which it is drawn as required. The boiling is done in what is known as the Powers kettle; the ones here used are 8 feet in diameter, and hold about 14 barrels at a charge. Formerly a good deal of trouble was experienced in the matter of kettles, to obtain such as would hold and not by reason of leakage allow the moisture to escape at the bottom, and thus interfere with the fires. The Powers kettle is the result of many failures by other inventors, and is thought to work admirably. The fires are fed beneath the kettles, the flames and heat enveloping the kettle, and also passing through it, through an 8-inch flue, which is covered by the boiling mass. Paddles, revolving horizontally, assist in securing the commotion and insure the rapid escape of the moisture, which is conducted into the tall chimney through which also escapes the smoke of the fires. The time occupied in the calcining process is about three hours, and when completed the gate in the bottom of the kettle is raised by means of a lever, and the kettle almost instantaneously empties itself into the large brick hopper

shaped bin, from which the elevating cups transmit the hot stucco to the bolts from which the sifted particles fall upon the inclined cooling pans, from which it falls into the chest beneath, from which it is conveyed on the broad carrying belts into the great warehouse, where it is stored and packed into barrels and paper sacks for shipment.

Although there is naturally much dust floating in the air, yet the men who for many years have been engaged in the business claim that it is healthy, and that no apparently injurious consequences arise from breathing the dust-laden air. In hot weather, in the summer, the heated particles of stucco falling upon the skin are not so agreeable, but in cold weather the work about the kettles is not unpleasant.

The motive power is furnished by three large steam boilers, which are fed from an elevated spring, from which also flows the water that is used in the cooling pans. The engine is an 18x26 cylinder. Shipments are made by rail or by water, as desired. The branch railroad connects with the Lake Shore & Michigan Southern Railroad, but shipments can be sent on any of the other roads by paying two dollars per car trackage.

The buildings are all new, substantial and extensive, and all of the appurtenances are of the latest and most approved patterns. As in the quarry so upon the surface, everything betokens the best of management and most careful attention to secure the best results.

Since the death of Mr. Wm. Hovey, who had been the company's agent since its organization, the charge of affairs has devolved upon his son. Mr. A. M. Apced, the present superintendent of the works, has also held that position in this company for many years, and it is very apparent that the confidence in his ability as a manager, which is shown by this long retention in the service of the company, is well merited.

Further down the river, about one-third of a mile distant to the southwest from the quarry of the Grand Rapids Company, are the mine and works of

NOBLE & CO.,

Successors of Taylor & McRingolds. Here also the quarry is entirely underground, extending, as in the former case, to the northwest, beneath the bluff on the northwest side of the river. The north line of the underground workings is close to the line between the properties. In several places, in the Noble quarry, this line has been crossed.

The quarry is entered by two shafts, or inclined skip roads, one extending up into the mill, which, as in the former case, stands close to the opening, and the other running out upon the surface to convey rock to the river, to carry out refuse, and to run in timbers and other materials into the mine. The deposit is like, in all respects, that in the Grand Rapids Company's quarry, and the method pursued in mining the rock is altogether similar to that heretofore described. The underground excavations extend over an area of about seven acres.

Recently, an apparently serious misfortune has been met with, which is occasioning a good deal of present expenditure and greatly retarding the work of production. The roof of the entire interior portion of the mine has fallen in; an area of about five acres is thus buried in ruins. The cause was due to failure to sustain the roof properly. The pillars were left too wide apart, and an insufficient number of timbers put in. One result of this catastrophe, which is, perhaps, more troublesome than any other, is the number of leaks

that have been opened, which cause, in the aggregate, a considerable water accumulation in the mine, and necessitating drainage and the work of a heavy pump for its removal. For this work a 10-inch Knowls pump has been placed in a recess near the west entrance to the mine, and is supplied with steam from the main engine boilers. The plan is to drive a gallery around on two sides of the old workings and thus open a new quarry to the south and west of them, leaving sufficient pillars between it and the ruined portion. As the part which has fallen in was already practically worked out there is perhaps no great loss, in the long run, in thus being forced to abandon it. Except for the present delay and the increase of water the fall, it would seem, need not be esteemed a very serious misfortune. The quarry will soon be in shape to afford its accustomed product.

The rock is drawn up from the quarry upon the floor of the crusher where, after passing through the crusher and the pulverizer, it is ground to fineness in a vertical iron mill situated on the floor below, and thence elevated to the bolt, of which there are two, one for stucco, and one for land plaster as well, the imperfect work of the mill rendering it necessary that the land plaster should be sifted after being ground. Thus prepared the plaster is conveyed to the warehouse on the long belt carrier and deposited as required. A new warehouse has been built within the past year. The building is three hundred feet in length and first-class, for the purpose.

The stucco works comprises three kettles for calcining, one kettle having been recently added. The branch to the Lake Shore & Michigan Southern Railroad extends alongside of the warehouse, and every facility is provided for rapidly loading the cars; a track also runs to the river for shipping by boat. The company owns forty-six acres of land.

The operations are controlled by Noble & Co., Grand Rapids, Michigan, and the superintendent of the works is J. A. Hurd. The product for each of the three past years is as follows—for the years prior to those given, the product is incorporated with those of the other companies, which aggregates have been heretofore stated:

Years.	No. Tons Land Plaster Sold.	No. Barrels of Stucco Sold.
1879	10,585	12,560
1880	9,570	24,504
1881	6,772	30,000

F. GODFREY & BRO'S. QUARRY AND WORKS.

On the opposite side of the river, southeast of the quarries previously described, are the important and long established quarries and works of the Messrs. F. Godfrey & Brother, who began here in 1861 and have since continuously produced plaster and stucco for market. The works are just outside of the city limits and the parties own several hundred acres of land. An excellent road—a pleasantly shaded summer drive—runs along the southeast bank of the river, between the works and the heart of the city. The rock is mined in an open quarry, situated a short distance east of the river. The deposit dips slightly to the north, and the ground also rises in that direction, which has occasioned the abandonment of the quarry first opened to the north, to avoid the increase of "stripping." A new opening was made south of the old one,

and in this the gypsum is now quarried. It was in this latter quarry that the boring was made, an account of which has been heretofore given.

The deposit is here covered with about 20 feet of earth, which has first to be removed, and the gypsum, to the depth of 20 feet—in two beds, 8 feet, and 12 feet, separated by 1 foot of shale—is taken out.

The quarrying is done in dry weather in summer, when there is the least water; during the remainder of the year the quarry is filled with water up to about the level of the earth stripping. At the proper time the water is pumped out, the superincumbent earth stripped away, and the work of quarrying begun. Holes are drilled through the entire depth of the deposit, and blasts inserted which loosen up from fifty tons to one hundred and fifty tons of rock at a single explosion. The rock is removed and stored under long sheds that suffice to hold several thousand tons each. Rock sufficient for the anticipated business of the ensuing year is thus gotten out and sorted for the manufacture of stucco and for land plaster. There is no practical difference, as shown by analysis, in the fertilizing value of the different grades of gypsum obtained in the Grand Rapids quarries. In selecting for calcining, the choice is determined by the hardness and grit, qualities essential to suitable stucco plaster. The product, as it comes from the quarry, is remarkably free from extraneous rock, and the deposits are of such unlimited extent, and are so easily mined that there could be but little gain in using impure rock, so that there would seem to be but little necessity or inducement for using worthless material in the manufacture of either land plaster or stucco.

Besides the difficulty of grinding the calcareous, flinty, or slaty material as compared to the soft gypsum would occasion a degree of injury or an increased wear of the mill stones, that it alone necessitates care in assorting.

The mill, calcining works, warehouses, etc., are close to the quarry, between it and the river. Both water and steam power are provided; the former is furnished by Plaster Creek, and formerly sufficient for the purpose of grinding, etc., but an increase of business and a diminution of water rendered necessary the added power of an engine. Mr. Godfrey contemplates putting in a new water wheel and otherwise improving the water power when he thinks it will nearly, or quite, enable them to dispense with the engine. The pump which is used in unwatering the quarry is operated from the water wheel. The crusher is an upright, double concern, with heavy cross lever above, the parts acting alternately, one jaw opening as the other closes. The rock from the crusher passes through the rollers beneath, which pulverize it for the burrs, from which it is carried on the broad belts to the land plaster warehouse or to the calcining works, as desired.

The calcining works are new, having been built within the past year, and the long experience of the Messrs. Godfrey has enabled them to build to the best advantage. The works are of a substantial character, and are calculated to secure the best product in the most economical manner. There are two kettles, each 10 feet diameter, with a combined capacity of one hundred and twenty barrels in ten hours work. Their aim was, in constructing these works, to secure such as should excel in every essential particular. The warehouse for calcined plaster is about 80 feet by 200 feet in size, and upon the opposite side of the calcine works, extending nearly to the river, is the land plaster warehouse, which is 180 feet by 100 feet; side tracks connecting with a branch of the Western Michigan Railroad pass along both sides of the warehouses, and the transferring of plaster or stucco to the cars is facilitated by such contrivances as are found to materially lighten the labor. The river is so

near that shipping by boat occasions but little additional trouble. Shipment by rail or by boat is governed by the matter of cost. The railroads are obliged to conform to the water rates. The river has usually a large volume of water. A recent government survey determined the fall of the river, from the mouth to the rapids, to be 7 feet. The navigation has been materially improved by the government dredges in late years, and further work of this kind could make this an important thoroughfare for Grand Rapids. The shipments from the works of Godfrey & Brother since 1878, are as follows. For the prior years their product is included in the general results heretofore given.

Years.	No. Tons of Land Plaster Shipped.	No. Barrels of Stucco Shipped.
1879	9,117	13,000
1880	9,000	23,000
1881	6,422	27,500

GYPSUM GRANDVILLE QUARRIES—UNION MILLS.

At Grandville, four miles from Grand Rapids, are found important quarries and accessory works,—The Union Mills Company, and the Wyoming Plaster Mills, the latter known as Day & Taylor, now controlled by Loren Day.

The Union Mills comprises the property lately possessed by the Union Mutual Life Insurance Company, and consists of two adjoining concerns, the one having forty acres of land and the other eighty acres, with a quarry and a mill upon each. The Insurance Company came into possession of the property through the foreclosure of a mortgage that had been given as security for money that was borrowed to construct the buildings. In 1878 the insurance company decided to operate the quarries, and Mr. T. N. Brosnan was appointed agent. In August, 1880, Messrs. Brosnan and J. C. McKee purchased the property and continued the work of mining and manufacturing plaster and stucco. On November 26, 1881, articles of incorporation were entered into under the title of

UNION MILLS PLASTER COMPANY,

With a capital stock of $150,000, divided into shares of $25 each. Both mills are in excellent order and provided with every appurtenance and convenience for effective and economical working. The mills are nearly opposite each other upon either side of the road. That known as the red mill on the west side of the highway is a large four-story building, furnished with three French burrs, 42 inches diameter, fed from the spouts that connect with the crusher. They have a capacity for crushing and grinding one hundred and twenty tons per day. The engine is unusually powerful for the purpose it serves, 22x30 cylinder, with three 30-feet boilers. The ground plaster is conveyed on the endless belts from the mill to the calcining room or to the warehouse, as required. The burrs, carrying belts, elevators, etc., are readily thrown into or out of gear at the pleasure of the foreman, without interfering with the engine. The workmen upon the distant warehouse floor can, at will, cause the long carrying belt to deposit its burden so that they may draw it from

the spouts into bags for immediate shipment. Much of the land plaster going to distant markets is shipped in bags.

For calcining there are in this establishment three kettles, each 8 feet diameter, similar to those already described. Three hours are necessary in heating a batch, and the mass is run out at the aperture at the bottom, by raising the lever that removes the gate, which covers it. The three kettles have a capacity of one hundred and forty barrels per day. When sufficiently boiled, and emptied into the cooler the plaster is elevated to the bolt and there sifted upon the cooling pans, which are filled with water by a force pump connected with the engine; the hot water from the pans is conducted back to the boilers.

The bottom of the kettles is 4 feet above the grates; the fuel used in the heating is soft coal, of which twenty-three pounds are consumed to a barrel of stucco.

To the west a short distance from this mill is an open quarry, which is not worked, all the rock being derived from the quarry near the opposite mill. It is not deemed economical to work both quarries, as one suffices and less pumping is required.

The quarry from which the rock is now taken out is the one on the east side of the road, a short distance to the southeast of the large white mill. The gypsum deposit is covered by from 5 feet to 8 feet of dirt, which is stripped away and the rock mined out to a depth of 12 feet. The mining is done in the summer season, the water being then pumped out, the steam pump being placed in a small building close to the edge of the quarry. The rock is very uniform in appearance and very pure, free from all extraneous matter. It is stored in long sheds, of which there are five, situated parallel to each other and close to the quarry and to the mill. The rock is thus covered from the weather and is comparatively dry when taken into the mill to be manufactured. It is sorted when taken from the quarry, and that intended for calcining is placed in separate sheds. The white mill, with the calcining works and warehouses, all joined together and constituting one building, is 400 feet in length, substantially built and nearly new.

The machinery, calcining kettles, and arches, carriers, etc., are all in excellent order and everything works admirably. The two mills, worked to their full capacity, would enable the company to make a large out-put, greater than any other company in the business. The demand for the product, with a margin of profit, is all that is needed to make the Union Mills Company a prosperous concern.

Side tracks along by the warehouse, etc., connect with the Western Michigan Railroad, and at the time of my visit a number of cars were being loaded for Tennessee. Orders were also shown me for land plaster to be shipped to Louisiana. A small stream near by, which empties into Grand River, suffices for carrying off the water, which is pumped from the quarries. The company have a number of dwellings on the property, also an office, store, etc.; the land is cultivated for farm products, for which it is well adapted. The stucco for the new court house and the city hall in Chicago, the Southern Hotel in St. Louis, and for the new chamber of commerce at Milwaukee, was produced at these mills.

During the year 1881 5,500 tons of land plaster from these mills were shipped into Wisconsin, and 1,500 tons of stucco were sold to a plate glass company. In the manufacture of plate glass the stucco is used for making a perfectly flat and smooth bed on which to grind and polish the plates of glass.

The general office of the company is at Grand Rapids, Brosnan & McKee, agents. The foreman of the mills is Mr. D. W. C. Blackmer, who is a very competent man for his position, having had many years' experience in the business.

The product of the mills since 1878 is given below. The amounts produced in previous years is included in the general statement of products heretofore given.

Years.	No. Tons of Land Plaster Sold.	No. Barrels of Stucco Sold.
1879	4,500	
1880	7,500	35,000
1881	6,077	34,913

WYOMING PLASTER MILLS.

About three hundred feet north from the east quarry of the Union Mills company is the quarry of Loren Day, known as the Wyoming Mills quarry, or the Grange quarry, formerly conducted by Messrs. Day and Taylor.

The deposit is the continuation of that just described, and is in all respects similar, covered with about the same thickness of drift.

The rock, however, has to be transported a distance of about one-third of a mile to the mills, which are located west of the quarry. A railroad track is laid from the quarry to the mills on which the cars are run to carry the rock. Near the mills are the sheds in which it is stored to await being ground into plaster.

The mill is run by water power, there being sufficient water for grinding during most of the year. The arrangements for grinding and disposing of the plaster are similar to those at the Union Mills. There are three burrs, and the ground plaster is carried by the long belt conductors into the immense warehouse which adjoins the mill on the north, where is found every facility for storing and handling an almost unlimited product.

Heretofore this concern has manufactured no stucco, but recently the arches and kettles and other appurtenances for calcining have been put in and are now ready for use.

The kettles are two in number, with wood furnaces for heating. The preparations would seem to warrant the assumption that the company will manufacture a first-class article of stucco. The location is a pleasant one, and the exterior and interior arrangements indicate a good degree of convenience.

Some years ago an arrangement was made with the State Grange Society whereby this company furnished its plaster at a considerable reduction in price, and the assertion has not unfrequently been made by prominent agriculturists, that the land plaster made at this mill was intrinsically more valuable than that produced at the other quarries. It has been claimed that more pains was taken to store the rock and preserve it from the snow and rain, thus making the plaster dryer; also, that as no rock was assorted out for stucco, the average rock was richer. So far as my observation goes, from the visits that I have made among the quarries, I judge that there is the requisite degree of protection given to the rock at all the mills, and an equal amount of care shown in casting out impurities. The rock, when it is not taken from

subterranean quarries directly into the mill, thus being never exposed to the weather, is placed under cover at all the quarries. The essential compound which gives to land plaster its value as a fertilizer is, undoubtedly, the sulphuric acid which it contains, which is an egredient that is not so all important in stucco. It does not appear that the rock which is ground for stucco is richer in sulphuric acid than that which is taken for fertilizer. The choice, as heretofore stated, is based upon the color, hardness, and grit—qualities which experience quickly detects.

In future, any claim of superior quality of product from the fact that no stucco is made will be altogether set aside from the fact that all the companies are now engaged in its manufacture.

I judge that dealers or farmers procuring either stucco or plaster can do so with entire confidence that from whichever of the companies they may obtain these products, they are assured of a good article. The choice, if any they may have, should be governed by other considerations than that of apprehension of receiving an inferior quality of gypsum in whatever form it is sent out.

The annual product for the years here given is as follows. The product of the previous years is added in with that of the other companies, and is therefore contained in the aggregate product for the different years heretofore given:

Years.	No. Tons of Land Plaster.	No. Tons of Stucco.
1879	7,000	None.
1880	10,000	None.
1881	6,093	None.

Office of the company, Grandville, Kent county, Mich. Loren Day, agent.

ALABASTINE.

Near the Wyoming mills are the works of the Grand Rapids Alabastine Company. Alabastine, so called, is the name given to a cement for wall finish, applied to plastered walls, to wood or brick. It is made from stucco, or rather stucco constitutes the chief ingredient, and is made of a variety of colors, and retails at about ten cents per pound.

The process of the manufacture is a patent, and the material is prepared for use by mixing with it an equal measure of water, when it is applied to the surface with a brush. The process of manufacture was patented in 1875, and a company to make it was organized under the laws of the State of New York in 1879. 1,200 tons of the alabastine were made in 1881; the stucco used was procured of the Union Mills Company. It makes a firm and seemingly durable covering for a wall, without any apparent tendency to scale or crack off, and possesses no disagreeable odor or poisonous constituents.

Stucco, or calcined plaster, is largely used for making cornices, friezes, plasters, and other forms of interior decoration, but its use also in making the wall itself, substituting it for the lime ordinarily used in the mortar, is rapidly increasing. It makes a far smoother and more durable wall than one made with lime mortar, and undoubtedly the hygienic advantages of stucco walls over papered or draped walls, are important. Plastered walls permit of ventila-

tion; the air finds its way, without difficulty, through the porous plastering, but a papered wall is comparatively impervious to it. A room with thickly papered walls, without ventilation, retains the foul and excludes the fresh air; with the wall unpapered very much of the pernicious air escapes, and pure air is admitted. The objection to bare walls, which is sometimes felt, is measureably removed in the use of stucco; with it walls can be made in any degree ornamental, and the alabastine, if it proves to be what is claimed for it, must be of great assistance. Office of the company, Grand Rapids, Michigan.

M. B. CHURCH, *Manager*.

At the alabastine quarry on Lake Huron but little has been done for the past few years; financial trouble has nearly stopped all production at this point. The quarry and mill are now owned by Mr. B. F. Smith, and the affairs are now in shape for the prosecution of the plaster business at Alabaster on a basis corresponding with that of any of the companies at Grand Rapids.

Product for	1879	2,500	tons	land	plaster.
"	" 1880	1,500	"	"	"
"	" 1881	——	"	"	"

COAL.

COAL.

The coal measures of Michigan are supposed to occupy an area comprising about one-fifth of the central portion of the lower peninsula. The seams of coal are interstratified with beds of shale, beds of coarse friable sandstone and clay. The entire formation has an estimated maximum thickness of about 300 feet. The upper rock of the series, in the southern part of the coal field, is the sandstone, a whitish, coarse grained rock, having a thickness, as shown where it is exposed in ledges, and where borings have been made through it, of from 20 to 50 feet. This sand rock is used as a building material, and answers very well for some purposes. The walls of the State Prison at Jackson are built of it, and rest upon it. From the center of the coal field to its northern limit the sand rock has been divided, and the drift rests upon the dark gray or blue shale; this slaty rock has generally little supporting capacity, and readily disintegrates on exposure to the action of the elements.

The extent of the coal field is embraced in a circle, with a radius of fifty miles, having its center southeast of the village of St. Louis, in Gratiot county, and its southern boundary passing a few miles south of the city of Jackson.

Over the greater portion of this wide field indications of coal have been found, and in many localities some incipient mining work has been done. But a limited amount of systematic exploring has been prosecuted, and the coal seams, which have been reached, vary from a few inches to a maximum of 4 feet in thickness.

The rock beds in lower Michigan have but few exposures; everywhere they are deeply buried by the overlying drift, so that actual boring is required to determine whatever of mineral value may lie beneath the surface in any particular locality. This operation involves considerable trouble and expenditure, and, unless for a specific object, is seldom resorted to. While the coal deposits probably exist over a wide field in Michigan, it by no means follows that the beds are continuous and that coal may be everywhere found in workable quantity. The basins in which the coal was originally laid down, unprotected by later deposits, have suffered from exposure to the forces of nature during the long geological periods that have intervened. Probably the greater portion of the coal originally deposited in this State during the epoch of the coal formation was subsequently worn away and destroyed by the moving glaciers of the drift period. The soft, yielding rock deposits of lower Michigan were eroded and swept away by the great rivers of ice that moved over them, to be again buried and hidden beneath the accumulated drift and debris furnished by these glacier masses, and by subsequent geological changes.

The coal and other formations which form the rock line in lower Michigan,

remain substantially horizontal as originally imbedded, but the valleys and chasms which here, as elsewhere, were doubtless formed by the eroding forces of nature, in this State are filled with the drift, so that the precipices and ledges, so frequent in other States, and which afford to the geologist the opportunity to study the strata and thus readily acquaint himself with the rock formations, are here excluded from his gaze.

With all the difficulties which have attended the geological investigation of the underlying rocks, enough has probably been done to render it certain that we have beneath our soil but a comparatively limited amount of coal. So far as is known there is but a single workable seam, and this has only a maximum thickness of 4 feet; more generally it is but from 2½ to 3 feet in thickness. Others may yet be found possessing an economic value, and the same seam may prove of greater thickness elsewhere than where now opened; but from present knowledge it may be stated that the stores of coal left by nature within the limits of this State for the future consumption of our people, are not enormously large. No doubt there is enough, when the proper time comes for demanding its use, to insure an adequate supply for the uses of the people of this State. The amount which has thus far been taken out is inconsiderable. The whole field remains practically untouched, and it is perhaps just as well that our limited supply of fuel below the surface should be reserved to meet the necessities of future generations, when we shall have exhausted the timber above it. Our State is so transcendently rich in other important minerals and in resources, that her people may well be reconciled to possess only a competence of coal. Coal was first discovered in place in this State in 1835, on section 1, in the township of Spring Arbor, in Jackson county, in excavating for the foundations for a mill. A shaft was sunk and some coal taken out, and the location became known as the Hayden mine. Subsequently the same company which operated here removed its operations to a point a mile further north, opening there what is known as the Woodville mine. This latter was started in 1857, and the shaft sunk to the depth of 27 feet, when some delay was occasioned, but in the following year the shaft was carried down to the bottom of the coal vein. From Mr. John Holcroft, M. E., who was also the company's agent at the time, I obtain the following statement of the section passed through in sinking the shaft.

	Feet.		Feet.
Drift	12	Bituminous coal	4
Sandstone	30	Fire clay	3
Shales	43		

From the bottom of the shaft drifts were extended into the coal seam, the average thickness of which proved to be about 3½ feet. To the east of the shaft, for a distance of 300 feet, the seam continued horizontal, when it rises in the next 190 feet, a height of 16 feet, and there ends, the coal vein having been, apparently, cut off by a deep erosion and the chasm afterwards filled with materials which now constitute sand rock. A gallery carried into this sand rock a distance of 100 feet failed to pass through it, but a boring put down from the surface 200 feet to the east intercepted the coal at the same horizon in which it was cut off to the west.

In the present underground work at the mine they are pushing forward to go through this intervening sandstone to open into the new ground to the east. West from the shaft the workings extend a distance of 500 yards, and to the north a distance of 330 yards; to the south, 240 yards. But over this area the coal has not been all taken out; a considerable portion of the deposit

yet remains to be excavated. The owners of the mine now, as from the beginning, are the Detroit and Jackson Coal Mining Company. This company operated the mine until 1872, taking out an annual product of about twenty thousand tons, which sold at an average of $3.00 per ton for the best, and from $1.00 to $1.75 for the slack or screenings. The coal is bituminous, highly so, evolving a good deal of smoke when burned, and it is also thought to contain too much sulphur to make it suitable for foundry purposes and for blacksmiths' use. The coal from the Woodville Mine was employed in the manufacture of gas at the Jackson gas works, and also at those in Detroit, but Michigan coal is now little used for that purpose. The objection arises from the inconvenience of purifying the gas of the sulphur which it contains. The best purpose to which our coal seems to be adapted is in the production of steam—used under the boilers of locomotive and stationary engines. In heat producing qualities it is unsurpassed. From 1872 until 1881 the mine was shut down, when it was leased by Mr. R. H. Emerson & Co., operators of the Slope Mine, etc., and work at the mine has been resumed. The machinery, buildings, shaft, etc., have been repaired and put in good working order, an elevated tramway constructed, extending 200 feet east from the shaft, where the coal shutes have been placed and to which the railroad track has been extended. The mine has been unwatered with a Cornish pump, throwing about four hundred gallons per minute. The company own the mineral right to six hundred and eighty acres of land, to which the lessees of the company's rights, Mr. Emerson & Co., add three hundred acres adjoining, of which they hold the mining right.

The shaft is sunk from the surface of moderately elevated ground, which gives good surface drainage. It is vertical, well lined up, and separated into two parts, so that the platform in the one part goes up as the other platform descends. The wire ropes for hoisting run over and under a drum operated from the engine. The boilers and engine are solidly placed, and all the machinery is of a substantial character. They are now hoisting some coal, though the main work is still repairing the mine, putting in new timbers, tram roads, clearing away the fallen ground, where necessary, etc. Eight years of abandonment have naturally accumulated a good deal of necessity for repairs.

The Woodville Mine is about four miles west from the city, and enjoys the distinction of being one of the oldest, and for some years having been the most important of the mines opened in the vicinity of Jackson. Forty-two men are now employed in the mine.

About a third of a mile distant from the Woodville shaft, to the southeast, and close to the main track of the Michigan Central railway, is the Michigan Mine, owned and worked by the Michigan Coal Company. This company was incorporated in May, 1879, with a capital stock of $30,000. Daniel McGarry, of Pennsylvania, President; Thomas A. Mason, Secretary, Jackson, Michigan; J. C. Eldred, Treasurer, Jackson. Eldred & Noyes, agents, Jackson, Michigan. The company secured the mineral right to five hundred acres of land, and hold in fee a small parcel in which the shaft is sunk.

The shaft is vertical, 80 feet in depth, and was opened soon after the formation of the company. The coal seam is from 3 feet to 4 feet in thickness, and has been worked a distance of eighty rods to the southwest of the shaft, and about the same distance to the north and to the east; in which work there was mined, in 1880, 20,021 net tons of coal, and in 1881, 23,987 net tons of coal.

The work for 1881 covers only about one-half of the year, as the mine in

December and January was filled with water, and from April until July a strike among the workmen in the mines caused all mining to be suspended. The water broke in through a weak place in the roof in such quantity as to flood the mine. This element of perplexity and hazard must always be inseparable with the prosecution of work in our coal mines, since it is impossible for the miner to know how much protection the overlying rock may afford him. At one point the sandstone may have considerable thickness, while at another point at no great distance it may have been entirely swept away. Two miles to the west, on the Michigan Central Railroad, a mine, which was opened and worked by Thomas Young some years ago, was abandoned for the reason of a want of support in the roof. The coal seam proved to be somewhat more than 3 feet in thickness, but the overlying rock is a soft shale with little tenacity, so that the whole dependence for support was in the timbers, rendering the liability of breakage and the cost of timbering too great.

The Michigan Mine is decidedly troublesome on account of water. They are using two 14-inch bucket lift pumps and three No. 10 Knowles pumps, and one No. 9 Pulsometer pump. They are going to try the efficacy of two 20-inch Cornish pumps. The machinery is good and of sufficient power to accomplish the hoisting with facility and dispatch. The lifts are worked with wire ropes running over a drum, and the cars discharge their loads directly into the shutes, which empty into the cars standing on the railroad track. As but little coal is held in store the amount hoisted from the mine per day depends upon the fact of having cars. When there are no cars to ship in, the coal is held in the mine until cars arrive at the shute; the accumulations are then hoisted. If the market is dull, or there is too long a delay, the miners are obliged to knock off from work until the glut in the mine is removed. Thus it is not uncommon for the mine to shut down for a day, or for a half day even, the pumps in the meantime being kept in motion, and the work of repairing tracks, roof, setting timbers, etc., being carried forward. The "flats," used for shipping coal on the railroad, hold from ten to fourteen tons. The Michigan company have now on their pay-roll the names of a hundred and sixty men.

The section of rock passed through in the shaft of the Michigan Mine corresponds very nearly to that of the Woodville shaft,—drift, sandstone, shale, coal. Underneath the coal, in these mines, is a bed of 3 feet of shale like that which is in contact with it above. The coal simply divides the shale. Nodules of kidney ore are found in the shale in considerable quantity. Interstratified with the coal, in all the mines, are thin belts of iron pyrites, which is easily separated from the coal. The coal has never been extensively coked for practical use.

Borings which have been made below the coal bed, show it to be underlaid, in some places, with sandstone, and in others by shales and fire clay. It was formerly thought that the sandstone was invariably the underlying rock, and that it was fruitless to search for coal below it; but further experience shows that there is no regularity in this respect. The sand rock, which is found in one point, is in another replaced by shales. And it is said that a 3-foot seam of good coal has been found after passing through 20 feet of what was thought to be the underlying Parma sandstone. It is possible, however, as there is little regularity in the occurrence of the rocks, which compose the coal formation, that the sandstone passed through was that which overlies instead of that which is found beneath the coal.

THE SLOPE MINE.

The largest of all the coal mines now being worked in the State is the Slope Mine, situated within the corporate limits of the city of Jackson. The name is derived from the fact of the shaft being inclined instead of vertical.

The Slope is adjacent to the old Porter Mine, which extends south of it—almost constitutes a northerly continuation of it. The two mines are only separated by a bar of ground, which is left for safety, as the Porter Mine has been abandoned and is now filled with water.

The inclined shaft has a direction of north 45° east, and a run of 300 feet, reaching a point 100 feet below the surface. In descending, it passes over the northerly workings of the Porter Mine. The Porter shaft is in lower ground than the Slope, but the sequence of rocks passed through in the two shafts is the same, the coal being reached in the same horizon. In the Slope shaft is found a greater amount of drift and sandstone. The Porter shaft begins in sand rock, with no overlying drift, and passes through 26 feet of it; then 17 feet of shale, when the coal is reached, a bed 4 feet thick. The shaft was carried down 30 feet further through alternating shales and sand rock.

The Slope shaft, after reaching the bottom, continues in a horizontal gallery in the same bearing a distance of 600 feet, where it separates, and two galleries parallel with each other extend 300 feet further, meeting with a fault, erosion, or dike, which cuts off the coal. The coal seam is generally 4 feet thick, and averages fully 3½ feet. The sand rock, which comes in 900 feet from the shaft and cuts off the coal, extends transversely 300 feet to the southeast, diminishing gradually until it disappears and the coal again continues regularly. But in the opposite direction, transverse to the gallery, the intercepting rock soon bends around to the west and continues in a west course for a distance of two hundred and forty yards, cutting off the coal seam completely until it runs out. West of this intercepting sand rock the mines have extended to the north of it 1,000 feet, and the Slope gallery has also been recently driven through it, so that the coal bed lying beyond this wall is now opened for mining; cross drifts will be extended through it and the coal seam chambered out.

The wall of barren ground is 50 feet wide, except at the extreme end, where it runs out. The available ground beyond it is about equal to what has been already worked out.

The bed is not quite level, but has an undulating form, in one part making a heavy roll so that the coal rises 15 feet above the bottom of the tunnel, which is driven horizontally 100 feet through the underlying sand rock; further on the coal seam comes down to its former level. The ground from the shaft north a hundred and thirty yards to the sand rock wall, and for five hundred yards east and west, is mined out; very little coal is left. The "rooms" come closely together; the partitions are very narrow, but by a free use of timbers an apparent safety is preserved. These timbers are from 3 feet to 6 feet in length, and about 6 inches in diameter. The longer ones are used along the main galleries, in which rails are laid and the mule trains are run; cross timbers and planking against the roof are also employed for its support. To the south the work is limited to the safety line preserved to prevent breaking through into the old Porter Mine. In all the Jackson mines water comes in pretty freely, and to get rid of it is a matter of some expense and trouble. A good deal of ditching is necessitated to run the water into sumps, and there are three No. 10 Knowles pumps kept running in the Slope Mine to pump

it to the surface, where the descent of the ground rapidly carries it away to the river. One of the pumps draws the water from a distance of a hundred and twenty-five yards.

But little blasting is necessary. The coal is mined by digging out the bottom of the seam as far in as practicable, and then by driving in wedges at the top, between the seam and the roof, breaking down the coal as far in as it was undermined. The miners work on contract, receiving thirty cents per car load, equal to about ninety cents per ton. They furnish their own tools and lights, etc., and push the cars to the main tracks, where it can be drawn out to the shaft by the mules. Eight mules are used—kept stabled in the mine—to do the hauling. The tracks are mostly laid with light T rail. The shaft is furnished with a double track, over each of which runs an endless chain that at the top and bottom of the shaft passes around large grooved pulleys, which revolve horizontally. The upright iron shaft to which the upper pulley is attached is connected by bevels with the main shaft of the engine below, and is thrown into and out of gear at pleasure. While hoisting is being done, however, the chains are continuously running, up one track and down the other.

The loaded cars are drawn by the mules in the mine to the shaft, thence pushed under the moving chain, which drops into the iron slots projecting up from each end of the car it is taken up to the track. The up track is elevated at the top above the down track; this elevation is to give the cars a down grade for a run of 30 feet to come under a chain that draws them 150 feet further to the chute. This endless chain, extending to the chutes, runs around a grooved pulley attached to the same upright shaft that carries the chain down the slope. The return of the chain brings back the empty cars, and in the same way they are taken down the incline. Cars can be attached at any time and anywhere on the chain, and are continuously going up and down the slope and to and from the chutes. One man at the top attends to the transferring. The chutes are at the end of the long elevated covered track, which ends in a room the floor of which is covered with tracks running to the different chutes, three of which are for the railroad and the others for town trade. The railroad chutes hold about forty-five tons, and have rack bottoms for screening the coal as it is dumped in and slides down the rack. When working full force they take out about four hundred tons daily. The mine now employs one hundred and twenty-five men. The mine has quite a local town trade. Teams are constantly hauling coal from the mine into the city, but the bulk of the product goes to the railroad company to be used on the locomotives.

They have three grades, to wit: Lump, nut, and screenings or slack. The former sells at about $3.00 to $3.50; the nut for $2.50 to $3.00; the screenings for about $1.00. The latter sells to stationary engines, etc., and by widening the bars in the grate so as to increase the draft and prevent caking it answers excellently well.

At present the coal trade is dull with these mines. By reason of the long strike last summer they were unable to meet the demand. The Michigan Central railroad made its contracts for Ohio coal, so that the railroad can now take only a portion of what it uses, from the mines, which is not all the mines are able to supply.

On February 26, 1881, the buildings were all burned, so that the shaft house, and all the buildings about it, are new. The mine was opened in 1879. During the nine years previous to that the same company had worked the Porter mine and had mined an average annual product of fifty thousand tons.

Since opening the Slope Mine in May, 1879, the amount of coal taken out is as follows:

1879	54,635	net tons.
1880	74,743	" "
1881	69,066	" "

The iron pyrites, which occurs in separate limited deposits in the coal seam, is sent to the chemical works, owned and run by the same company, where it is used in the manufacture of crude sulphuric acid. These works are but a short distance from the mine, and take about three tons of the sulphuret per day, using what is found in the Slope mine and purchasing what the other coal companies are able to furnish. These works turn out about one hundred tons of acid per month, and it is all sold to the Michigan carbon works, and used in the manufacture of the so-called superphosphate—agricultural fertilizer. The mine foreman is John Robinson, a coal miner of lifelong experience, and the company's business office is Jackson, Mich., R. H. Emerson & Co. Mr. R. H. Emerson, Jesse Hurd, and Wm. E. Hawkins have leased the Williamston coal interests in Ingham county and commenced in the fall of 1881 to re-open an old mine, which was worked to a limited extent there some years ago. On the banks of the Cedar River, near Williamston, a coal seam comes to the surface enclosed in an exposed bed of shale. Not far from this exposure two shafts have been sunk—one vertical and one inclined. There are two coal seams, the upper one lying immediately under the drift, with no intervening rock. At the shaft the upper coal seam is 20 inches thick, underlaid with 12 feet of fire clay, 3 feet of black shales, white, soft fire clay 3 feet, slate 2½ feet, bituminous coal 3½ feet, fire clay 4 feet. A large territory has been explored in this neighborhood by means of borings, and the results show an underlay of two coal seams, 15 to 20 feet apart, over the entire region tested; the upper one is too thin to be of value, and the lower seam has an average thickness of 3 feet, but has, unfortunately, a poor roof. The coal is of good quality, with the usual seams of pyrites, readily separated from the coal. Several attempts have heretofore been made to work it, which thus far have proved failures. Perhaps Messrs. Emerson & Co., bringing greater capital and experience to the undertaking, will make the work successful. The company has put in adequate machinery and otherwise equipped the mine.

About one mile northwest of the Slope Mine is the Eureka Mine. This mine is entered by a vertical shaft 53 feet deep, which is sunk in a rise of ground 200 feet west from the main line of the Jackson & Lansing railroad. The company was organized in June, 1879, with a capital stock of $25,000. President, John Bullock; Henry Bullock, Secretary; M. S. Hitchcock, Treasurer and Superintendent; office, Jackson, Mich. The mine is just outside the city limits, and the company hold the mineral right to one hundred and five acres of land. The coal seam is 3 feet to 4 feet thick, and has been worked out over an area of twenty-five to thirty acres. But little coal was taken out the first year, but in 1880 30,000 net tons were raised, and in 1881 37,477 net tons were raised.

The mining right is based on a royalty of fifteen cents per ton for screened coal. Ten to fifteen cents per ton is the usual royalty paid by all the coal companies. Considerable trouble is experienced on account of water. Four No. 9 Knowles and one No. 9 Dickson pumps are used; the latter draws the water 400 feet. The company pay the miners thirty-seven and a half cents per ton for mining, which includes pushing the cars to the shaft and taking

back the empty ones. Sixty miners are employed and about fifteen surface men. During the strike, from April till July, 1881, the mine was idle, so that the company lost its trade and has not yet fully recovered it.

The machinery comprises two large boilers in use, and one idle, and a hoisting engine. The platforms carrying the cars, etc., are raised and lowered in the shaft with wire ropes running over and under a drum, worked by the engine. The railroad track enters the shaft house so that the chutes are close to the mouth of the shaft. The coal is hoisted and loaded into the cars with rapidity. Nearly the entire product is sold to the railroad company.

The Slope, Eureka, Michigan and Woodville are the only coal mines now working in Jackson county, and their aggregate output as heretofore given is,

1880.	Net tons.	1881.	Net tons.
Slope	74,743	Slope	69,066
Eureka	30,000	Eureka	37,477
Woodville	.....	Woodville	.....
Michigan	20,021	Michigan	23,987
Total	124,764	Total	130,530

CORUNNA.

The only other coal mines in the State that are now in operation, besides those already mentioned, are near the city of Corunna, in Shiawassee county. Here there have been five mines opened, three of which have for a long time been idle.

Coal was first taken out here by Mr. Alexander McArthur from an outcrop in the bank of a stream on the W. ½ N. E. ¼ of Sec. 22, T. 7, R. 3, Caledonia township. A son of McArthur related that the discovery of the coal was made by a party of Indians, who had built a fire upon the coal seam where it outcrops, and who, upon returning to the place a few days afterwards were astounded to have their eyes and olfactories greeted with a dense, sulphurous smoke emanating from the earth. Considerably excited, and frightened withal, they hastened to the village to relate what they had seen, declaring in their Indian tongue that they had found a veritable hell. Some white men going to the spot solved the mystery.

McArthur mined out coal more or less for upwards of twenty years, employing from twelve to thirty men. It was sold mainly to blacksmiths. The vein averaged about two feet in thickness. About half a mile to the east of the McArthur mine was the Frazier mine, which started later than the former and thereafter was worked contemporaneously with it.

This mine was upon lands owned by Mr. Alexander Frazier, of Detroit, and was operated by Mr. Stanton as agent for Frazier until about 1870. No money was made, a good deal of indebtedness was incurred, and the undertaking was abandoned.

In 1870 a company was organized at Youngstown, Ohio, for the purpose of mining coal at Corunna, a large amount of land was leased, and a mine opened on the S. W. ½ Sec. 23, T. 4, R. 3. Under the direction of Mr. Gilbert, the company's agent, twenty houses were built for the use of the employés, and other improvements made. Gilbert seems to have been well qualified for his duties, but after four years of service he resigned and returned to Ohio, and was succeeded by Peter Rush as agent, who proved not so fortunate in the management of the company's affairs. Through neglect in preserving the proper repairs the shaft fell in, stopping the pumps, and the mine becoming filled

with water work was suspended. This was in 1875. The location of this mine is about two miles northeast of Corunna, upon the east side of the Shiawassee River, in the bottom lands through which the river makes its bed.

The shaft was inclined and extended vertically downward about seventy or eighty feet, passing through

	Feet.		Feet.
Drift	10	Fire clay	4
Dark shale	30	Black slaty shale	8
Sandstone	4	Coal	3
Slaty shales	6	Fire clay	4
Coal seam	1		

The underground workings extended 600 feet east and west, and 1,000 feet north and south. The work to the east was limited by a "sand bank," a deposit of sand rock, having a northwest and southeast direction, which cuts off the coal in a very similar manner as occurs in the Slope Mine at Jackson. The mine was not unwatered, and for two years no work was done; but in 1878 the company sent Mr. Todd Kincaid to examine the property and to recommence mining.

It was decided to sink a shaft and to open a new mine adjacent to the old one, and west of it a distance of 50 feet. The shaft is vertical, about 70 feet in depth, from the bottom of which the workings run 1,600 feet to the north and the same distance south and west, while to the east the old mine limits the extension in that direction, as does also further north, the "sand bar" found east of the old mine, by bending westerly as it goes north. The coal seam has an average thickness of about 2½ feet, becoming 4 feet in places. A good deal of trouble is experienced from the large amount of water to be pumped out, requiring ten tons of coal every twenty-four hours to run the pumps. The roof is a black shale, smooth and tolerably compact in places; in others it is loose and insecure; it is also of variable thickness. Above the shale is the sand rock, from 4 feet to 20 feet thick. The drifts are laid with wooden rails for the cars, which are hauled to and from the shaft by mules. Under the coal is a bed of 4 to 6 feet of fire clay, perhaps adapted to the manufacture of tile, pottery, and brick; a few barrels of it have recently been sent to Akron, Ohio, to be tested for this purpose. A seam of iron pyrites runs through the coal similarly as at Jackson, but it is claimed that the coal here contains less of the sulphur than the Jackson coal does; in appearance it is the same, and is mainly sold to the Detroit & Milwaukee Railroad Company, to supply the locomotives on the west end of this road. It is also used, to a limited extent, by blacksmiths and in foundries. The machinery consists of hoisting engine, working a drum with wire ropes, which extend down the shaft, and three large boilers for supplying the steam to the engine and to the pumps. A track from the branch of the Detroit & Milwaukee Railroad comes into the shaft house so that the skips have but a few feet run to the chutes that discharge into the cars.

During the three years that it has been worked, the mine has yielded about twenty thousand tons of coal, an average of nearly seven thousand tons per year; but it has afforded no profit. About $140,000 have been expended and not half the amount returned from the sales of coal. It costs about $1.30 per ton to mine the coal in addition to the royalty, which is ten to fifteen cents per ton. Besides, they have had to work up a market; the quality of the coal has been held at a low estimate, and the railroad company had but little faith in the continuance of the supply. It was not felt that the coal mining industry was permanently established, but only prosecuted as a trial or venture that

was liable at any time to be abandoned. Realizing the situation the company has prosecuted a series of borings with a view to thoroughly explore the surrounding country, and in future to conduct their mining operations with a better understanding of the situation. Upwards of sixty holes have been drilled and a record of them kept. Some of the old leases were relinquished and new ones made. The company have now about twelve hundred acres of contiguous lands under lease which they have sufficiently proved to establish the fact that this territory is underlaid with a coal seam 3 feet to 4 feet thick, with a reasonably good roof.

It became plain that the present mine must be abandoned; it was too costly to work, and it was thus decided to open a new one. Accordingly the location was carefully made and the work of sinking another shaft was begun in June, 1881. The site for this new mine is the S. W. ¼ of the N. E. ¼ of Sec. 23, T. 4, R. 3.

The shaft is 67 feet in depth, 8x16 in size, well lined up and is divided into two equal divisions. A good deal of difficulty was met with in sinking it, owing to the quick sand. From the bottom of the shaft a main drift has thus far been opened, east and west each way from the shaft 200 feet; to the east the roof is very smooth, hard, and firm, but to the west the ground gives evidence of disturbance; the roof is broken and rough, and cross timbers are required to support it. A parallel drift runs to the pumping shaft and thus secures air drainage—the air coming down the main shaft passes up the drift and is thence drawn off into the side drift, down which it flows and up and out of the pump shaft. At the foot of this shaft is the sump into which all the water is conducted, and thence forced up to the surface by a heavy Blake's pump.

The plan upon which the mine will be worked is to run off lateral drifts each 300 feet along the main drift, and at every 30 feet to extend out short sub-laterals at the ends of which the "rooms" will be made from which the coal is mined out.

In the main drifts the bottom is taken out below the coal sufficiently to give enough depth for the mules to travel, but in the lateral drifts, unless for drainage or for some especial purpose, the depth is only the thickness of the coal seam, and in traversing about one has to keep in a stooping posture to an extent that to the unaccustomed soon becomes excessively tiresome. Old coal miners, however, do not mind it, but work all day in these places without experiencing any extraordinary inconvenience.

The coal in the new mine of the Corunna Company is in places 4½ feet thick, and is nowhere under 3 feet, and it is certain that over an area of several hundred acres in this vicinity it preserves a pretty uniform thickness. The coal bed rolls somewhat, the upward curves being several feet above the depressions. The same is true of the formation in all the coal mines in the State; but the bottoms of the drifts must be kept uniform for drainage and for the tramways.

This new Corunna Mine seems likely to prove a success. The agent, Mr. Kincaid, declares that if he were not certain of raising and disposing of at least two thousand tons per month they would not have opened the mine. When this mine is fully opened and working, it is intended to abandon the old mine. The yield of the old mine in the last month of 1881 was eight hundred tons. The company employ about one hundred men. The general office is at Youngstown, Ohio. George Todd, President; Todd Kincaid, Secretary and Treasurer, Corunna, Michigan.

OWOSSO.

No mining is now being done at Owosso, three miles west from Corunna; but a shaft was formerly sunk there within the city limits, near the margin of the river. The shaft was 40 feet in depth. In this distance two seams of coal were intercepted, each one about 1¼ feet in thickness. The coal is of a sufficiently good quality, but the seams are too thin to insure profitable working. Several attempts to work them have been made, but were soon after abandoned as unremunerative undertakings.

Near the depot, at Owosso, of the Detroit & Milwaukee Railroad, a hole was bored to the depth of 307 feet, but only a single seam of coal was found of 6 inches in thickness. The record in full is as follows:

	Feet.		Feet.
Drift	40	White sandstone	16
Fire clay	5	Shales	22
Blue shale	20	Blue sand rock and shale	46
White shale (arenaceous)	8	White sand rock	11
Blue shale (partly arenaceous)	107	Dark shale	5
Coal	6 inches.	Sand rock	27

The boring terminated in shale.

FLUSHING.

A small amount of coal has from time to time been mined at Flushing, in Genesee County. There are several outcrops of this mineral in the vicinity; but mining work has never been systematically prosecuted. Perhaps a lack of railroad facility has retarded exploration; but coal seams, which are 2½ feet thick at the outcrop can, it is said, soon thin out. Occasionally a few miners have gotten out a small amount of coal and sold it to local buyers.

A boring recently begun passed through a seam of coal 3 feet in thickness at a depth of 14 feet below the surface.

SANDSTONE AND CLAY.

SANDSTONE AND CLAY.

The sandstone belonging to the coal measures furnishes at various points some important quarries of building stone. Notably at Flushing, the sandstone is of a micaceous texture, of a greenish color, and in portions occurs in beds, so that it can be quarried in blocks of a suitable size, and made into fine cut stone. This stone does not probably possess sufficient resistance to crushing force to make it adapted to the construction of large buildings, neither does its texture seem to be firm enough to enable it to withstand, for a long period, the disintegrating force of the extremes of our climate. It is claimed by those who have been familiar with these quarries for a considerable time, that durable building stone can be obtained here in any amount.

The sandstone here has a thickness of about 25 feet, some of which is thinly laminated, and other portions are in regular beds, of a thickness varying from 1½ feet to 2 feet.

Numerous sandstone quarries have been opened in Jackson county, chiefly in the townships of Springport, Sandstone, and Parma. It is a light-colored rock and has a glistening appearance in the sun, due to the clear quartz crystals which it contains. In some of these quarries the rock is in thick beds and of firm texture, and is said to be a first-class building stone, strong and durable. It is a white—sometimes yellowish colored—quartzite, or glittering sandstone, containing traces of vegetation. The walls of the Times building, in Chicago, are made of this stone, quarried and shipped from Sandstone, Jackson county.

At Napoleon, in this county, is an extensive quarry of gray sandstone. The section is nearly 80 feet, and the quarry covers upwards of a hundred acres. The beds are of a different thickness and furnish both flagging and building stone of an excellent quality.

Some of the beds have a fineness and sharpness of grit to answer for grindstones, and the stone has been used for this purpose to a considerable extent.

CLAY.

Another important industry has grown up in Jackson, known as the Jackson Fire Clay Company. This company has extensive works in the vicinity of the Slope Mine, where they manufacture fire brick and sewer pipe.

The clay is brought from near the Spring Arbor coal mines, and from five miles north of Jackson, from what is known as Batcheldor's Place. The clay is found here in unlimited quantity and proves to be excellent for the manufacture of sewer pipe and for fire brick.

COPPER.

COPPER MINES—ONTONAGON DISTRICT.

Ontonagon is one of the largest counties in Michigan, and while one of the most isolated, is really, in material resources, one of the richest in the State. Its whole territory is as yet almost an unbroken wilderness covered with forests of pine and hard wood that must ultimately be of great value. The soil, everywhere in the county, is a rich, productive loam, susceptible of cultivation and will yield to the farmers who in the future are sure to till it, abundant harvests of hay, oats, wheat, barley, potatoes, and even corn. Messrs. Stannard and Hoyt, of Rockland, have recently, on application, sent to the Agricultural college specimens of their crop of 1881, showing as handsome, sound Yankee corn as can be produced anywhere.

Perhaps it is as well for the county, in the long run, that its resources have thus been, from necessity, held in reserve; its great areas of pine, birdseye, birch, lynn, poplar, etc., will be all the more valuable for the delay; the time must inevitably arrive when it will all be demanded. It is folly, in this late day, to regard our timber as only an incumbrance—something to be wasted—and got rid of as speedily as possible; thoughtful men have witnessed the rapid disappearance of our forests with too much concern not to realize that this vast wilderness, which covers the soil of Ontonagon County, is among its most valuable resources—a possession in which the business of the whole country claims an interest.

In a few years more the isolation of Ontonagon County will be a matter of the past; already its primitive solitudes have been awakened by the scream of the locomotive; the first twenty miles of the railroad, which is the occasion of so much controversy, have been constructed, and when it reaches the State line it will be met by the Milwaukee & Northern, of which line it will form a part. A line has been surveyed from Wisconsin northwesterly to Lake Agogebic and thence to Union Bay. The Menominee branch of the Chicago & Northwestern will be extended to the Agogebic iron range; and the Marquette, Houghton & Ontonagon Company, aroused to the necessity of effort to preserve its franchises, has extended the survey of its line westerly and begun the work of clearing out the line thus located, so that in all probability Ontonagon County will soon be in railroad communication with the rest of the country.

The chief consideration entertained toward Ontonagon County, heretofore, has been due to its mines, which of late have been possessed of but little comparative importance; but

ITS IRON DEPOSITS—

Agogebic iron range—are now attracting much attention, and the explorations,

which have been prosecuted during the past year, have developed the existence of ore in sufficient quantity and purity to insure the opening of iron mines and the prosecution of the iron mining industry, in this range, on a scale of considerable magnitude, while its copper interests have recently received an impetus through the revival of work at the

NATIONAL.

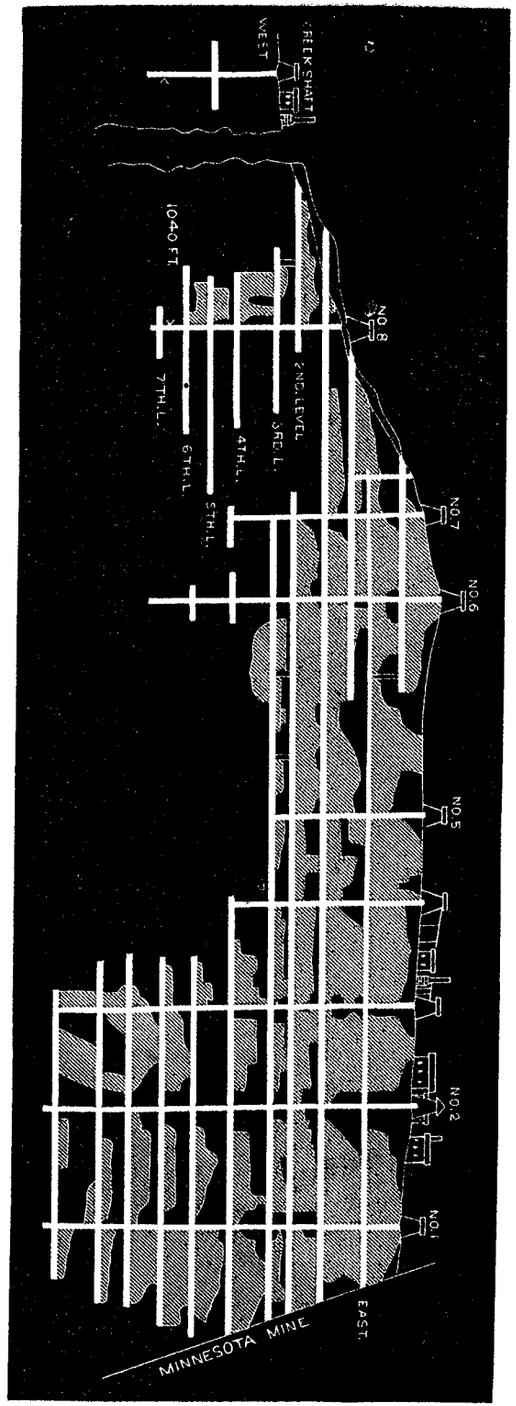
Nearly all Lake Superior mining men who are acquainted with its history have faith still in the National, and fully believe that when again opened and worked, with the improved appliances and methods that now prevail in mining, this abandoned mine has a future history that shall rival its remarkable past.

The location of this mine is in Sec. 16, T. 50, R. 39, and mining work was inaugurated here in 1848, and from that time, for a period of twenty-three years, until the company shut down in 1871, its record was one of abundant success. Notwithstanding the long and expensive litigation which it carried on with the Minesota, in order to secure its title to the land, the company was enabled to produce upwards of five thousand tons of refined copper, affording an aggregate income of $2,295,231.50 from which the stockholders had received, in return for their original expenditure of only $110,250, the sum of $319,255—nearly three hundred per cent., or $3 returned for every dollar expended. This very favorable showing was accomplished with the comparatively crude methods at that time in vogue. Only what seemed to be certainly productive ground was pushed into. No risks were taken; the stamping facilities were so meagre as to occasion, when compared to those of the present day, almost a total absence of production from that source.

The mine was opened to a length of 2,820 feet, and to an extreme depth of 950 feet. There were ten levels and eight shafts, and in all of the levels very much of the ground was left untouched. But the mine failed to afford its accustomed dividends; the stockholders began to be apprehensive of assessments, and without waiting to push on or to push down; without accepting the uncertainties of mining and endeavoring to determine if there might not be still further hidden treasures to reward the efforts of the explorer, they somewhat precipitately, in 1871, shut down.

Thenceforward, for several years, the mine was turned over to the destructive working of tributers, and from their share in this work of pillage the stockholders derived an income from the mine in dividends of $40,000. But the floors were torn up, the pillars were stoped away, the stulls and supports knocked out, and waste rock and timbers were dumped down into the shafts until they became filled from the bottom up with the rejected materials. The ground was worked away from under the shaft houses and machinery so that the engines and boilers had nearly disappeared beneath the surface. The houses and other buildings, of which there are a goodly number, and which were originally substantial and well made, were left for ten years with little or no repairs. And thus the National, once the pride of Ontonagon County and the boast of her mining men, was fast taking on the appearance of abandonment and ruin.

In 1878 the control of the affairs passed into the hands of the present owners, who removed the office of the company to Boston, and resolved to unwater and to work the mine. Capt. E. W. Parnell, a former mining captain at the National, was chosen to undertake the charge of this work, and in May, 1880, left the Phœnix and entered upon the discharge of is new duties



LONGITUDINAL SECTION OF THE NATIONAL MINE, JAN., 1881.

Scale, 300 ft. to one inch.

Everything was so greatly out of repair and so in need of immediate attention that it was difficult to decide where first to begin. But the captain began with a will and the results of his work are agreeably apparent everywhere about the mine. The buildings have been repaired, furnished with foundations where such were wanting, and put in shape to be occupied. A substantial shaft-house has been built. The great hoisting engine has been unearthed and placed upon a solid stone foundation, where it stands ready to work. A small engine for hoisting was placed in the south end of the shaft-house, and the wire hoisting rope carried up to the top of the building and down the shaft to haul up and let down the skip loads of waste rock and timbers met with in clearing the shaft and the drifts. The pumping engine, which is doing the work of raising the water from the mine, was also placed on a solid stone foundation. A stone boiler house was built and three locomotive boilers resurrected from the earth, into which they were fast disappearing, and placed therein. The stone change-house has been repaired and put in excellent condition for the accommodation of a large number of men.

In January, 1881, the work of pumping began. Freeing the National of water meant draining a reservoir 5,580 feet in length, including the Minesota and the Rockland Mines, and 500 feet in depth, from which the water had to be raised a further height above the adit of 250 feet, and then, below the connection with the Minesota, a further depth of 300 feet, and 2,850 feet in length. But the raising of the water is the easiest part of it. Clearing out the rubbish, supporting the ground, enlarging and relining the shaft, constitute by far the most difficult part of the undertaking, and this is being done in a thorough and systematic manner. No. 2 shaft, leading down into the east part of the mine, was the one chosen. The shafts were originally nearer together than is now thought necessary, and No. 2 shaft will suffice for working the whole of the east end of the mine as heretofore opened. They are already down 700 feet, and 50 feet more will relieve them from further unwatering the Minesota; and about 300 feet will bring them to the bottom of the mine. The water is raised with a Cornish plunger pump, pipe 12½ inches inside diameter. The lifts are 200 feet apart; thus far there are three, and they are going down with the fourth. No mining has been done, as the shaft is constantly used in hoisting the debris. Eighteen men are employed in this underground clearing away work. They work in three shifts, eight hours each, six men in a shift. Between No. 3 and No. 6 shafts the mine was never worked below the fourth level.

Recently Capt. Parnell has begun the work of sinking a shaft in the north lode, lying 140 feet north of the main lode. This new shaft is distant 250 feet from No. 2. The results met with are very encouraging. The shaft is down 100 feet and considerable mass copper has been taken out, amounting thus far to several tons. The lode is a conglomerate made up of a mixture of a variety of minerals cemented together by a silicious matrix; it was formerly slightly explored by the old company in 1862–3, by a cross-cut from the second level below the adit, and some drifting done in it, but the company, believing it to be a stamp lode, being only in search of mass copper, and having very limited stamping facilities, abandoned the work of further exploration. Capt. Parnell intends, as soon as he has sunk to the requisite depth, to drift in the lode to intersect this old opening, and thus connect the two mines. If the lode is found to yield stamp rock, as is anticipated, a mill for working it up will become necessary, and the question of the location of such a mill become one of the problems to be solved. The little stream that winds

between the bluffs on which the old stamp mill was placed, affords but a small amount of water, and certainly cannot be esteemed of much value for washing purposes, but possibly a single head of Ball's stamps, with improved washers, might be erected on the old site and answer for a limited amount of work, and then be removed to some better location when further development had enabled the company to determine the matter of the necessity of a larger mill and upon its location. It is but a short distance to the Ontonagon River, which affords water enough for stamping, etc., if any plan can be devised by which the water can be rendered available for this purpose without interfering with other interests connected with the use of the stream.

The railroad is now completed to Ontonagon village and its track runs three miles in the National property; a stamp mill could thus be built on Lake Superior and the rock transported thence twelve miles. But if the Marquette, Houghton & Ontonagon Railroad is built through from L'Anse, it is possible that it may be thought to be more advantageous to build stamp mills east of the mines, in the direction of L'Anse, than to the west, since it is eastward that all the product is destined to go, and there would be a saving in transportation. But the question of a stamp mill does not, at the National, demand an immediate solution. To clear the mine and get ready for mining will occupy the attention of the management for yet six months to come, after which they will probably be ready to prosecute mining work. The work of clearing the mine of water and refuse timbers and rock, and of making the unavoidable repairs underground, has proved to be a more difficult undertaking than was at first anticipated, and will require a longer period of time to consummate than was originally believed to be necessary; but the work is being thoroughly performed, and it would seem also that all due economy was being exercised. The estimated cost of clearing the mine and of making necessary repairs, etc., is $75,000.

The company's estate comprises 1,889 acres of land, stretching in irregular shape, a mile in width, across half of the mineral range. The Ontonagon & Brule River Railroad Company has three miles of its line built in the National property.

There are a number of well determined metallic lodes crossing the National lands that have been proved by previous work to be worthy of further exploration.

The officers are J. C. Watson, President, Boston, Mass.; D. L. Demmon, Secretary and Treasurer, Boston, Mass.; Wm. E. Parnell, Superintendent, Rockland, Mich. No. of shares, 40,000, par value, $25.00 each.

THE MINESOTA MINE

Adjoins the National, and is the oldest and most celebrated mine in the Ontonagon district. The mine is situated on Section 15, T. 50, R. 39, and its underground drifts are connected with those of the National to the depth of about 700 feet. The mine is 2,820 feet in length, and about 1,200 feet in extreme depth. Its direction conforms to the rock formation, being about N. 65° E. The formation dips about 44° northwesterly, but the lode has a varying dip of 52° to 64°. The surface at No. 4 shaft, is 650 feet above the Ontonagon River, which is one and a half miles distant to the west of the mine. The lode is irregular, having a varying width of from 2 feet to 8 feet. The gangue is quartz, calcite and epidote, and the mine has afforded many very beautiful specimens of crystallized minerals, including copper.

The first shipment of copper, consisting of six and one-half tons, was made from this mine in 1848, the same year that the company was first organized under a special charter from the State of Michigan. In 1855 a reorganization was made under the general mining laws of Michigan, and the capital stock was fixed at $1,000,000, divided into 20,000 shares.

The first dividend, $30,000, was paid in 1852, the fifth year of working. The assessments amounted to $60,000, and up to the period of paying dividends $400,000 had been expended, $320,000 of which sum was obtained from the sale of copper.

The total dividends paid amount to $1,920,000. The maximum product was obtained in 1860. Nearly 70% of the product of the mine, up to 1861, was in mass copper, and only about 6% in stamp work; but as the yield of masses fell off more attention was given to the stamp rock. But the stamp mill was a crude affair, as compared to those now in use, and the water supply was very inadequate, so that when the mine failed to yield masses to the extent necessary to meet the current expenses, the company resolved to shut down, and accordingly the pumps were stopped in 1870, and from that period the mine has been allowed to remain filled with water. For a few years prior to that date, and subsequently, the mine has been mostly worked by tributers, and its condition is undoubtedly similar to that of the National, heretofore described.

The work of the company during the past two years has been confined to exploration with the diamond drill along the south bluff. Holes are sunk to a distance of from 100 to 300 feet in length, at an average cost of $1.55 per foot. The results have not led to the commencement of active mining in this bluff. There is a rumor that the company contemplates completing the unwatering of the old mine and exploring it to greater depth, etc.

At the last annual meeting a new board of directors was elected, consisting of the following named gentlemen: Geo. D. Pond, E. M. Jerome, J. J. Dwight, Thos. F. Neasmith, J. Olis Wetherbee, Benj. F. Pond, and Thos. D. James. Geo. D. Pond was elected President, and J. Geo. Rippelon, Secretary. Office in New York, N. Y.

It is inferred that the change of management implies increased activity, and the Ontonagon people are greatly in hopes that such may prove to be the case. Many good mining men are of the opinion that with the present improved appliances and methods of mining favorable results would follow the resumption of work in the old mine.

The results of the operations for the past year, the company's financial condition, etc., are set forth in the following annual report, dated March 15, 1882:

We have to report that work during the past year has been chiefly devoted to explorations by means of the Diamond drill, and which so far have given no results of a character warranting the opening of any new mine. We have expended for this purpose $3,730.99, and propose to continue another year to work the drill in such parts of our property as have not already been thoroughly investigated, when it will be necessary to determine definitely, in case of no greater success than has hitherto attended our efforts, whether to cease further expenses in this direction.

The product of copper by the aid of tributers has diminished, to quite a nominal quantity, consequent on the rate of wages having increased in the region to an extent that makes working a tribute undesirable to the men hitherto engaged in this way, who can generally do much better now through regular employment. The ground, however, is by no means exhausted, and at

some future time it may be practicable to get a large number of men willing to go to work, when our resources may be increased. The accounts for the year are hereto annexed.

H. S. Henry, President; Edmund Hendricks, G. P. Saterlee, and Charles M. Stead, Directors.

PRODUCT AND VALUE OF MINERAL.

The product of the mine, in mineral, for the year 1881, was 35,030 lbs., yielding ingots 24,227 lbs., and in cash	$4,297 75
The product of mineral for December, 1881, is 3,686 lbs.; bought of the tributors for	290 46
	$4,588 21

COST OF PRODUCTION.

Balance—mineral at mine December 31, 1880	$242 49	
Wages—amounts paid tributors, $2,773.58; surface labor, $787.62; salaries at mine, $1,500; powder, wood, etc., $155.18	5,216 28	
Transportation, $217.40; insurance, $9.96	227 36	
Smelting, $313.77; taxes, $1,158.32	1,472 09	
Salaries at New York	1,600 00	
Office and general expenses	807 45	
	$9,565 67	
Less profit on interest, rents, farm, merchandise, etc	1,355 17	
	$8,210 50	
Expenses over value of product	3,622 29	
		$4,588 21

(The amount expended in working the Diamond drill was $3,730.99.)

INVENTORIES OF PROPERTY.

Real estate at original cost ($64,800), less sales		$19,261 18
Surface improvements, buildings, stamp mill and dam, cleared lands, tramways, Ontonagon dock, etc		39,385 00
Personal property, engines, machinery, tools, materials, and diamond drill		57,709 44
Supplies: In store, $140.30; blacksmith shop, $1,828.86; farm, horses, and wagons, hay, wood, etc., $942.00		2,911 16
Accounts receivable at mine, $381.36; and in New York, $1,524.48		1,905 84
Mineral at mine		290 46
Cash in hands of agent, $62.09; and treasurer, $5,660.06		5,722 15
		$127,185 23
Deduct: amounts payable in New York	$1,337 42	
Outstanding drafts	1,357 06	
		2,694 48
		$124,490 75

TREASURER'S ACCOUNT.

Receipts—		
Cash on hand as per last report		$2,429 86
Sales of copper—Product of 1881, 24,227 lbs		4,297 75
Assessment		10,000 00
Interest		232 05
		$16,959 66
Disbursements—		
Agent's draft for tributor's wages, etc	$6,365 10	
Transportation, smelting, insurance, taxes, general expenses, salaries, etc	3,141 28	
Carbons for drill	1,793 22	
		11,299 60
Cash balance		$5,660 06

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4,588 21

4,588 21

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9,385 00
7,709 44
2,911 16
1,905 84
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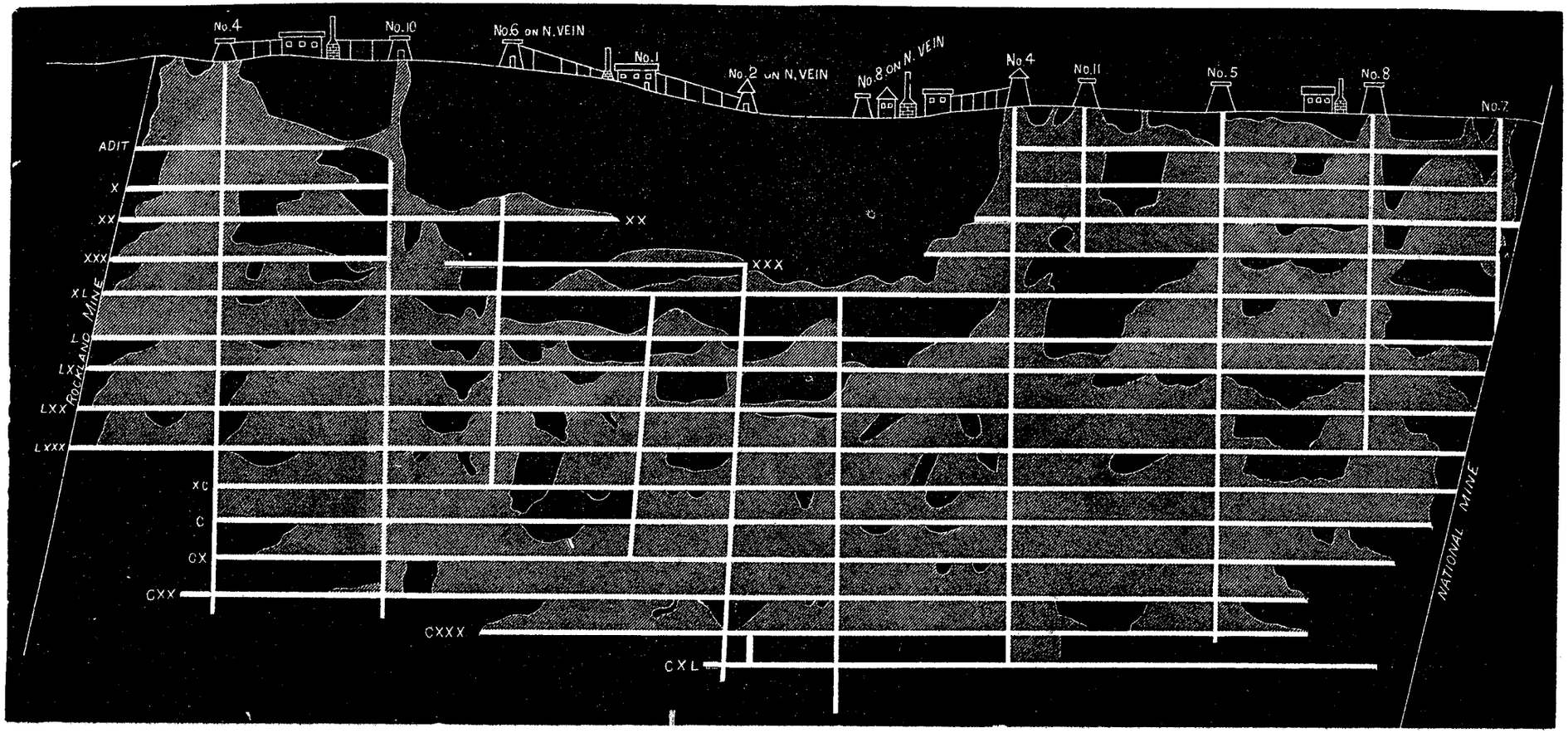
LONGITUDINAL SECTION OF THE MINESOTA MINE.

Scale, 300 ft. to one inch.



GENERAL STATEMENT.

Resources—		
Mineral at mine		$ 290 46
Supplies at store, shops, and farm		2,911 16
Accounts receivable at mine, $381.36; and in New York, $1,524.48		1,905 84
Agent's cash balance		62 09
Treasurer's cash balance		5,650 06
		$10,829 61
Liabilities—		
Accounts payable in New York	$1,337 42	
Outstanding drafts	1,357 06	2,694 48
		$8,135 13

The capital stock is $1,000,000, divided into 40,000 shares. The estate consists of 4,653 acres of land, a tract worth careful exploring.

THE RIDGE MINE

Is situated in the S. W. ¼ of Sec. 35, T. 51, R. 38, and the company was organized under a special charter from the Legislature of the State of Michigan, April, 1850, and mining work was begun at that time in what is known as the Butler or Champion lode. The company worked the mine for five years and leased the property to Capt. Stephen Martin, who operated it until 1863. The mine was purchased by Thomas F. Mason for $200,000 in 1860, who three years thereafter reorganized the company under the general mining laws of the State, with a capital stock of $500,000, divided into 20,000 shares. Two hundred thousand dollars in assessments were levied and collected during the two succeeding years, since which time the product of the mine has sufficed for the expenses, and dividends to the amount of $160,000 have been paid, the first dividend, $50,000, having been declared in 1872.

The Ridge forms one of the Evergreen Range Mines, and has ever been esteemed as one of the best in the district. The estate comprises 1,494 acres of land, and is crossed by all the veins of the Evergreen Range, the value of some of which has never been proved on this property, although found to be productive elsewhere. The present mine is in what is called the Evergreen vein, and it is the desire of Agent Harris that the old mine in the Champion lode be reopened. The formation here is very irregular, both in dip and in trend, the general inclination and bearing being 38° northwesterly, and S. 43° W.

The mining plant is much behind the times, the machinery, having been long in use, needs replacing with newer and improved patterns. The compressor and power drills should replace the slow and expensive hand work. The mine needs a compressor and air drills to extend the openings with greater rapidity than is now possible. If pushed with the same vigor as the Osceola there is but little doubt that the Ridge would be a paying mine.

The following is the report of the Ridge Copper Company for the year 1881:

The product of the mine for the year has been—

	Pounds.
Barrel Copper	101,150
Stamp "	80,050
Mass "	54,540
	235,740
Or 117 1740-2000 tons, which has realized, including mineral remaining at the mine at 80 per cent., yield	$36,233 99
Received from interest	142 68
Total receipts	$36,376 67

The expenditures of the year have been as follows:

Mine expenses	$33,384 63	
Other expenses, as per Treasurer's balance sheet	6,111 71	
		$39,496 34
From which deduct total receipts as above		36,376 67
Shows the loss on the business of the year		$ 3,119 67
The statement of assets and liabilities in last report showed a balance of		$25,969 39
Deduct loss on business of 1881		3,119 67
Balance on January 1, 1882, as per statement attached		$22,849 72

The openings made in 1881 were as follows:

Drifting 148 10-12 feet, at an average price per foot of	$9 44
Sinking shafts, 54 5-12 feet, average price per foot of	28 00
Stoping 463 67-72 cubic fathoms, average price per cubic fathom of	22 01

Making the whole amount of ground broken, 512 18-72 cubic fathoms, which produced about 460 pounds of mineral copper per cubic fathom of ground broken.

STAMPING.

The stamp mill worked seventy days, stamping 2,300 tons of rock, which yielded about 1.74 per cent of mineral copper.

WORKING FORCE, ETC.

The average monthly number of employés was	52½
The average monthly number of miners	27
The average monthly wages of miners on contract was	$40 06

CONDITION OF THE MINE.

The work done during the past year was confined almost entirely to the vicinity of No. 3 shaft. The shaft was sunk to the 70-fathom level, at which point the vein made a large pocket of very productive stoping ground. The 70-fathom level was drifted a short distance west of shaft, but from want of time no drifting was done at that level east of shaft.

The rest of the drifting done was at the 60-fathom level east and west of No. 3, and at the 50-fathom level east of No. 3 shaft. The only work done in the western part of the mine was a little stoping at the 50-fathom level, just east of No. 2 shaft, and at the 40-fathom level, some 250 feet and 670 feet west of No. 2 shaft. The vein at those places was rather small, but moderately productive of small mass and barrel copper. Some stoping was also done at the 30-fathom level, west of No. 3 shaft. At all these places the vein was generally large and promising in appearance, but sparingly productive of copper.

The principal and most valuable stoping ground was just west of No. 3 shaft, at the 70-fathom level, and just east and west of the shaft at the 60-fathom level. This stoping was mostly in the irregular jumble of vein apparently dipping west, which was spoken of in my last report. The vein here is more than usually twisted and broken, being sometimes but a mere string, and then swelling out into pockets of from 20 to 30 feet in width. The prospect for the continuance of this copper ground is quite favorable, and from its appearance at the 70-fathom level, we may reasonably expect it to grow richer as greater depth is attained.

I would now respectfully call your attention to the advisability of taking immediate steps to introduce machine drills into the mine, and to procure a new hoisting engine and other necessary equipments. We cannot expect to do

our work with desirable economy and to the best advantage unless we have the same kind of appliances and facilities that are now in general mining use. I think that the appearance of the mine will warrant the levying of an assessment for that purpose, and I so recommend.

In laying out any new work I would provide in some measure for the reopening and working of the old mine vein, which could be done, whenever desired, either independent of or conjointly with the present workings. The old mine vein was very productive of copper. It is many years since anything was done there, and far better results could be obtained to-day because of the improved methods and appliances for mining.

I estimate the required outlay approximately as follows:

Hoisting engine, boilers, drums, and gear	$10,000
Air compressor, pump, steam pipes, etc	6,000
Pipes for compressor, power drills, shafting, etc	2,000
Planer, lathe, drill, small engine for machine shop	2,000
Two new shaft houses, skip, wire rope, etc	2,500
Building for engine house, compressor, machine shop, etc	4,500
Add one-fifth per centum, say	5,000
For opening new ground, drifting and sinking	8,000
Making a total estimate of	$40,000

The foregoing does not include anything for the old mine vein, except machinery; nothing for shaft-houses, pumps, and labor for unwatering the mine, straightening and retimbering shafts, etc., etc.

If the above plans are approved, and they are certainly worthy of your serious consideration, I would recommend that for the purposes mentioned, $50,000 be raised by assessment on the stock. Yours respectfully,

S. B. HARRIS, *Agent.*

The subject of equipping the mine for work on a larger scale, and with modern appliances, has been under the consideration of the board of directors for some years, but they have not hitherto found it in accordance with their judgment to take any steps to that end. The failure for the past two years to show any earnings, now decides the board to submit to the stockholders for their definite action, whether they will assess themselves to provide the equipment necessary to put the mining operation on a profitable basis, as recommended by the agent, Captain Harris. The directors fully concur in his recommendation; and in order that the question may have the fullest consideration, submit this report to each individual holder of stock in advance of the annual meeting, and with it a form of proxy, which may be used by any who cannot attend the meeting in person. If signed and returned to the office of the company, the proxy will be voted in favor of the election of a board of directors, who will assess the stock as herein indicated.

The stockholders are reminded that no election of directors has been held at the last three annual meetings, because a majority of the stock was not present, and did not vote either in person or proxy, as the law under which the company is organized requires; and all are earnestly solicited to see that their stock is properly represented at the meeting, which will be held at the office of the company, No. 4 Exchange Court, New York City, on Thursday, March 2, proximo, at 11 a. m. Unless a majority of the stock is present or represented, no business can be transacted.

All of which is respectfully submitted.

THOS. F. MASON, *President.*

BALANCE SHEET FROM THE BOOKS OF THE RIDGE COPPER COMPANY, JAN. 1, 1882.

EXPENDITURES.

Real Estate—		
Cost of property		$203,541 00
Expenditures—		
As per published statement to January 1, 1881		1,012,618 70
1881—		
Mining account	$39,550 37	
Smelting	2,363 56	
Expenses, taxes, and copper charges	2,486 40	
Transportation	1,103 70	
Insurance	158 05	
		45,662 08
Dividend Account—		
Paid February 24, 1873	$50,000 00	
" " 23, 1874	20,000 00	
" " 8, 1875	20,000 00	
" " 10, 1880	9,742 00	
		99,742 00
Company Stock—		
One hundred shares, costing		239 70
Treasurer's Account—		
Cash in bank	$6,020 41	
Call loan	10,000 00	
		16,020 41
		$1,377,823 89

RECEIPTS.

Capital Stock—		
Paid in for property	$200,000 00	
Assessments	200,000 00	
		$400,000 00
Copper Account—		
Sales to January 1, 1881	$914,149 71	
Sales in 1881	47,493 71	
		961,643 42
Interest Account—		
Collected to January 1, 1880	$16,037 79	
Collected in 1880	142 68	
		16,180 47
Shipment, 1881 — 289,880 lbs.		
Yield — 81 per cent.		
Ingots — 235,606 lbs.		
		$1,377,823 89

STATEMENT OF LIABILITIES OF THE RIDGE COPPER COMPANY, AND OF AVAILABLE ASSETS, JANUARY 1, 1882.

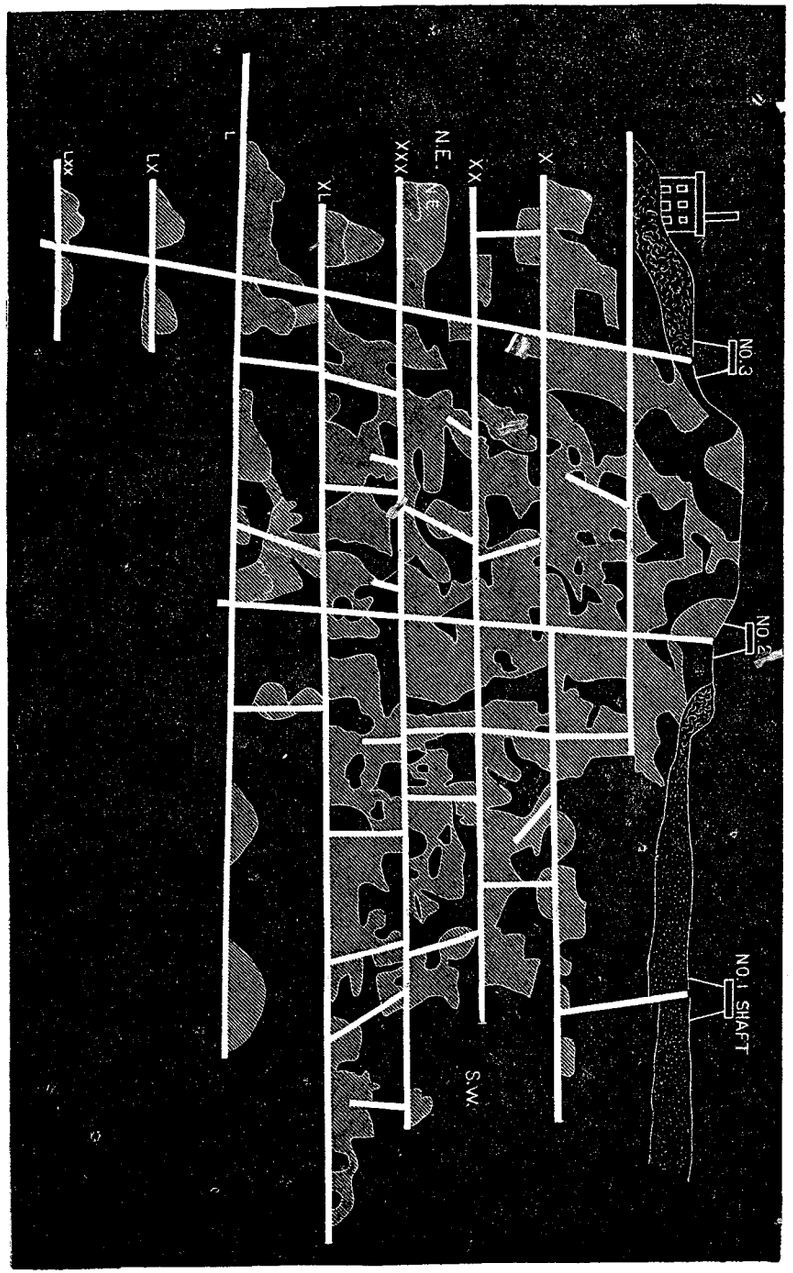
LIABILITIES.

Unpaid dividends	$258 00
Drafts outstanding	1,241 02
Accounts payable at mine	2,032 13
Balance	22,849 72
	$26,380 87

ASSETS.

Treasurer's account	$16,020 41
Cash on hand at mine	8 95
Accounts receivable at mine	292 92
Mineral at mine, 20,130 lbs. at 80 per cent yield and 15 cents per lb	2,415 60
Supplies at mine	7,642 99
	$26,380 87

Balance of available assets over liabilities.....$22,849 72.



LONGITUDINAL SECTION OF THE RIDGE MINE, JAN., 1882.

Scale, 180 ft. to one inch.

obtained from November 1, 1880, to November 1, 1881, was 620,914 pounds, all of which was shipped from the mine; of this, about 530,000 pounds, smelted, yielded 383,886 pounds of copper, making the total amount obtained 427,824 pounds, which sold for $70,895.84, leaving 90,000 pounds of mineral on hand. The forfeited stock of the company, which had been bought in and held, was divided pro rata among the stockholders.

TREASURER'S REPORT OF RECEIPTS AND EXPENDITURES TO DECEMBER 1, 1881.

RECEIPTS.

Assessments paid in		$149,202 00
Sales of copper to date of last report	$292,531 17	
Sales of copper since date of last report	70,895 84	363,427 01
Debts due		9,634 43
		$522,263 44

EXPENDITURES.

General expenditures to December 1st, 1880	$423,141 48
Labor drafts paid	87,579 15
Taxes	671 11
Interest	8 98
Expenses	1,407 43
Freight	1,808 50
Insurance	570 50
Smelting	3,876 75
Due from sundry parties	221 84
Cash on hand	1,977 70
	$522,263 44

LIABILITIES.

Labor drafts outstanding	$ 6,788 03
Debts due	9,634 43
	$ 16,422 46

CASH ASSETS.

Cash	$ 1,977 40	
Ninety thousand pounds mineral, estimated value	12,000 00	
Due from sundry parties	221 84	
	$14,199 24	

The Superintendent's report of the mining operations is as follows:

The operations are still confined to the Knowlton vein, and consist of

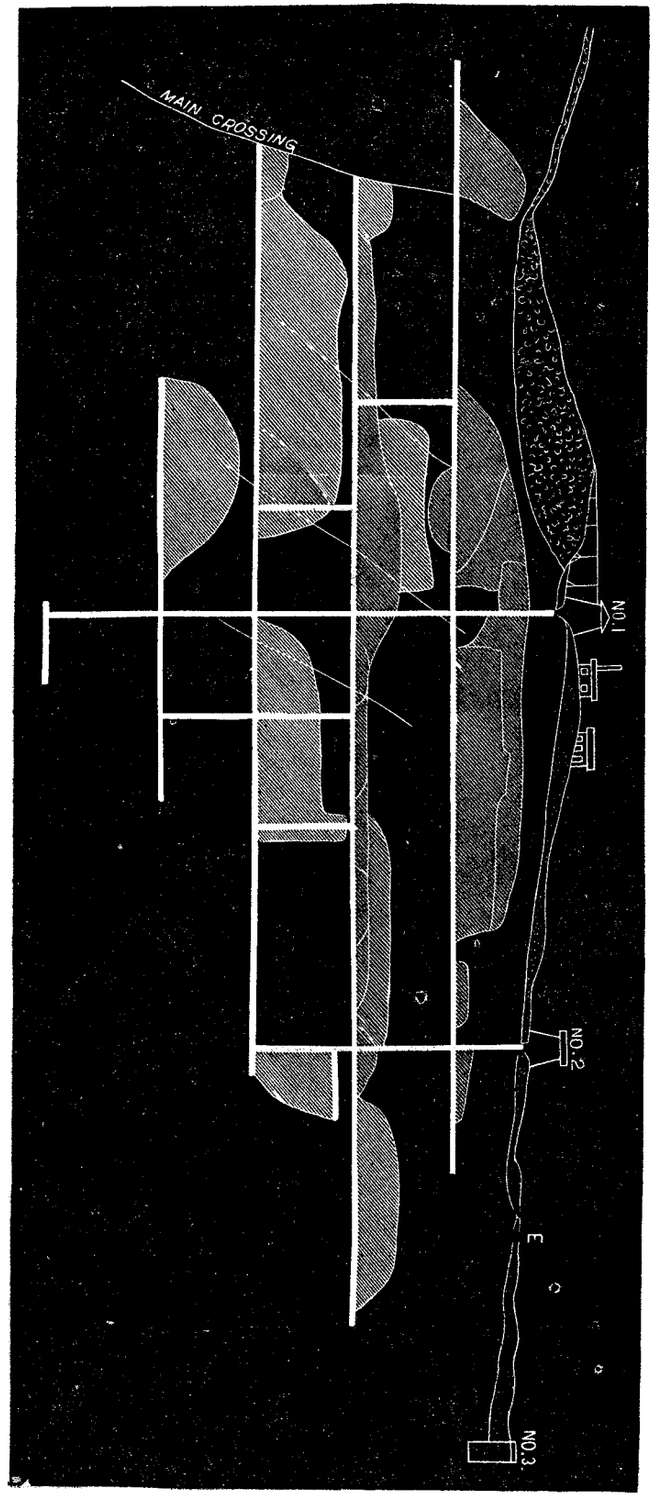
Drifting 511 feet 5 inches at a cost per foot of $13.11	$6,709 81
Sinking winze 79 feet 9 inches at a cost per foot of $15.58	1,198 75
Sinking shafts 137 feet 9 inches at a cost per foot of $22.02	3,037 82
Stoping, 1,335 cubic fathoms at a cost per cubic fathom of $13.12	17,514 54
Sundry work	4,133 51
	$32,594 43

The number of men employed and the amount of wages expenses were:

Sixty-one and four-tenths miners and timbermen	$32,594 43
Fifty mechanics and laborers	22,488 56
Total wages	$55,082 99

Additional expenses incurred, as follows:

Three thousand cords of wood	$6,221 00
Mining supplies consumed	2,584 80
Amount paid for machinery	10,676 68
All other expenses, including transportation, taxes, salaries, etc	8,840 72
Total expenditures for the year	$83,406 19



LONGITUDINAL SECTION OF THE MASS MINE, JAN., 1882.

Scale, 120 ft. to one inch.

The results of the leading features connected with the works, are shown in the following statements:

Total amount of rock mined	22,500 tons.
Amount hoisted to surface	20,064 "
Amount selected for stamping	7,761 "
Cost of selecting, delivering and stamping	$10,489 62
Amount of mineral produced from stamps	318,665 lbs.
Amount of masses and rough mineral produced	302,249 "
Total mineral product	620,914 "
Amount of mineral per cubic fathom of rock	465 "
Proportion of masses and barrel work to whole product	48 67-100 ℔ cent.
Proportion of stamps copper to whole product	51 33-100 "
Proportion of stamp rock to whole amount mined	34 50-100 "
Percentage of mineral in selected stamp rock	2 05-100 "
Percentage of mineral in whole amount of rock mined	1 37-100 "

The facilities for economical mining have been greatly increased during the past year by the erection of an air compressor, and the introduction of the Rand air drills.

We have nine of these drilling machines now on hand, seven of which are employed in stoping.

These machines will soon be started in the drifts and shafts, and, with the great expedition in making openings by this means, a large amount of stoping ground can be prepared for breaking with a comparatively small force.

With these improvements, the amount of rock mined will be nearly doubled, and the scale of operations and degree of success correspondingly increased without much additional working expense.

Where the air drills are used we find it necessary to employ high explosives exclusively for blasting, which largely increases this item of mining cost; but the data that we have been able thus far to obtain indicates that the cost of producing each ton of rock is reduced nearly one-half.

The No. 1 shaft is now down to the fifth level, and drifting commenced at that level. The vein in this locality shows considerable copper, and for that reason we think it advisable to resume the sinking at an early date.

The No. 2 shaft is sunk to the third level, and has a communication from that point westward to No. 1 shaft.

The vein at the bottom of No. 2 shaft has yielded some stamp rock, and a large proportion of masses and barrel work.

We still have considerable stoping ground opened, but the openings should be vigorously pushed ahead; not only to keep up the supply, but for the purpose of discovering other valuable deposits of mineral.

With reference to the general appearance of the mine, and its prospects, I would say that during the past year no material change has taken place. The vein throughout the lower levels has settled into a sameness of character and production. Since the exhaustion of the large surface deposits of mineral there has been a decrease in the quality of the vein matter, but it has now apparently settled into a condition in which the yield of copper will be in about the same proportion as it has been during the past year.

Our success will now depend upon the result of the recent introduction of drilling machinery, and as the new mode of working is now well established, it is reasonable to expect a largely increased product with very little additional expense.

We are provided with a stock of mining supplies, consisting of feed, iron, nails, etc., for winter's use, amounting, per inventory, to $2,800.

There are also on hand 200 cords of wood, valued at $500, besides several hundred cords in the woods, cut on this winter's contract.

It is very desirable to have seasoned wood for consumption, and for this reason we have made arrangements for a larger supply than usual, and shall endeavor to have delivered, during the coming season, five or six thousand cords. Yours truly,

JOHN CHYNOWETH, *Superintendent.*

The Mass Mine location is the S. W. ¼ of Sec. 6, T. 50, R. 38, and the company was organized in 1856, with the President, then as now, Dr. C. G. Hussey. The other present officers are James W. Brown, Secretary and Treasurer, Pittsburg, Pa. John Chynoweth, Superintendent, Greenland, Mich,

The capital stock is $500,000, divided into 20,000 shares.

The product for December, 1881, was 37 tons, 120 lbs. The product for January, 1882, was 38 tons, 1945 lbs. The product for February, 1882, was 38 tons, 1214 lbs.

No. 1 shaft—the working shaft—has been sunk to the 5th level, about 360 feet from the surface, on the lay of the vein.

The other mines in the Evergreen Range have continued idle since our last report with the exception of a limited amount of tribute work having been done at a few of them.

The Ogima produced 8 tons and 259 pounds.

The Flint Steel produced 3 tons and 668 pounds.

The Evergreen Bluff produced 0 tons and 1210 pounds.

The Adventure produced 0 tons and 9614 pounds.

No changes observable have been made in any of these mines.

INTERNATIONAL.

The sale of the International—Old Bohemian—is reported. The sum paid is stated as being $50,000. This mine adjoins the Aztec, being the E. ½ Sec. 31, T. 51, R. 37. The first copper shipped from it was in 1853, and the estate comprises 1,480 acres of land. Considerable money has been expended on the property in past years.

THE WINONA,

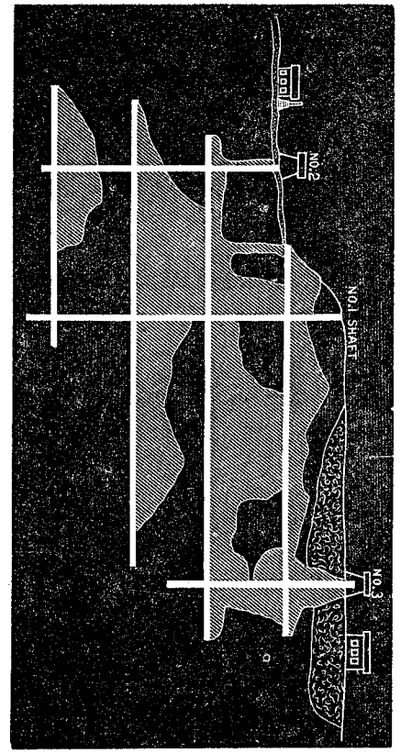
It is said, has also been sold, through the agency of Messrs. Kruse & Traverse of Chicago. Some men were put to work in the winter to clean out the pits, etc., to prepare the property for examination.

HARTFORD.

At the Hartford location, Sec. 32, T. 50, R. 40, some work has been done within the past year under the direction of the owner, Wm. H. Stevens of Detroit. The indications are said to be favorable and a company has been organized to work the property.

NONESUCH.

Early in 1881 the Nonesuch Mine was sold; the purchasers also bought out Capt. Hooper's lease. Preparations were immediately made for future mining



LONGITUDINAL SECTION OF THE KNOWLTON MINE,

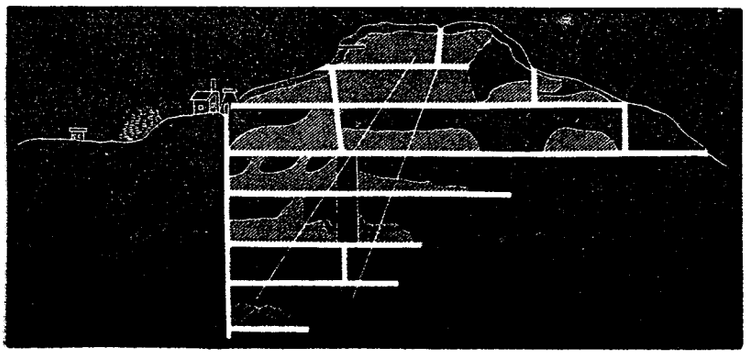
JAN., 1881.

Scale, 180 ft. to one inch.

LONGITUDINAL SECTION OF THE EVERGREEN BLUFF MINE,

ONTONAGON COUNTY, MICH., 1881.

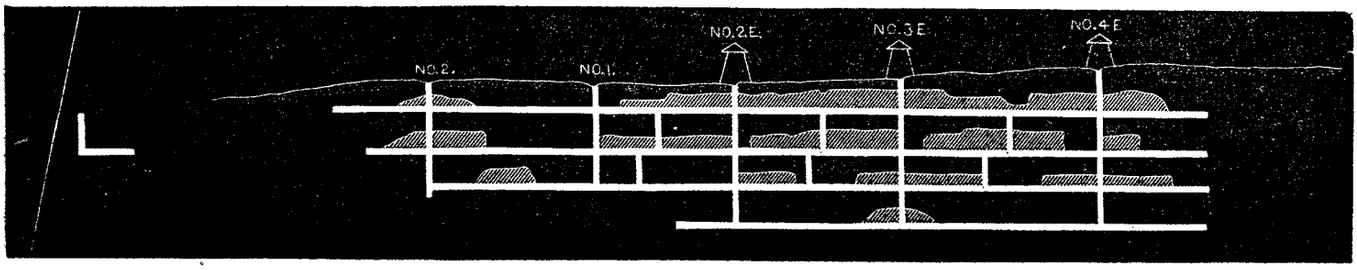
Scale, 250 ft. to one inch.



LONGITUDINAL SECTION OF THE TOLTEC MINE,

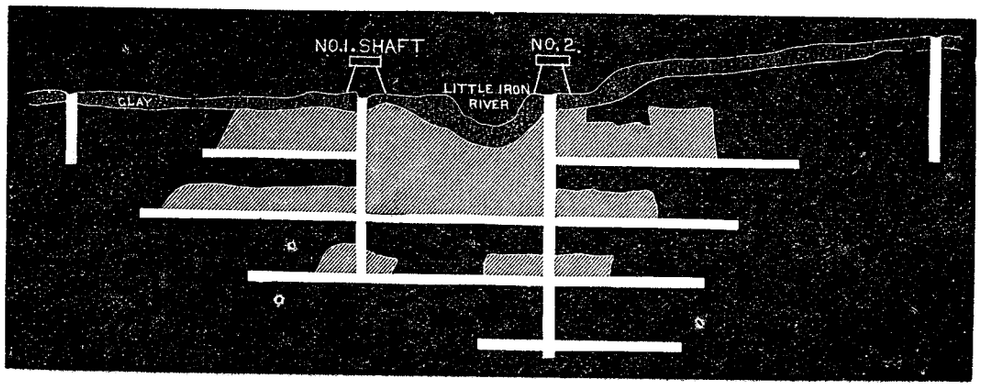
ONTONAGON COUNTY, MICH.

Scale, 300 ft. to one inch.



LONGITUDINAL SECTION OF THE NONE-SUCH MINE.

Scale, 200 ft. to one inch.



on a large scale, and within the year much surface improvement has been made. The progress of the work has recently been somewhat delayed, awaiting the results of trials and experiments which were made in testing the rock. Several tons of the rock were sent to the smelting works at Portage to be tested in the furnaces, and a like amount was shipped to Chicago for chemical manipulation.

The chief improvements which have been made consist of engine house, stone and iron, 42x50 feet, in which has been erected a hoisting engine, Hodge's pattern, 24x36 feet, 250-horse power.

The upper floor of the new engine house is fitted up for a machine shop, provided with planer, lathe, bolt cutter, etc., all of which are run by an engine on the same floor.

The new boiler house is 48x52 feet, also of stone and iron. In it are placed three large boilers and two smaller ones, to furnish steam for hoisting engine, compressor, and stamp mill.

The new compressor is Rand duplex, 16½x20 feet, and will suffice for forty air drills.

There are two hoisting drums, Hodge's pattern, ten feet diameter, friction gear.

The new stamp mill in process of erection is to be 130x67 feet, in which will be placed the three Ball stamps now on the ground. Adjacent to the stamp mill will be placed the rock house. The compressor is ready to work and 16 drills have been procured.

Fifteen new dwellings have been built; also a store, office, hotel, etc., making twenty buildings in all.

The tram road to the lake has been completed and laid with T rail most of the way, the intention being to use a locomotive to operate the road. Two ware houses have been built at the lake terminus of the road—Union Bay—and the dock has been enlarged and improved.

Very little sinking or drifting has been done in the mine. A limited number of miners have been at work stoping sufficient rock to supply the stamps and washing mill. A product for the year of 104¼ tons of mineral have been obtained, yielding 60 per cent ingot.

About 120 men are employed.

Capt. Hooper states that it is possible that the building of the stamp mill, the foundations of which are laid and the materials for the completion of which are on the ground, will be abandoned, and a system of rollers, grinders, sieves, and jiggers substituted. The stamp heads pound the rock up too finely, thus making a great deal of slime from which it is impossible to mechanically separate but a portion of the copper. The experiments made with rollers in treating rock show that they do not make slime. This is shown to be the fact at the Petherick Ash Bed, where they are now treating 25 tons per day with rollers and Hodge grinders. Much of the copper in the Nonesuch rock is too fine to be saved by any process of washing now in vogue, especially if a sufficient quantity is treated to make a large mining business. It is said that while the experiments made at the smelting works were not sufficiently favorable to induce the adoption of that method to separate the copper, still a greater percentage of copper was obtained by smelting the rock than by manipulating it in the stamp mill, but it is declared that this process would prove too expensive and that the chemical manipulations proceeded with in Chicago gave much more favorable results, both as to quantity of yield and the cost of obtaining he copper.

The plan which the company now think of adopting to separate the copper will be a process partly mechanical and partly chemical. By the rollers, grinders, sieves, and jiggers a certain degree of separation will be effected which will be completed by a process of chlorination, precipitation, and roasting, the details of which they have not made known. It is nearly decided to sell the new, unused machinery for the stamp mill and to commence the erection of the works for carrying out the newly devised plan.

Certainly experiments of such a magnitude as this which is contemplated, and the corresponding delay occasioned, are expensive and vexatious; but there is no doubt but some better plan should be devised for treating this rock than the use of stamp heads. As to that matter, it is an open question whether a better process than the use of stamp heads could not be adopted in any of the mines.

THE WHITE PINE MINE.

Working, or rather exploring, the Nonesuch lode, two and a half miles distant from it, to wit: on Sec. 5, T. 50, R. 42. The land is leased from The Ship Canal Company. A shaft has been sunk 60 feet in the lode and the deposit is in all respects similar to that at the Nonesuch. The work was begun in the fall of 1880 by Byron White and John Parker of Ontonagon village, who have sold out to Chicago parties. One-half ownership of the lease is now held in Chicago, and the other half by Capt. Thomas Hooper.

KEWEENAW COUNTY.

THE CONGLOMERATE MINING CO.

The Conglomerate Mining Company, Keweenaw County, has accomplished a great deal of work both on the surface and underground during the past year, or since its organization in January, 1881. It has become the most conspicuous of the Keweenaw County mines. Three hundred and fifty thousand dollars have been expended, $145,000 of which sum has been incurred for new mining plant, and for new houses and store, etc.

The new openings are all in the wide conglomerate underlying the greenstone—Allouez Conglomerate—and are very extensive considering the time that has been occupied in making them. This new mining work has been greatly facilitated from having the old Northwest Mine from which to drift and to hoist, etc.

The drifts in the Northwest Mine extend to the green stone, through the conglomerate, and so the work in the conglomerate could be readily prosecuted from this mine.

Besides the Northwest the new mine is opened with three working shafts and two surface winzes. The formation here runs east and west, and the shafts are numbered with reference to their position from the old mine. One shaft, situated west of this mine, is called No. 1 west; it is 330 feet from the old mine, and is sunk to the first level, 110 feet in depth, measured on the incline. No. 1 east, is 660 feet from No. 1 west, or 330 feet east of the old mine; it is sunk to the fourth level, or to a depth of 447 feet. No. 2 east is a winze, and is 520 feet east of the old mine; it is sunk to the second level, or to a depth of 233 feet. No. 3 east is 790 feet east of No. 1 east—1,020 feet east of the old mine; it is sunk to the second level, or to a depth of 290 feet.

No. 4 east is a winze, and is 420 feet east of No. 3 shaft, and is sunk to a depth of 2,207 feet, so that the distance between the extreme shafts is 1,540 feet; the shafts are all connected in the adit level.

The lowest level is the fourth below the adit, and all the levels are run east and west from the old mine, all intersect No. 1 shaft, east. No stoping has been done, and all the product, since work ceased in the old mine, in April last, has come from the new openings. The belt is wide, 12 feet to 20 feet and upwards in places, and as it runs rich and poor in streaks as well as in bunches and shoots, its probable yield cannot well be determined. So far the percentage of the copper obtained from the rock taken from the openings has been low; too low to afford any encouragement of ultimate financial success, unless the rock from the openings prove to be below the average of the lode, or unless, hereafter when the openings are made, the productive ground be selected and the openings be kept well ahead to enable the selection of stoping ground to be advantageously made. It is the plan of the management to have the mine extensively opened, so that when the new stamp mill shall be built the mine will be in condition to keep the stamp heads at work.

West of the fissure vein—old Northwest Mine—may be seen in the conglomerate a fine stretch of copper ground. This shoot pitches to the west. There are other good shoots of copper to be seen in the mine, but withal there is much poor ground, too large a proportion, to all appearances, to make one feel perfectly sure that the owners will realize the results which they anticipate.

Everything is thoroughly and substantially done. The new store is the best in the county; the new compressor is of stone and iron, and the duplex Rand compressor, which has been erected therein, has been placed to stay. The cylinders are 24x48, and suffice for fifty drills. It cost $20,000, and with building, cost $63,000.

The boilers are Babcox & Wilcox, a peculiar pattern, made up of pipes in sections. There are two—320-horse power—for the compressor, and two boilers of same size and pattern have been placed in the stamp mill. The hoisting in No. 1 and No. 3 shafts is done with two small engines. A new pump has been placed in the stamp mill. Eighteen new dwellings have been built and substantial shaft-houses erected. Elevated railway tracks connect the several shafts with the main track leading to the rock house, and the hauling will be done with a small dummy engine, which has been procured for the purpose. The cars will discharge into the rock house from the side, the cars themselves being made to dump sidewise.

The total length of the drifting which has been done in the tenth level is 658 feet; total drifting in the 20th level is 476 feet; in the 30th level it is 472 feet, and the total cross-cutting is 73 feet. (March 1, 1882.) Contract miners make $2.17 per day; company account miners received $1.74 per day, and underground laborers $1.43 per day.

Contract for drifting by hand costs $16.65 per lineal foot; contract for drifting with drills costs per lineal foot, $11.11, which includes only the price paid the men. Sinking by hand, $16.97 per foot; sinking with drills, $14.75 per foot, which includes what the men are paid per foot, the company furnishing the power and the men paying for supplies.

Average number of miners employed was 94 and the average number of underground laborers other than miners was 28; boys employed underground, 7.

Cost of compressor power per foot of drift was $2.52; cost of compressor power per foot of sinking was $3.31.

A party of six men average in drifting, by hand, 26 8-10 feet per month, size 7x7 feet.

With power drills a party of four men and one boy average, 43 1-10 feet per month, the size of the drift being 8 feet wide and 12 feet high. Drifts made with power drills are nearly always larger than when made by hand drills.

Six men sinking winzes by handwork, accomplished 23 6-10 feet per month; four men and one boy with power drill averaged 32½ feet of shaft sinking per month. The winzes were 7x8 feet in size, and the shafts were 8x13 feet.

Comparison of cost of drifting in the conglomerate by hand drill work and with power drills:

Contract cost per foot of measured length of drift—hand work, 1881.

Wages	$13,238
Supplies	3,415
	$16,653
Cost of sharpening drills	436
	$17,089
Less 25 per cent profit on supplies	854
Total cost per foot	$16,235

Cost of drifting per foot with power drills, 1881. Cost on conglomerate, Rand drills, per foot.

Contract cost per foot—wages	$5,776
Supplies	5,338
	$11,114
Cost of running compressor, including repairs on compressor, drills, etc	2,162
Cost of sharpening drills	387
Interest on compressor plant	434
	$14,097
Less 25 per cent profit on supplies	1,334
Total cost per foot	$12,763

The interest on compressor plant was figured, on $18,000, $15,000 invested in large compressor, boilers, piping, etc., and $3,000 invested in small compressor—Bowers—manufactured by Griffith & Wedge.

The cost of sinking, per foot, of shafts, including all items, is as follows—Rand drills.

Contract wages	$9,300
Supplies	5,456
Drill sharpening	509
Interest on compressor plant	571
Compressor, cost for fuel, attendance, etc	2,343
	$18,179
Less 25 per cent. profit on supplies	1,364
Total cost per foot	$16,815

Using the same figuring for hand work as against the power drills the cost per foot would be $30.

Items of cost for stoping on the amygdaloid in the Northwest Mine, with Rand power drills.

	Stoping contract by the fathom.	Contract by the foot of hole drilled.
Days' labor per fathom (men)	$2 38	-------
" " " " (boys)	98	-------
" " " " (miners)	-------	$1 71
" " " " (blasters)	-------	35
" " " " (boys)	-------	60
Contract wages per fathom stoped	5 54	3 30
Wages paid to blaster and helper	-------	1 06
Supplies used by miners	8 77	33
Supplies used by blasters	-------	6 21
Compressor cost per fathom stoped	1 79	1 28
Interest on compressor cost, plant	67	48
Total cost per fathom stoped	13 77	12 76
Less 25 per cent profit on supplies furnished	1 44	1 63
Final cost per fathom	12 33	11 03
Amount of rock broken per one drill and four men	43 70	60 80
Wages earned by miners per day	1 93	1 68

The contracts were let per foot of hole drilled, the men furnishing light, oil for drilling machine, and the company furnishing power, drills, caps and fuse, also the charger, who measured the depth of the hole when he inserted the charge.

The men were paid twelve cents per foot of hole drilled. In contracts by the fathom the men paid for all supplies and the company only furnished drills and power to run them.

The cost of stamping and washing a ton of rock, including repairs, $1.10.

Rock house expense, including cost of carrying to rock house, per ton of rock, 35 cents.

Average number of tons stamped per day for 10½ months, 100. Total product for the year, 235 tons 1,708 pounds, mineral.

The machinery for the new stamp mill has been purchased, which includes 3 Ball heads, procured at the Cuyahoga works, Ohio, each 18-inch cylinder and 10-inch shaft, having a capacity of 200 tons per day of rock for each head.

The location of the mill has not yet been definitely decided upon. If placed at Lac La Belle, the long talked of railroad will have to be constructed, about seven miles. It is doubtful if any better plan can be devised than to carry out this original project. If 600 tons of rock per day are to be treated, access must be had to the lake; there is not sufficient water otherwise.

The fuel used under the boilers is cord wood, which costs $3.25 per cord for maple and birch, etc. The total number of men now employed is about 350.

It is apparent from the preparations which have been made and are making, that the managers have abundant faith in the mine. The estate is a very large one, exceeding 20,000 acres of land, and the history of the mining enterprises which have heretofore been inaugurated to work portions of it, chronicles no success. It is certainly to be hoped that the Conglomerate is not doomed to a like fate. But it illustrates the vast preliminary expenditure which must, in all cases, in a measure, be necessarily incurred, and the uncertainty of copper mining, even at this late day, and in Michigan, when a mine

as the "Conglomerate," shall have, perhaps, expended two-thirds of a million of dollars before the richness of the deposit of which all this expenditure is based, shall be definitely determined.

If the project of building the railroad to Lac La Belle is abandoned, and the stamp mill is erected upon the site of the present one, or near it, much of the preliminary cost, otherwise necessary, will be curtailed; but on the other hand the mine will be correspondingly crippled. Undoubtedly the future success of the Conglomerate will depend upon working up a large amount of the rock, and that can only be accomplished by having the most ample stamping and washing facilities, which cannot be secured without recourse to the lake. Under the present methods of separating the copper from the matrix the successful operating of the Conglomerate Mine upon the scale contemplated renders the building of the projected railroad, or its equivalent, apparently, a necessity. However the work at the mine is being vigorously pushed, both on the surface and underground, and there is no sham about any of it. Everything is thoroughly and substantially done. The description of the estate is as follows: Secs. 13, 14, and 15, T. 58, R. 30, Keweenaw County, Mich. 100,000 shares. Capital, $2,500,000. H. C. Davis, President; Charles M. Foulke, Treasurer; George H. Lewars, Secretary; Alex. P. Thomas, Superintendent; James Hoatson, Mining Captain. Philadelphia office, 205 Walnut Place. Mine office, Delaware Mine, Keweenaw County, Michigan.

The following interesting items of comparison of hand drill work and of power drill in the Northwest Mine were furnished by Mr. Frank Klepetko, engineer of the mine. To the same gentleman I am much indebted for the preceding data of the working of the mine.

The table and comparison between drifting by hand and drifting with Rand drills is based on the average work done during 1880 at the Northwest Mine, Keweenaw County, Michigan, the property, at that time, of the Delaware Copper Mining Company. The drifting was done on the amygdaloid belt, which underlies the first conglomerate below the greenstone, and is separated from it by about 130 feet of trap. The wages were high on account of the mine not having been working regularly for some time, and consequently higher rates of wages had to be offered to induce men to come there to work.

The compressor cost includes repairs on compressor and drills, wages of man running compressor, fuel, oil, packing, etc. The cost per foot drifted was obtained by dividing the compressor cost for the seven months that the drills were running by the entire number of shifts worked by miners with the drills. This quotient was multiplied by 2.18, the number of shifts to each foot drifted. The product is the compressor cost per foot drifted. The cost is high because the full number of drills was not run continuously. The repairs again make it lighter, as the compressor plant was new.

The interest on compressing plant was obtained by reckoning interest at 10 per cent. for seven months on $15,000, which was estimated to be the construction cost of the entire compressing plant, including compressor, boilers, receivers, pipes, and ten drills.

The interest per foot of drift was obtained in the same manner as the compressor cost per foot of drift. The table here given will show more clearly what is meant:

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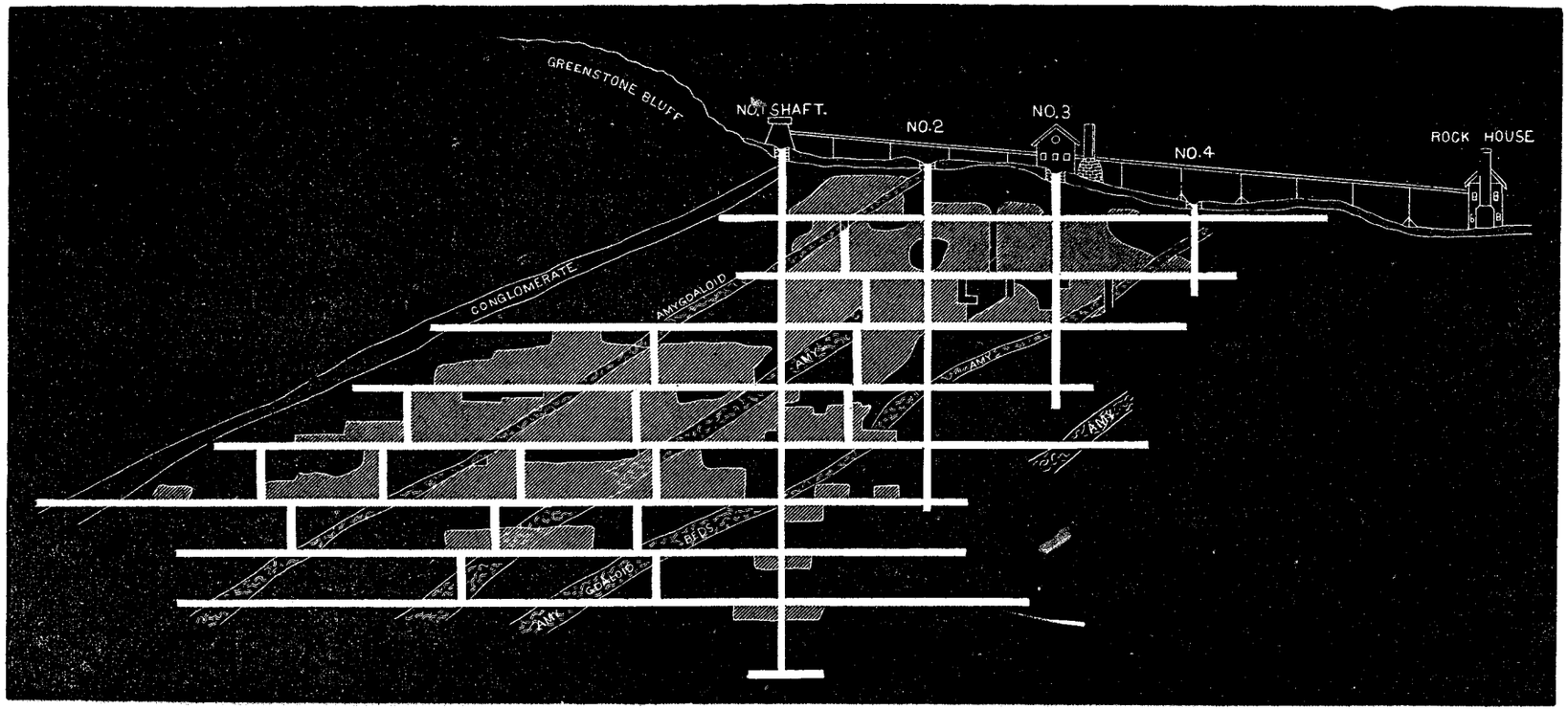
VERTICAL SECTION OF THE DELAWARE MINE (CONGLOMERATE MINING CO.), JAN., 1881.

Scale, 240 ft. to one inch.



of the hanging.

	Drifting by Hand Drills.	Drifting with Power Drills.
Days labor per foot (men)	$4 79	$2 18
" " " " (boys)	-------	53
Advance per month—104 shifts—No. of feet drifted	21 07	47 07
Comparison in speed	1	2 2
Contract cost per foot	$11 95	$10 04
Supplies per foot—cost	$2 07	$4 12
Profit on supplies, 25 per cent	52	$1 03
Net contract cost per foot	$11 43	$9 01
Compressor cost per foot	-------	$1 64
Interest on compressing plant	-------	62
Total cost per foot	$11 43	$11 17
Wages earned by miners per day (men)	$2 06	$2 50
" " " " " " (boys)	-------	96

From the table we see an advantage of 26 cents per foot in favor of drifting with power drills. This would be the advantage in cost per foot if the drift passed through poor ground which it did not pay to stope. If the ground were to be stoped an additional advantage would result from the fact that the machine drift is carried larger in section than the hand drift. Let us see what this amounts to.

The hand drift is carried 6x5 feet, and in a length of 100 feet there is broken 3,000 cubic feet of rock.

The machine drift is carried 7x8 feet or more, and in a length of 100 feet there is broken 5,600 cubic feet of rock, or 2,600 cubic feet more than in the hand drift. This is equal to 12 cubic fathoms, which the undercutting stope would not have to break. This would have cost during 1880, $15 per fathom, especially in such a narrow belt as the Northwest amygdaloid, 12 fathoms @ $15=$180, or an advantage of $1.80 per foot in the machine drifts being carried larger. This amount must be subtracted from the cost per foot of machine drifts, which brings down the final cost to $9.37 per foot with machine driven drifts against $11.43 per foot with hand drifts, or an advantage of $2.06 in favor of drifting with power drills.

The extra speed in drifting and sinking with power drills reduces the the fixed expenses per foot. With power drills an amount of opening can be accomplished in one year, which will take 2.2 years to accomplish by hand drilling. The fixed expenses, such as salaries of officers, pumping cost, etc., and which do not vary appreciably with the amount of work done, amount to at least $10,000 per year. Hence the power drills will result in a saving of $3,000 per year on the fixed expenses. At this rate it would not take very long for a compressing plant to pay for itself.

In stoping with power drills the speed is still greater, about four times as much ground being broken by a party of men with a drill as by the same number of men without it.

We must here remark, before leaving the subject, that for the purpose of making the case of handdrifts as favorable as possible, we took the size of the machine drift, the minimum that it is or can be carried. Usually the drift is about 8x9 feet. This would make the extra amount of rock broken in a length of 100 feet, 19.4 cubic fathoms, which at the rate of $15 per fathom= $291, or $2.91 per foot to be subtracted from the cost of the machine drift. This gives for the cost of the machine drift $8.26, or $3.17 less than the cost of the handdrift.