

45 minutes the decalescence, or AC1, point is reached, which may extend over a 5- or 10-minute period; at this point temperature readings are taken. In one actual test made in the furnace at the Cliffs Shaft Mine these temperature readings over a 5-minute period ran from 1325 degrees F. to 1330 degrees F., readings which apparently showed that the pyrometer was reading from 25 to 30 degrees too low. After the decalescence period has been readied, the temperature of the furnace is allowed to rise until at the end of about two hours 15 minutes it will be approximately 1500 degrees F. At that point the heat is shut off and the furnace is allowed to cool. The recalescence, or AR3, point is reached at the end of about two hours 45 minutes. With the furnace at the Cliffs Shaft Mine, this point usually extends over a period of 15 minutes, the temperature readings remaining fairly constant at almost exactly 1300 degrees F., although at the beginning of the recalescence period the temperature momentarily drops to 1295 degrees F. Experience has shown that it is easier to calibrate the pyrometer during the recalescence period because then the temperature remains fairly constant in the test bar for a much longer time than at the decalescence point. Consequently, the pyrometer is now calibrated at the recalescence point.

OPERATING DATA

In order to actually show the increased efficiency obtained by the use of detachable bits, actual instances are cited of results obtained underground. These results are obtained by averaging the data for certain contracts, the tests usually running over a period of from four to six months. Actual cost figures are purposely omitted, percentages being substituted in order to bring out the proper comparison:

Contract "A"—

Formation: Hard Steel Ore.

Operation: Drifting.

Size of Drift: 10 x 10 ft.

	Detachable Bit	Regular Drill Steel Conventional Bit
Inches drilled per minute (cutting time).....	2.90	1.77
Inches drilled per bit dulled	10.35	8.99
Number of bits per ft. of hole.....	1.16	1.33
Gauge of starting bit, inches	2	2-9/16
Size of machine drill—inches	3½	3½

Contract "B"—

Formation: Cherty, Abrasive, Siderite.

Operation: Drifting.

Size of Drift: 8 x 8 ft.

Inches drilled per minute (cutting time).....	2.98	1.69
Inches drilled per bit dulled	9.15	7.91
Number of bits per ft. of hole	1.32	1.51
Gauge of starting bit, inches	2	2-9/16
Size of machine drill—inches	3½	3½

Contract "C"—

Formation: Siderite and Diorite.

Operation: Drifting.

Size of Drift: 10 x 10 ft.

Feet advance in heading per miner per shift....	2.62	1.96
Cost per ft. drilling labor plus explosives.....	85%	100%
Average daily wage	120%	100%

NOTE—The above shows a 15 per cent decrease in cost per ft. and a 20 per cent increase in daily wages.

Contract "D"—

Formation: Siderite.

Operation: 7 x 7 Raise.

Feet advance in heading per miner per shift....	2.09	1.55
Cost per ft. drilling labor plus explosives.....	72%	100%
Average daily wage	111%	100%

NOTE—Cost per ft. decreased 28 per cent.
Average daily wages increased 11 per cent.

Contract "E"—

Formation: Siderite.

Operation: Drifting.

Size of Drift: 8 x 8 ft.

Feet advance in heading per miner per shift....	2.29	1.55
Cost per ft. drilling labor plus explosives.....	90%	100%
Average daily wage	119%	100%

Contract "F"—

Formation: Siderite and Diorite.

Operation: Drifting.

Size of Drift: 10 x 10 ft.

Feet advance in heading per miner per shift....	2.22	0.93%
Cost per ft. drilling labor plus explosives.....	61%	100%
Average daily wage	121%	100%

Contract "G"—

Formation: Siderite and Steel Ore.

Operation: Drifting.

Size of Drift: 8 x 8 ft.

Feet advance in heading per miner per shift....	1.65	0.93
Cost per ft. drilling labor plus explosives.....	69%	100%
Average daily wage	116%	100%

The above instances clearly illustrate the increase in footage, the decreased cost per foot, and the resulting increased wages paid to the miners working in each particular contract.



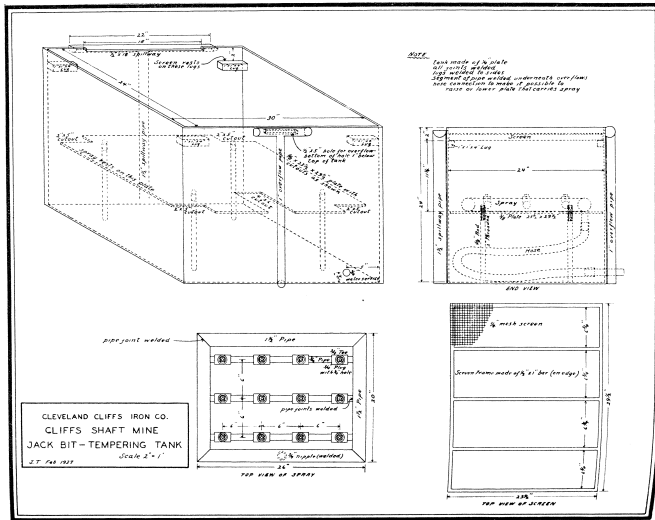
FIG. 8—RACKS FOR FINISHED DRILL RODS.

CONCLUSION

An appreciable saving has been effected in the total cost per foot of hole drilled with the use of detachable bits, partly because of the reduction in the size of the starting bit partly because of the improved quality of the bit compared with ordinary mine steel bits, partly because of their chemical composition and partly because of better tempering practice.

A saving has also been effected in the total cost per foot per hole because of the reduction in transportation expense and in the labor cost for drilling. In a large property like the Cliffs Shaft Mine, where the contracts

are widely scattered over a large area, the transportation of ordinary mine drill steel takes up a considerable portion of each miner's working cycle. The introduction of detachable bits has reduced this time to a minimum.



The detachable bit is a better drilling bit because in the first place it contains a higher carbon content than ordinary drill steel. This higher carbon content makes for a harder cutting edge, more highly resistant to abrasive wear, and longer life of bit.

The introduction of a thermostatically, electrically controlled heating furnace provides a more uniformly tempered bit because of better heat control.

The use of detachable bits also materially decreases the amount of drill steel in use underground. Prior to the introduction of detachable bits, from 69 to 70 tons of drill steel was scattered throughout the mine. This has been reduced to about 10 to 12 tons, because under the old system each contract averaged about 65 rods per drilling machine compared with 12 rods per machine per contract with detachable bits. Under the old system of using mine steel, the average contract had seven to eight sets of steels from 2 ft. to 12 ft. in length. Changes in gauge running from 29/16-in. to 1 5/8-in. were made every nine inches. With detachable bits, every contract has about 12 rods, usually of the following lengths: 2 ft., 2 1/2 ft., 3 ft., 4 ft., 5 ft., and so on up to 12 ft.

The greatest advantage in the use of detachable bits is naturally shown in those contracts where the ground drilled is the hardest and where transportation is the most difficult. In the ordinary ore stopes the increase in drilling efficiency is approximately 10 per cent, but in the development contracts the increase is more marked, running from 35 per cent to 140 per cent.

THE USE OF DETACHABLE BITS AT THE GREENWOOD IRON MINE, INLAND STEEL COMPANY, MARQUETTE COUNTY, MICHIGAN.*

BY R. D. SATTERLEY, ISHPEMING, MICH.**

The Greenwood mine, located near Ishpeming, Marquette County, Michigan, is operated by the Inland Steel Company. This mine produces iron ore in the form of hard hematites and magnetites. The principal use of this ore is as a lump ore for open-hearth purposes. The ore deposits in this property occur as isolated lenses distributed somewhat as plumbs in a hard iron formation locally known as jasper. The winning of these ores requires a large amount of development work in this very hard formation and also requires the mining of a number of isolated deposits. As originally operated, this property used shop forged bits, and the transportation problem of moving the steel from the shop to these isolated deposits was a considerable item of expense. It was, accordingly, decided by the management to make experiments with detachable bits chiefly for the purpose of eliminating this transportation problem. These experiments have been carried on over the past two years and some definite results have been obtained which will be discussed in this, paper.

The shop forged bits as previously used were cross bits with gauges ranging from 2 5/8-in. on the starter drill to 1 5/8-in. on the longest steel with 1/8-in. gauge changes for every foot of increase in steel. The drilling speeds with this type of bit in the rock or jasper formation using a 4-in. mounted machine was about 2-in. per minute. The ore consisting of hard hematite and magnetite was drilled with 3-in. mounted machines and the rate of drilling in ore was approximately 3 1/2-in. per minute. Under ordinary circumstances about two contracts with four machines were working continually in rock and about six contracts with twelve machines were working in ore. It will be realized that a very large tonnage of steel was required each day for this rock and ore drilling.

*Presented, Annual Metal Mining Convention, Western Division, The American Mining Congress, September 23-27, 1935.

**Superintendent, Inland Steel Co.

The cost of forging bits on drill steel was nominal as the equipment used was the customary drill shop equipment with the ordinary labor employed in a modern drill sharpening shop. The cost of transportation into and out of the mine and into isolated working places involved a large expense when figured back to the cost, of each bit used.

At the time detachable bits were considered for this mine little if anything was known in this district concerning this tool, and the experiments involved pioneering. To our knowledge, none of the mines in the district were employing detachable bits. The experiments on detachable bits were carried on with the idea of determining the following facts concerning their use:

- 1—The ultimate number of uses of a bit before discard.
- 2—The increase, if any, in the drilling speed with the use of detachable bit.
- 3—The life which could be secured from the threaded end of a drill rod and the cost of threading a drill rod.
- 4—The saving in drill steel due to detachable bits.
- 5—A comparison of the total cost of drilling with the forged bit as compared with the cost of drilling with the detachable bit.

As the experiments progressed a further factor appeared and this was the possibility of using smaller machines with smaller bits to accomplish the same results.

The first experimental work with detachable bits was discouraging. These bits were new to our operation and to the manufacturers and many imperfections were found. The manufacturers cooperated with us in this work and as fast as we discovered these imperfections they were corrected and the bits were rapidly improved. Since our experiments on detachable bits were begun other operators in this district have started to use them and several manufacturers are working on these bits. It has been found that the detachable bit can be greatly improved by improving the quality of steel used in it. Originally these detachable bits were of the same material as the rods which were formerly forged to make shop forged bits. It has been found that the bits can be made of higher carbon steel than that used in the drill rods which results in a harder temper and a longer drilling life. The steel in the rod from which the shop forged bit is made is selected for a combination of fatigue resistance in the rod and the cutting edge in the bit. The detachable bit allows the separation of the two characteristics above mentioned and it is, therefore, desirable to have the character of the steel in the bit different from that in the rod. It is our belief that further progress can be made in this direction by the use of special steels and alloys, and that continual improvement in the detachable bit can be made on account of the quality of steel used.

The second difficulty experienced with the use of these bit-the matter of regrinding. We found no satisfactory equipment on the market for regrinding bits, and it was necessary for us to work along with the manufacturers of grinding equipment to secure machines which would handle this work. This involved experiments as to the machines and also as to the grinding medium to be used. Many grinding wheels were used before a satisfactory grade of material was secured. The type of grinding machine finally selected was a wet grinder with two wheels, one wheel for grinding the cutting edges and one wheel for grinding-the gauge. The cutting edge is ground with a V-shaped wheel grinding two faces at the same time. The gauge is ground by revolving the bit against a flat wheel.

The cost of grinding at first was excessive, but after the machine and grinding wheel were perfected this cost was finally brought down to a reasonable basis. The

cost of grinding as now carried on is 5 cents per bit which includes all labor and supplies. Our experiments indicate that it may be possible to make a grinder which will further increase the grinding speed and decrease the cost. We believe that a machine can be developed which will grind several bits in one operation. Our facilities do not permit the development of this machine and this will probably have to await a more general use of detachable bits to interest the manufacturers in this undertaking.

A third difficulty encountered in the use of detachable bits was the matter of educating the miners to their use. It was difficult to teach them to screw the bit, on properly so as to make a contact between the bottom of the bit and the end of the rod. If this contact were not made the burden of the work rested on the threads and this resulted at first in many broken threads and in the stripping of the threaded end of the rod. Another difficulty was to educate the men into frequent changing of bits so that they would not become dull. The efficiency of a sharp bit is very much greater than a dull bit and inasmuch as transportation is no item with these bits it is cheaper to change frequently. The habit of drilling with shop forged bits until they were very dull had been firmly fixed in the minds of the miners and it was difficult to get them out of this habit.

Our experiments have now shown at the Greenwood mine that a new bit will have a total of from six to seven uses before being discarded. We have been able to regrind the bit three times at which point the face of the bit is worn down below the factory temper. The bit is then reground and retempered in our oil burning muffle furnace. These bits in the retempering process are quenched by standing the cutting edge of the bit on a screen through which the water bubbles giving a depth of water of approximately $\frac{3}{8}$ -in. on the screen. After the bit has been retempered it may be reground twice more before it is finally discarded. We then have the bit used as follows: First in its new condition, then with three regrinds; it is again reground and retempered and can be reground twice more making a total of six uses for the bit before discard.

The cutting properties of the detachable bit are much greater than those of the shop forged bit. A summary of the results of our experiments has shown that the detachable bit will show a 40 per cent increase in drilling footage over the shop forged bit. The following data will indicate this increase in drilling speed:

3-in. machine using 1 $\frac{1}{4}$ -in. round hollow steel	
with shop bits	3.46-in. per min.
3-in. machine using 1 $\frac{1}{4}$ -in. round hollow steel	
with detachable bits	4.75-in. per min.
3-in. tappet machine using 1-in. hexagon steel	
with detachable bits	5.21-in. per min.

This large increase in drilling footage has resulted in several important savings; first, in the saving on the cost of bits; second, in saving in transportation charge; third, in saving on drill machine repair cost; fourth, material reduction in air consumption; fifth, saving in the use of smaller machines; sixth, saving in the use of smaller drill

steel. It has been found in this connection that the best results in ore are obtained by using 1-in. hexagon steel with a smaller bit than with using 1¼-in. round steel with a larger bit.

When we first began the use of detachable bits the threads on the drill rods were made on a lathe and the rods were heat treated in an ordinary oil burning drill furnace without pyrometer control. This method of thread making was found to be slow and costly and the heat treatment was not sufficiently uniform which resulted in excessive breakage in the threaded end of the rod. Dies were purchased for our bolt threading machine and this machine was used to cut the threads on the rods. The rods were first sized to the proper diameter in the drill sharpener, then annealed in lime or mica and the threads were then easily and cheaply cut with the bolt threading machine. A muffle oil furnace was purchased having pyrometer control which gave accurate temperature control. This furnace was used satisfactorily for heating the rods before tempering. The cost of conditioning and threading the rods for detachable bits has now been reduced to 3 cents per run of each bit. This cost includes labor and supplies used in the shanking and threading of the rods. The average life of a threaded end of a rod using detachable bits is from 250 to 300 minutes of drilling.

The cost of drill steel purchased in order to keep the mine adequately supplied with rods has decreased 33½ per cent since the use of detachable bits. The better cutting condition of the bit reduces the fatigue in drill rods materially reducing breakage. There is also a saving in steel through the decrease in the number of time a piece of steel is heated. With the shop forged bit the end of the steel is heated each time the bit is forged, while with the detachable bits a single threading will last out many bits. This continual heating of drill steel causes serious deterioration loss.

An efficiency engineer was employed at the Greenwood to supervise experiments on detachable bits and much data were collected for use in the comparison of cost between the shop forged bits and the detachable bits. The following is a general summary of this cost data.

Shop Forged Bits—

The cost of shop forged bits including sharpening, loss of steel, and transportation at this property was 26.4 cents per bit used.

Detachable Bits—

The following is the cost of the use of detachable bits:

No. of Bits	No. of Regrinds	Cost	Total Cost
1000	New	27c	\$270.00
1000	1 regrind	5c	50.00
* 933	2 regrind	5c	46.65
* 867	3 regrind	5c	43.35
* 800	4 regrind & temper	7c 2c retemper	56.00
* 400	5 regrind	5c	20.00
5000	6 uses		\$486.00

*—The loss on regrind was caused by breakage and loss in transportation.

The average cost per detachable bit run is 9.72 cents.

The total cost of using detachable bits is then as follows:

Cost of each run of bit	9.72c
Cost of conditioning rods per run of bit.....	3.00c
Loss of steel per run of bit	2.40c
Total cost	15.12c

From these figures it will be noted that there is a saving of approximately 11 cents per bit for the detachable bits over the shop forged bits.

The use of the detachable bits at the Greenwood property has been satisfactory and has resulted in greater drilling efficiency and lower costs. The advantages of the detachable bit as shown by our experiments at this property are as follows:

- 1—A saving of 11 cents in the cost per bit used.
- 2—An increased drilling speed of approximately 40 per cent.
- 3—A saving in drill steel of approximately 33½ per cent.
- 4—The use of smaller bits and the drilling of smaller holes resulting in material increase in drilling efficiency.
- 5—The use of smaller drill steel and lighter machines resulting in smaller repair costs and decrease in air consumption.

STRUCTURE DRILLING AS APPLIED IN WESTERN MESABA MINING PRACTICE—THE EXPLORATION OF ORE BODIES

BY H. C. BOLTHOUSE, COLERAINE, MINN.*

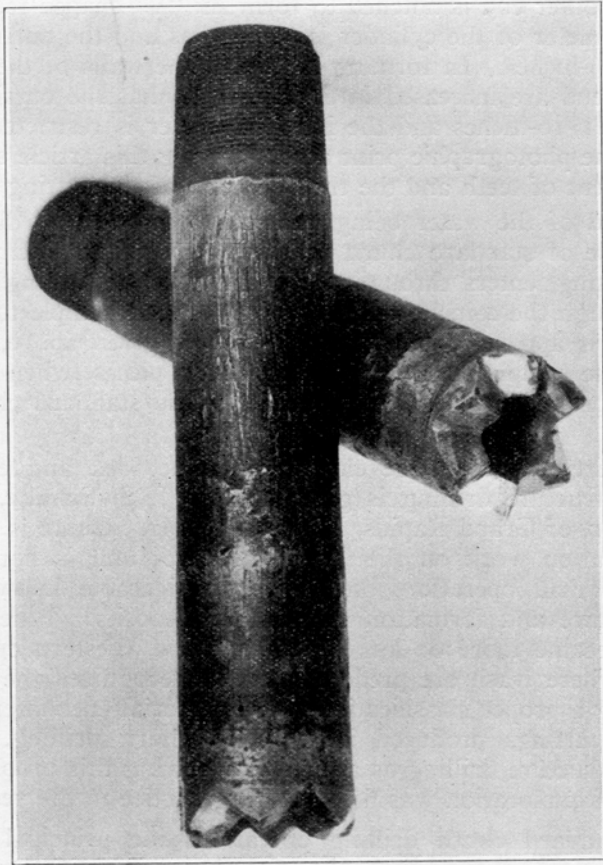
Structure drilling, as the name implies, is a method of sampling iron ore bodies, whereby a better idea of the physical structure of the material encountered is disclosed, than by the standard process of churn drilling. This method of exploration is particularly applicable to the Western Mesaba Range, where the developed ore bodies consist largely of "Wash Ore." "Wash Ore" in it's natural state is not merchantable, and, under ideal conditions, is composed of alternate layers of fine, free silica or "sand," and iron ore. There are numerous variations from the ideal condition, in that the ore material is often mixed with decomposed taconite, broken taconite, seams of solid taconite and paint-rock as well as with the sand. The state in which this undesirable material exists, (as to whether it is hard or soft, frozen to or free from the ore seams), determines the method of treatment. In order to obtain a merchantable product, it is necessary to eliminate the impurities by a process of "Washing," or concentration. It is very essential that the washability of the ore be definitely determined by wash tests, classifications and analyses of samples obtained from drill holes, before large expenditures of money are made in equipping, developing and operating a mine.

From the foregoing, it is apparent that it is not only desirable to obtain a true sample of the chemical composition of an ore body, but also of its physical characteristics, and, for that reason, the coarser the

condition in which the cuttings can be secured, the more readily the latter quality can be determined.

*Superintendent, Mesabi-Cliffs Mining Co.

The general principles involved in standard churn drilling and in structure drilling are practically the same. In both cases, the cuttings are produced by a tool, or "bit" attached to the end of a string of pipe or drill rods, which is given a churning action by means of a rope, wrapped several times around a revolving drum, and alternately tightened and released by hand, thereby raising and dropping the rods. The drilling is done inside of a casing, which prevents caving and retains the water and loosened material. Water, under pressure, is pumped into the drill hole, holding the cuttings in suspension and carrying them up through the pipes, and delivering them into a settling tank on the surface. The essential differences in the two methods of drilling are found in the type of cutting tool, the size of the casing, the size of drill rods, method of introducing the water and bringing up the cuttings, and the size of the particles produced.



PICTURE SHOWING ARRANGEMENT OF TEETH AND THE THREADED END OF THE CUTTING TOOL

In standard churn drilling, the cutting tool is made in the shape of a chisel, with perforations near the end to let out the water, which is pumped down through the 1-inch drill rods. These rods are operated inside of a 2-inch casing, through which the water rises, carrying the cuttings to the surface. The maximum size of the particles which can be brought to the top is equal to the difference between the inside diameter of the 2-inch

casing and the outside diameter of the couplings on the drill rods, or 5/16 of an inch. It is apparent that considerable pulverizing must be done to the loosened material before it can find its way through this narrow opening.

In structure drilling, the cutting tool is cylindrical in shape. It is threaded at one end to make connection with 2-inch drill rods, while the other end is notched to form six "V"-shaped teeth. The inside diameter of the cylinder is 1½-inches and the outside diameter is 2¾-inches. In forming the teeth, the walls of the cylinder near the end are increased in thickness, so that the outside diameter is 211/16-inches and the inside diameter is restricted to 1¼ inches. The photographic print accompanying this article shows the arrangement of teeth and the threaded end of the cutting tool.

Instead of the water being pumped through the drill rods, as in the case of standard churn drilling, it is delivered through the 3-inch casing, enters through the opening in the cutting tool and rises through the 2-inch drill rods, carrying the sample to the surface. It is apparent, from the dimensions given above, that the pulp of the sample consists of much larger pieces, when produced by structure drilling, than is possible by the standard churn drill method.

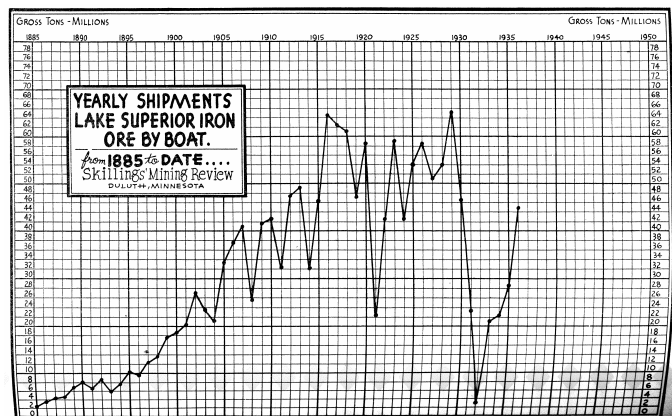
Full credit for the development of the idea and equipment used in structure drilling is given to Mr. J. S. Schultz, Drilling-Contractor, of Grand Rapids, Minnesota. Mr. Schultz is a pioneer in exploration work on the Mesaba Range; and is not only an expert in drill operation, but has a considerable knowledge of the structure and formation of iron ore deposits. When his activities became more or less confined to the Western end of the Range, where wash ore predominates, he recognized the difficulty in making a proper classification of the material encountered, from the fine cuttings produced in standard churn drilling, and developed structure drilling as a means of solving this problem. This method of exploration was first put into practice in the year 1914.

In standard churn drilling operations the principal units of surface equipment used were the tri-pod, a vertical boiler, a steam winch and a water pump. These units were retained by the Contractor in structure drilling, the only changes made were in the casing, the drill rods and the cutting tool. During later years, when the various mining companies began to do their own exploration work, the tri-pod, boiler and winch were discarded,—and were replaced by standard electrically-operated blast hole drilling machines, with some auxiliary attachments.

Structure drilling has been generally adopted on the Western Mesaba Range. It is not only used for regular exploration work, but has replaced test-pitting as a means of sampling ore bodies for operating data; it being cheaper and the samples more accurate. From every standpoint, the results are highly satisfactory, and show a distinct advantage over those obtained by the old method. Structure drilling is being used more

extensively in this mining district and is now recognized as the standard method for accurate exploring.

[Iron Ore Shipments by Water, 1885 to 1936 (Chart)]



BIOGRAPHICAL

CLEMENT L. ADAMS

Clement L. Adams, superintendent of the Mohawk Mining Company stamp mill at Gay, Mich., from 1921 until the company suspended operations, and widely known Copper Country engineer, died at Calumet & Hecla hospital February 13, 1934.

The late Mr. Adams was born in Sault Ste. Marie, Mich., and was graduated from the Michigan College of Mining and Technology in 1904. He received the degree of B. S. in 1909. Following his graduation he accepted a position at the Copper Range mill at Freda and after remaining there for two years went to Globe, Ariz., to accept a position with the Old Dominion Mining Company. He returned to the Copper Country in 1908 to become assistant superintendent at Freda and in 1921 became superintendent of the Mohawk mill at Gay, succeeding David Vivian.

He is survived by his widow, a son, Robert N., of Calumet, a daughter, Mrs. E. R. Thompson, of Saginaw, and two grandchildren. Several brothers and sisters also survive.

FREDERICK WHITNEY ADGATE

Frederick Whitney Adgate was born on a farm near Keeseville, New York, on June 5, 1868. He was the son of George Adgate and Martha Whitney Adgate. He attended the public schools in Keeseville and, later, studied for three years at the Kansas State Agricultural College, at Manhattan, Kansas.

Mr. Adgate's engineering experience covered a wide variety of work. From May, 1889, to August, 1890, he was engineer and superintendent for his grandfather, Captain Luther Whitney, on government work on Lake Champlain. From August, 1890, to October, 1893, he was with General Sooysmith, first in charge of machinery on the construction of Missouri River bridges, at Sioux City, Iowa, and Omaha, Nebraska, and, later, as superintendent of the concrete work on the foundations of the Stock Exchange Building, in Chicago, Illinois. From January, 1894, to February, 1896, he was a contractor on Lake

Champlain, engaged in the construction of docks and foundation work.

In March, 1896, Mr. Adgate went with A. B. Clark & Co., and was superintendent on rock tunnel work at Jerome Park Reservoir, for the water supply of New York City, until September, 1897. He then returned to General Sooysmith and was superintendent on bridges over the St. Regis and Paquet Rivers, until May, 1898. From May, 1898, until January, 1899, he was with the late Charles H. Deans, Assoc. M. Am. Soc. C. E., as assistant superintendent on the intercolonial bridge, at Ottawa, Ontario, Canada. From January, 1899, to May, 1900, he was with the Engineering Contracting Company and was superintendent, successively, on the Thames River bridge, at Chatham, Ont., Can., the Chicago and Alton Railroad bridge over the Missouri River, at Glasgow, Mo., and the foundations for the Boone, Iowa, viaduct. From December, 1900, to December, 1901, Mr. Adgate was assistant superintendent for John Pierce on the construction of the dry dock at Portsmouth, New Hampshire, Navy Yard. From December, 1901 to October, 1902, he was superintendent for the Ohio River Bridge & Ferry Co. on the construction of a bridge across the Ohio River, at Marietta, Ohio, and from October, 1902, to November, 1903, he was superintendent for the Foundation & Contracting Co., on a bridge over the Missouri River, at Omaha, Nebr.

From November, 1903, to January, 1910, Mr. Adgate was with The Foundation Company as superintendent on many large foundation jobs for bridges and buildings and numerous mine shafts. In January, 1910, he was appointed Western manager of The Foundation Company, in charge of all that Company's business in the Central West, and, with the exception of a brief leave of absence, he continued in that capacity until his death.

He was survived by his widow, Dolly M. Adgate, one son, George, two daughters, Mrs. Douglas Edward Huncke and Elizabeth Triplette Adgate, and by one sister, Mrs. John R. Dean, of Buffalo, N. Y.

Mr. Adgate was elected an Associate Member of the American Society of Civil Engineers on January 6, 1904, and a member on May 28, 1912.

He died October 23, 1934.

JOHN WARD AMBERG

John Ward Amberg was born August 10, 1870, a son of William A. Amberg and Sarah Agnes Ward. His birthplace was Chicago.

He attended St. Ignatius College and later became president of the Loretto Iron Company and the Amberg File & Index Co.

Surviving him were his widow, Marie Inderrieden Amberg and six sons and six daughters.

Death occurred on March 3, 1936, and burial took place in Chicago.

BENJAMIN W. BATCHELDER

Benjamin W. Batchelder was born in Marinette, Wisconsin, May 6, 1879. He was educated there and at the Michigan College of Mining and Technology.

In 1903 Mr. Batchelder went to Hibbing, Minnesota, as mining engineer at the Agnew mine of the International Harvester Company. Two years later he was transferred to the Hawkins

mine at Nashwauk, Minnesota, and late in 1905 was named superintendent of the property.

In 1914 Mr. Batchelder was appointed general superintendent of the Company's mines in Minnesota, and he also had jurisdiction over the Company's coal mines at Benham, Kentucky.

Death occurred October 1, 1933, in Hibbing, Minn.

JOHN CRICHTON BAXTER

John Crichton Baxter was born July 16, 1877, in East Orange, New Jersey, and at the age of two was taken by his parents to Scotland, where they remained three years.

The family went to San Francisco and later to Salt Lake City, where the son attended the public schools. Portland was their next home and Mr. Baxter remained there until the advent of the Spanish-American War when he enlisted in the Second U. S. Volunteer Engineers. The regiment was ordered to Scofield Barracks, outside of Honolulu, Hawaii.

Back again to Portland, Mr. Baxter became a rodman for the Oregon Railway & Navigation Co., and in rapid succession held the following positions: Civilian recorder for the U. S. Engineers, instrument man for the Columbia River Paper Company, instrument man for the Oregon Short Line, transit man for the Northern Pacific Railway, assistant engineer for the Northern Pacific Railway, survey man for the U. S. Engineers, division engineer for the Alaska Central Railway, location engineer for the Chicago, Milwaukee & St. Paul Railway and division engineer for the Oregon Trunk Railway.

Mr. Baxter, after all these changes, decided to engage in construction work and entered the employ of Guthrie, McDougall & Co., as superintendent of construction. That was in 1912, and four years later he became general superintendent of the reorganized firm of A. Guthrie & Co., Inc. He later was elected vice-president and in 1930 resigned to become a partner of Carey, Baxter & Carey. This later became Carey, Baxter & Kennedy. He was active in building the New Cascade Tunnel and in mining and stripping operations on the Mesabi Range. He was killed in an automobile accident in August, 1933.

WILLIAM P. BELDEN

William Patch Belden was born on a farm in Richford, Tioga County, New York, May 17, 1873.

He received a law degree from Cornell University and went to Grand Rapids, Michigan, to practice. He became a partner in the firm of Burlingame & Belden and there he was married to Laila Burlingame.

Mr. Belden enlisted for service in the Spanish-American War and was stricken with malaria while at Montauk Point, New Jersey. Later he became a member of the National Guard in Grand Rapids.

In 1903 Mr. Belden went to Ishpeming as attorney for the Cleveland-Cliffs Iron Company and he also engaged in the general practice of law. Fred H. Berg, Thomas Clancey and Clarence B. Randall were associated with him in the law business. He was a member of the Ishpeming School Board for several terms, City Attorney and otherwise active in affairs in the city. He figured in many important mining law-suits.

In 1917 Mr. Belden went to Cleveland, Ohio, where he became a member of the legal firm of Andrews & Belden and later

organized the firm of Belden, Young & Veach, with which he was connected when he died.

Mr. Belden left his wife and one son, William.

Death occurred December 23, 1935, in Cleveland and burial took place in Richford.

ARNOLD ARCH BELL

Arnold Arch Bell was born April 28, 1896, in Wamego, Kansas, and his early years were spent in Wamego, St. Mary's and Ottawa, in that state. He entered the University of Kansas in the fall of 1914 and left in the Spring of 1917 to enter an officers' training school at Fort Riley. He was transferred from there to Fort Monroe, then to Fort McKinley. He saw service at the front in the Coast Artillery. He re-entered the University and received a degree of mining engineer in 1921.

Mr. Bell was for four years a member of his college football team and served as captain in his senior year. He was a member of Psi Upsilon fraternity.

In 1921, 1922 and 1923 Mr. Bell was athletic director at Colby high school, after which he went to Hibbing as engineer for Pickands, Mather & Co. He was later connected with the John McNabb Construction Company, of Grand Rapids, Mich., leaving to become technical representative for the DuPont Powder Company at Ironwood.

He married Alice I. West, of St. Paul, Minn., who, with two children, Janet Rae and Robert Graham, survived him.

Mr. Bell met death in a motor car accident near Iron River, Wis., October 11, 1936. He had been a member of the Institute for only six weeks.

WILLIAM H. BENGRY

William H. Bengry was born in Shropshire, England, April 11, 1864, and when 18 years of age emigrated to Buckingham, Quebec, Canada, where he was employed in a phosphate mine.

After spending six years in Buckingham, Mr. Bengry went to Ishpeming, where for five years he worked in the Ropes gold mine, one of the few gold properties ever worked in the Lake Superior district. He went from there to the Salisbury mine, Ishpeming, where he was employed for seven years.

In 1900 Mr. Bengry went to Vulcan, where he had accepted a position as mining captain at the Vulcan No. 2 mine. At that time the operating company was the Menominee Exploration Company. After a year and a half spent at the Vulcan, Captain Bengry was transferred to the Baltic mine at Caspian. This property later became known as the Buck-Fogarty.

On January 1, 1930, Captain Bengry received a pension from Pickands, Mather & Co.

He died July 3, 1932, leaving a wife and six children.

WILLIAM D. CALVERLEY

William D. Calverley was born in Penetanguishene, Ontario, Canada, August 5, 1853. He went to Houghton County with his parents in 1861. He attended the old Rock high school in Houghton and attended the first classes of the Michigan College of Mining & Technology when the fire hall was the only building used by the new school.

After leaving college Mr. Calverley went to work for the Wisconsin Central Railway, at Stevens Point, Wis. Later he became employed as a bookkeeper for George C. Sheldon and Carlos D. Sheldon, in Houghton. He decided to try his hand at sailing on the Great Lakes and advanced to a captaincy. He gave up this life to work for one year for a mining company in Honduras.

Returning to the Copper Country, Mr. Calverley and Carlos D. Sheldon, who was a Michigan Congressman for a number of years, organized the Sheldon Towing Company, which operated a fleet of tugs on the Keweenaw waterway.

Later the same men became interested in mineral lands in Iron County, Mich., and on part of their holdings the Tobin and Odgers mines were developed.

Mr. Calverley served as vice-president of the Houghton National Bank from 1908 until his death. He served Portage Township as Supervisor from 1904 to 1907 and was a member of the Board of Control of the Marquette Branch Prison during the regime of Governor Bliss. He was a member of the State Constitutional Convention in 1907 and 1908.

Mr. Calverley married May T. Rose, of Duluth, who, with three children, Harry, William D. Jr., and Mary survived him.

Death came to him in Houghton on August 30, 1931.

THOMAS CLANCEY

Thomas Clancey was born in Ishpeming July 11, 1885, a son of James Clancey, who was for many years in charge of mechanical operations on the Marquette Range for the Oliver Iron Mining Company.

He attended the Ishpeming schools and then entered the University of Michigan, receiving a bachelor of arts degree in 1908 and a law degree in 1910. In the latter year he entered the law offices of William P. Belden, in Ishpeming, and in 1917, when Mr. Belden left to make his home in Cleveland, Mr. Clancey and Fred H. Berg organized the law firm of Berg & Clancey. A few years later Clarence B. Randall, now a vice-president of the Inland Steel Company, in Chicago, was admitted to partnership, and when Mr. Randall went to Chicago to reside the firm name again reverted to Berg & Clancey.

The legal firm handled law matters for the Cleveland-Cliffs Iron Company, the Oliver Iron Mining Company, Pickands, Mather & Co., the St. Paul railway and other large industrial enterprises in the Lake Superior district.

For six years Mr. Clancey served as prosecuting attorney of Marquette County and he was active in Republican politics, serving as Marquette County Chairman and on state commissions.

Mr. Clancey was survived by his wife, the former Louise Persons, a son, James, and two daughters, Mary Louise and Sara.

Death came suddenly on August 1, 1936.

CHARLES D. COLE

Charles D. Cole was born in Wales County, N. Y., in 1852, and spent the greater part of his life in Ishpeming.

At an early age he was employed in an art gallery in Saginaw, Mich., and at the age of 16 moved to Marquette, where he continued in the same line of work. When near the age of 30

he went to Ishpeming to take employment in the Emery studio. Later he became associated with R. W. Childs in a photographic business in Ishpeming and this he continued to operate until his death.

Many of the photographs that have appeared in the Proceedings of the Institute were the work of Mr. Cole. He won praise for an assortment of mine scenes, underground and surface, which were exhibited at the St. Louis Exposition in 1904.

Mr. Cole never married. He died February 26, 1931, in Ishpeming.

CHARLES W. COOK

Dr. Charles W. Cook, professor of economic geology at the University of Michigan, was born in Fenton, Mich., September 17, 1872, and lived in Ann Arbor for 30 years.

Dr. Cook received a bachelor's degree from the University in 1904, his master's degree in 1906 and a doctor of philosophy degree in 1913. He served two years on the staff of Pacific University, Eugene, Oregon, and then returned to the University of Michigan. He was granted a full professorship in 1920.

In 1912 Dr. Cook was married to Susan Baker, of Grand Rapids, Mich. Besides his wife, a daughter, Susan Ann, survived him.

Dr. Cook died February 17, 1931.

WILLIAM COYNE

William Coyne was born July 14, 1866, in Calumet, Indiana. He studied railway engineering in the Scranton School.

Following are the positions which he filled during an active career: Telegraph operator C. M. & St. P. railway, telegraph operator M. & St. L. and C. St. P. M. & O. railway, train dispatcher M. & St. L. and C. St. T. P. railways, chief dispatcher S. F. & N. railway, Spokane, Wash., superintendent V. & S. W. railway, Bristol, Tenn., traffic manager Dominion Steel & Iron Co., and Dominion Coal Co., Sydney, N. S., assistant to president of Lake Superior Corporation, Ontario, Canada.

In 1904 Mr. Coyne joined forces with the DuPont Company as a traffic investigator in the development department. The same year he became manager of the traffic department and in 1907 was made director of the commercial sales department. In 1914 he was elected a director of the DuPont Powder Company and a member of the executive committee. In 1916 he was elected a vice-president and had charge of military sales during a part of the World War. In 1919 he resigned from the executive committee and became a member of the finance committee. After 1930 he was not actively engaged in the company's affairs.

In addition to his duties with the DuPont organization, Mr. Coyne was a director of Canadian Industries Limited, of Canada, a director of the Dunlop Tire & Rubber Co., of Toronto, Canada, and a director of the Farmers' Bank of Delaware.

Death came to Mr. Coyne on October 31, 1933.

CHARLES T. FAIRBAIRN

Charles T. Fairbairn was born in Detroit, March 8, 1865, and went to Ishpeming when a young man to enter upon a mining career.

He started as bookkeeper at the National Mine, near Ishpeming, in 1888. He was associated with various activities, including that of postmaster at Ishpeming.

In 1901 Mr. Fairbairn went to Virginia, Minnesota, as general superintendent for the Inter-State Iron Company. In 1906 he became general manager of mines in the Lake Superior district for the Republic Iron & Steel Co., and in 1910 he was transferred to Pittsburgh as manager of mines for the same company.

In 1912 Mr. Fairbairn was appointed manager of the Birmingham, Alabama, district, for the same corporation and occupied this position until 1930, when he retired to devote his time to his private interests.

Mr. Fairbairn was president of the Lake Superior Mining Institute in 1917, the year that the Institute met in the Birmingham district.

He died October 15, 1932, in Louisville, Kentucky, following an operation. Mrs. Fairbairn died in 1921.

HERMAN W. FESING

Herman W. Fesing, who was a member of the first class to be graduated from the Michigan College of Mining & Technology, was born in the Village of Houghton.

After completing his studies he went to work for the Tamarack Mining Company and left there to join the staff of engineers of the Calumet & Hecla Consolidated Copper Co. During the later years of his life he was mining engineer for the Sheldon Estate, of Houghton, and lived for a while in Crystal Falls.

Mr. Fesing died at his home in Houghton October 23, 1934.

NELS P. FLODIN

Nels P. Flodin was born in Sweden in 1862. Upon arrival in this country he went to Duluth, where he remained for six years and then, in 1890, went to Marquette, where he made his home the remainder of his life.

Mr. Flodin learned the machinist's trade and became an expert. He was advanced in the employ of the Lake Shore Engine Works, in Marquette, until he became director of sales. No man who called upon the mining industry of the Lake Superior district was better known or better liked than Mr. Flodin. He held patents on several mining machines and was constantly striving to develop new machinery that would be of value to the mining world.

Mr. Flodin was survived by his wife and one son, F. A. Flodin, of Iron Mountain.

Death occurred October 15, 1934.

FRANK H. HALLER

Frank H. Haller was born in Lanark, Illinois, in 1874 and was educated there and at Northwestern University, from which he was graduated with a Ph.B degree in 1898.

He taught school in Illinois and Michigan for two years and in 1900 enrolled at the Michigan College of Mining & Technology.

Completing a course of study in mining engineering, Mr. Haller went to Ironwood as principal of a school in that city and followed this profession for a few years before turning to the career which he afterwards followed as a mining engineer.

Mr. Haller's first position as an engineer was with the Oliver Iron Mining Company. In 1905 he went to Osceola as assistant superintendent for the Osceola Mining Company. In 1909 he was made superintendent and in 1924 was transferred to the railroad department of the Calumet & Hecla Consolidated Copper Co., which had previously absorbed the Osceola Company. He continued in this capacity.

Death occurred July 19, 1936, in Calumet, Michigan.

LOUIS M. HARDENBURG

Louis M. Hardenburg was born in Plattsville, New York State, January 27, 1867, and was the last of his family to bear the family name.

He attended school in Rome, New York, until the family moved to Tecumseh, Michigan, where he was graduated from high school. He attended Hillsdale college, in Michigan, and received a bachelor of arts degree. He taught school for several years and then enrolled in the Michigan College of Mines, now Michigan College of Mining & Technology, at Houghton, and was graduated with a science degree.

Mr. Hardenburg taught at the mining school for a few years and then went to Iron Mountain, Michigan, to work for the Pewabic Mining Company, in charge of the concentrating plant. He left there for Montreal, Wisconsin, to become superintendent of the Gary mine, a position he held for 10 years.

In 1912 Mr. Hardenburg went to Ironwood to take charge of the mines of Pickands, Mather & Co. as general superintendent. He retired in 1926, but continued to serve the company in an advisory capacity.

Mr. Hardenburg was married to May D. Hoar, a member of an old Houghton family, in 1902. He was survived by his wife and one daughter, Mrs. D. S. Morton, of Sudbury, Ontario, Canada.

He died January 21, 1936.

GUY ELMER HARRISON

Guy Elmer Harrison was born in Excelsior, Minnesota, April 7, 1880, and received his early schooling there and in a high school in Minneapolis, where the family moved in 1896. In 1898 he entered the school of mines at the University of Minnesota and remained there until 1900.

In 1900 Mr. Harrison found employment on the Mesabi Range with the Corrigan, McKinney Steel Company at the Fayal mine, Eveleth, as shipping clerk. In succession he was engineer's helper at the Fayal mine, mining engineer at the Stevenson mine, Hibbing, engineer for all of the Company's mines on the Mesabi Range, assistant to the general superintendent, superintendent of the Stevenson mine and superintendent of the St. Paul mine.

In 1918 Mr. Harrison was transferred to Crystal Falls, Michigan, as district superintendent for the McKinney Steel Company. In 1927 ill health forced him to retire from active mining practice and in that year he moved to Minneapolis and opened offices as consulting engineer. In 1932 he was compelled by ill health to give up all work.

Death took place October 31, 1935. He was survived by a widow, one daughter and three sons.

DR. LUCIUS L. HUBBARD

Dr. Lucius L. Hubbard, PhD., geologist, of Houghton, Mich., was born in Cincinnati, Ohio, in 1849. He attended the Cincinnati schools, spent two years at Phillips Exeter Academy, was graduated from Harvard in 1872, studied at Heidelberg, also at Bonn University, Germany, where he received degrees of A. M. and Ph.D.

In 1891 he came to the Upper Peninsula as assistant on the State Geological Survey, and became one of the instructors at the Michigan College of Mines. In 1893 he was appointed state geologist and served six years. He resigned to accept the position of general manager of the Champion Copper Company. He was a member of the Board of Control of the Michigan College of Mines from 1905 to 1917. In 1910 he was appointed a member of the Board of Regents of the University of Michigan by Governor Osborn. He was elected a regent in 1911 and re-elected in 1919 and 1927. He resigned January 8, 1933, on account of ill health. Dr. Hubbard was the author of several books and papers on Mineralogy and Geology.

He died August 3, 1933.

JOHN HUHTALA

John Huhtala was a native of Finland and after arriving in the United States spent one year in the Michigan Copper Country. He went to Negaunee in 1887 and for three years served that city as its chief of police.

In 1899 Mr. Huhtala went to Palmer, on the Marquette Range, where he engaged in mining work. He was advanced until he became superintendent of the Richmond mine of the M. A. Hanna Company. He served for a number of years as supervisor for Richmond Township and also as a member of the Township Board of Education.

Death occurred on September 16, 1932.

WILLIAM P. KAUPER

William P. Kauper was born in 1888 and during his business career was in the construction and engineering fields.

He made his headquarters in Green Bay, Wisconsin, where for a time he was associated with the Greiling Bros. Company, marine contractors, as construction superintendent. Later he was district sales manager for the Northwest Engineering Company. He was a captain of infantry during the World War and stationed at Newport News, Virginia.

Mr. Kauper died July 20, 1932.

THOMAS J. KITTS

Thomas J. Kitts was born at Quincy, in the Michigan Copper Country, July 2, 1876, a son of Mr. and Mrs. Thomas Kitts, pioneer residents of that place.

For a number of years he was a draftsman in the machine shop of the Quincy Mining Company. In 1908 he entered the employ of the Johns-Manville Company as salesman and in 1924 left the Copper Country for Duluth as representative of the same Company. His territory included the mining area of the Lake Superior district.

Mr. Kitts married Lena Isler, of Lake Linden, Michigan. A son and a daughter were born, John, of Duluth, and Betty, of Boston.

Mr. Kitts died December 31, 1936. Burial took place in Duluth.

EDWARD KOEPEL

Edward Koepel was born January 28, 1865, in Manitowac, Wisconsin, and went to the Michigan copper country at the age of 10.

He was superintendent of the Copper Falls mill in Keweenaw County for a number of years and later was master mechanic at the Arcadian mill at Point Mills. For 28 years he was a resident of Freda and there he was superintendent of the Champion mill of the Copper Range Company.

Mr. Koepel was one of the outstanding mill men of the Michigan district. He was the father of many original ideas in stamp mill practice during his long career as a practical metallurgist. He was one of the first to appreciate the possibilities of flotation as applied to amygdaloid ores, as well as the advantages of fine grinding and the tabling of coarse ores. He built the first balance cone for improved feed on a jig table.

Mr. Koepel worked with A. W. Fahrenwald and metallurgists of the Michigan College of Mining & Technology to improve mill practice and they found that much of the free copper that had been lost could be recovered. This resulted in a complete revision of the flow sheet in the Champion mill.

Mr. Koepel served Stanton Township as supervisor from 1909 to 1932.

Surviving him were Mrs. Koepel, three sons and two daughters.

Death came to him April 4, 1932.

W. G. LARUE

W. G. LaRue was a pioneer explorer on the Vermilion Range and left there when the Mesabi Range was first opened up. He spent many years in Duluth before going to Los Angeles, Calif., to live in 1927.

Mr. LaRue was associated with Robert B. Whitside in the exploration of the Baraboo, Wis., mineral area and retained an interest there in iron lands at the time of his death. A townsite was platted in the Baraboo district by Mr. LaRue which he named after himself.

He died in Los Angeles June 9, 1931. He was in the late seventies.

CHARLES E. LAWRENCE

Charles E. Lawrence was born in Cleveland, Ohio, September 26, 1865, and lived in that city until 22 years of age, when he arrived in Upper Michigan to work in the office at the Republic mine, in Republic.

After remaining in Republic for a short time, Mr. Lawrence went to Ishpeming in the employ of the Fitch Iron Company of Pickands, Mather & Co. Later he was connected with the Minnesota Iron Company and then went to work for Pickands, Mather & Co. and remained with that firm until his death.

He lived for 12 years in Amasa and six years in Iron Mountain and then went to Caspian as general superintendent of the iron

ore properties in the Iron River field. He served as president of the Village of Caspian and took an active interest in all civic affairs in Iron County. In 1921 he was named a member of the Michigan Commission of Conservation and served the state in this capacity for six years.

In 1893 Mr. Lawrence married Eliza Gentry, of Ishpeming, who preceded him in death. Mr. Lawrence died November 9, 1934, and burial was made in Ishpeming. A daughter, Mrs. A. J. Harris, of Muskegon, Mich., survived.

FRANK R. LLOYD

Frank Ralph Lloyd was born in Carnegie, Pennsylvania, June 4, 1870, and at an early age went to work in the coal mines of that region. At the age of 18 he became a brakeman on the Pennsylvania Railroad, running between Pittsburgh and Dennison, Ohio.

When he reached the age of 21 he went to Chicago to work for the Chicago & Northwestern Railway Co. as a switchman in the Clinton Street yards. He left the Northwestern for a few years to work for the Milwaukee Railroad, between Chicago and Savanna, Illinois.

In 1895 Mr. Lloyd re-entered the employ of the Northwestern as a switchman in the Chicago coach yards, which is on the Galena Division, and in 1902 was made yardmaster and awarded the position of trainmaster during the elevation of the lines of the Galena and Wisconsin Division. He next became passenger trainmaster on the Galena Division, a position which he held until 1915, when he was transferred to the Southern Illinois Division and later he became trainmaster at the Proviso yards on the Galena Division.

In 1920 Mr. Lloyd was appointed assistant superintendent of the Galena Division, with headquarters in Chicago, and in February, 1924, was named superintendent of the Peninsula Division, with offices in Escanaba. This position he held until his retirement.

Mr. Lloyd died in Escanaba March 2, 1935, leaving a wife and a daughter, Mrs. Rudolph E. Olson.

D. B. McDONALD

D. B. McDonald was a pioneer of the Mesabi Range, locating in Virginia, Minn., in 1887, and was an active leader in the building of that city and several other range communities.

Mr. McDonald was the founder and also president of the Cole-McDonald Exploration Company, at one time the largest diamond drill company in the world. He also was president of the Northern Cold Storage Company, president of the Zenith Dredge Company, president of the American Exchange Bank in Virginia and director of the Northern National Bank in Duluth.

He was born in Kincardine, Ontario, Canada. Death occurred in Coldwater, Florida, where Mr. McDonald was wintering. His age was 75. Burial took place in Duluth.

JOHN H. McLEAN

John H. McLean, general manager of the Oliver Iron Mining Company for 19 years, was born in Neenah, Wisconsin, June 6, 1860.

He joined the Oliver Company as chief clerk in 1897 and was appointed general manager in 1909, a position which he filled until his retirement in 1928. From that time on Mr. and Mrs. McLean spent the summers in Duluth and the winters in

Hollywood, California. He was vice-president of the Minnesota National Bank.

Members of his family who survived were Mrs. McLean, a daughter, Mrs. M. E. Scroggins, of Minneapolis, and two sons, Wilbur F., of Duluth, and Howard, of Livingstone, Montana.

Mr. McLean died May 4, 1933, in Hollywood. Burial took place in Duluth.

WILLIAM R. MEYERS

William R. Meyers was born in Louisville in March 1885, and in 1907 was graduated from Lehigh University with a degree of mining engineer. The same year he entered the employ of the Cleveland-Cliffs Iron Company at the Ashland mine in Ironwood. He was there only a brief time when he was transferred to the Gwinn district and in 1916 went to Iron River to assume charge of the Spies mine as superintendent.

In 1917 Mr. Meyers enlisted for army service and after training at Fort Lee, Virginia, went to Bordeaux, France, where he had charge of unloading vessels at that busy port. In 1919 he returned to this country and went to Hibbing, Minn., as assistant superintendent under Max H. Barber.

In 1925 Mr. Meyers returned to Michigan and was stationed at Republic, with both the Republic and the Spies mines under his supervision. In 1928 the Republic mine was abandoned and Mr. Meyers was named chief engineer for the Cleveland-Cliffs Company and also placed in charge of the Tilden mine. In 1933 he was appointed superintendent of the Maas property.

Mr. Meyers was a member of the American Legion, the American Institute of Mining & Metallurgical Engineers in addition to the Lake Superior Mining Institute.

He left his wife, Harietta, a son, Theodore, and a daughter, Joan.

Death occurred in Louisville, Kentucky, December 25, 1936.

PENTECOST MITCHELL

Pentecost Mitchell was born October 18, 1861, in Hancock, where his father was engaged in construction of the Quincy stamp mill. During his childhood the family moved to Negaunee.

In 1873, when a panic was on, Mr. Mitchell obtained employment in a drug store and later operated stores of his own until 1886, in Negaunee and in Bessemer. He walked into Bessemer from the end of the rails of the old Milwaukee, Lake Shore and Western Railroad.

In 1886 and 1887 Mr. Mitchell was employed at the Iron-ton mine, near Bessemer, and in the latter year was made superintendent of the Comet mine at Wakefield. In that year he married Minnie Merrie, of Negaunee, a daughter of Captain Henry Merrie.

Mr. Mitchell's work at the Comet mine was in the interest of the Penoque and Gogebic Development Co., which later became interested in Mesabi Range mines.

Early in 1894 Mr. Mitchell was placed in charge of the Hull-Rust, Burt, Pillsbury and other mines on the Mesabi that were operated by the Lake Consolidated Iron Mines Company, which later became a part of the Oliver Iron Mining Company. He was made general superintendent in 1903.

Mr. Mitchell remained in Hibbing until 1906, when he was named general manager of the Oliver Company and removed to Duluth. In 1909 he became vice-president and upon the retirement of W. J. Olcott, in 1928, was elected president.

He died in Santa Barbara, Calif., July 18, 1933, leaving his wife and one daughter, Mrs. Curt Ralph Bomonti, of Alexandria, Egypt.

BENJAMIN C. NEELY

Benjamin C. Neely was born in Negaunee December 14, 1873, and spent the early part of his life in that city.

At the age of 26 he was elected mayor of his home city and was the youngest man ever to hold this office. He went from Negaunee to Crystal Falls and that city was his home until his death. He dealt in Wisconsin and Michigan mineral lands and was interested in iron ore mines.

Mr. Neely left a wife and one son, three sisters and a brother.

Death occurred on April 17, 1936.

WILLIAM J. OLCOTT

William J. Olcott was born in Detroit January 22, 1862, and was graduated from the University of Michigan in 1883 and took a second degree a year later.

Mr. Olcott did his first work at the Chapin mine, at Iron Mountain, where he served as mining engineer. He remained at the Chapin until May 30, 1886, when he went to Hurley, Wisconsin, as engineer and chemist for the Ashland and Germania mines under the Hayes Brothers.

In January, 1890, Mr. Olcott accepted a position as engineer under Alton Dickerman, in Ironwood, and in September of the same year moved to Bessemer and was made superintendent of the Colby mine. In January, 1892, he was made general superintendent on the Gogebic Range for a number of mines and in February, 1894, went to Duluth, as superintendent of the Consolidated Mines of the Mesabi Range.

Mr. Olcott was made general superintendent of the United States Steel Corporation's mines on the Mesabi Range in April, 1901, and in July, 1902, general manager of all of the Corporation's mines in the Lake Superior district. Later he became president of the Oliver Iron Mining Company, a position which he filled from 1909 to 1928, when he retired. He also served as vice-president and later as president of the Duluth, Missabe & Northern Railway. He was a charter member of the Institute.

For 18 years Mr. Olcott's father, Harlow Olcott, was superintendent of the schools in Ishpeming and his sister, Amelia F. Olcott, served as principal in Ishpeming and later as superintendent of the Bessemer schools.

Mr. Olcott died in Pasadena, Calif., April 29, and burial took place in Duluth, May 6, 1935.

JOHN M. PERKINS

John M. Perkins was born at Eagle Harbor, in Keweenaw County Michigan, in 1867 and left there with his parents, going first to Humboldt and then to Negaunee. His father was a well-known mining man who for a number of years prior to his retirement had charge of properties on the Menominee Range.

John M. Perkins engaged in the drug business in Negaunee and continued in that line until his death. He married Ida

Mitchell, of Negaunee, also a member of a well known mining family. She and three daughters, Mrs. George Clark, Mary and Lillian, survived.

It was on August 27, 1932, that Mr. Perkins died suddenly while playing over the Wawonowin Golf course.

JOHN ALBERT REDFERN

John Albert Redfern was born in Derbyshire, England, October 10, 1867. Mr. Redfern moved with his parents at the age of four, to Owen Sound, Ontario, where he lived for some ten years.

Upon then moving to Michigan he began his life work in mining as a powder boy, gradually working up through blacksmith's helper, boiler fireman, timekeeper, shipping clerk, assistant mining engineer, engineer and then to mine superintendent for the Platte Mining Company at Palmer.

In 1895 he was married to Miss Lillian Seass, of Negaunee, Michigan, and transferred to Hibbing, Minnesota, as superintendent of the Penobscot mine. He held this position until 1903, at which time he became agent for the Mississippi Land Company, fee owners, and remained in this capacity until he retired from mining work in 1924.

Active in virtually all of Hibbing's major civic problems, his special services to the community might be listed as follows: One of Hibbing's first Mayors, School Director, Secretary of the Community Fund during the World War, Chairman of the Victory Loan Drive, Chairman of the Hibbing Charter Committee, Chairman of the Civic Council, originator of the Hibbing Aldermanic Form of Government Bill, and one of the founders of the Swan Lake Country Club.

Mr. Redfern is survived by his widow and a sister, Mrs. Peter Durkin, of Nakusp, B. C.

He died April 13, 1934, and interment was made at Maple Hill Cemetery, Hibbing, Minn.

JOHN H. RICE

John H. Rice, who was for years president of the Houghton National Bank, was born in Missouri, December 7, 1861. His parents went to Houghton in 1875.

In October, 1880, Mr. Rice entered the employ of the bank, previous to which time he was graduated from Lawrence College, Appleton, Wis. He was appointed cashier in November, 1895, and promoted to the presidency in January, 1910.

He took an active interest in civic affairs in Houghton County. He was one of the organizers of the Houghton Club, the Amphidrome Company and the Houghton County Agricultural Society. He was director of the Copper Range Railroad, the Peninsula Wholesale Grocery Company and the M. Van Orden Company.

Surviving were Mrs. Rice and a daughter, Mrs. Peyton Rudsell.

Mr. Rice died in Houghton January 3, 1931.

WILLIAM J. RICHARDS

William J. Richards, who served for some years as master mechanic for the Copper Range Company, at Painesdale, was born in Mineral Point, Wis., in 1872, and went to the Michigan Copper Country with his parents when one year old. The

family located at Copper Falls, where the father was killed in the Copper Falls mine when William J. was 16 years of age.

Mr. Richards' first job was that of mill runner, and later he went to work in the Tamarack shops. He attended Ferris Institute for a while and returned to the Tamarack as shop foreman. He next took up work in the Michigan College of Mining & Technology and in 1902 went to the Atlantic mine as master mechanic.

In 1905 Mr. Richards went to the Copper Range company as master mechanic and he held that position until ill health forced him to retire.

Mr. Richards died May 31, 1932, leaving his wife and one daughter, Mrs. W. M. Houghton, of Lancaster, Pennsylvania.

ROBERT S. ROSE

Robert S. Rose was born in Fond du Lac, Wis., November 26, 1865.

He attended the Michigan College of Mining & Technology and was graduated with the Class of 1896. Two years later he married Florence D. Merritt, of Marquette.

Mr. Rose was associated with the John M. Longyear interests as consulting engineer for 25 years and played a prominent role in the development of iron ore mines on the Gogebic Range.

He was survived by Mrs. Rose and two children, Mrs. James Draper, of Toledo, Ohio, and Robert S. Rose, of Tomaquah, Pa.

Death occurred in a hospital in Ann Arbor on September 2, 1936.

LOUIS ROUCHLEAU

Louis Rouchleau, pioneer of the Mesabi Range, was born a native of Michigan and went to Duluth in the early eighties and from there to the range, where he was successful in exploration work. The Rouchleau-Ray Iron Land Company was the outcome of his efforts. The properties were sold to the Lake Superior Consolidated Mines. One, near Virginia, is known as the Rouchleau. About 1913 Mr. Rouchleau moved to Minneapolis, where he continued to make his home until his death on December 29, 1933. His age was 74. A wife and two daughters survived him.

JOHN A. RYAN

John A. Ryan was born March 22, 1876, in Ishpeming and when a boy his family moved to Escanaba. He attended Pionona College, near Milwaukee, and returned to Escanaba to work for the Chicago & Northwestern Railway as shipping clerk.

In 1900 Mr. Ryan went to Iron Mountain to take a similar position with the Oliver Iron Mining Company. Two years later he was promoted to the office of chief clerk, a position which he ably filled until his death. He served a long time as secretary of the Iron Mountain General Hospital.

Mr. Ryan was married to Mary Catherine Lang, of Escanaba. There were no children.

Death occurred August 11, 1931, in Iron Mountain.

JOHN SAMPSON

John Sampson was born April 5, 1874, at Negaunee, Michigan.

At an early age he engaged in railroad work and for many years was connected with the iron ore traffic, practically all of the time with the Chicago & Northwestern Lines on the division which extends from Antigo, Wisconsin, to Ashland, in the same state.

It was on June 21, 1885, that the M. L. S. & W. Railroad completed the line into Ashland and the first ore dock at that port was built in the same year. The first boat to dock there was the barge Cormorant, which cleared July 29, 1886, with 1,300 tons of iron ore for Cleveland. The first coal boat to reach Ashland was the Iran Age, on August 5, 1886, and docked at what is now the Reiss Coal Company's dock.

On December 26, 1900, John Sampson was named dock agent, and by that time the original railroad had been taken over by the Chicago & Northwestern. He continued in that capacity until February 1, 1906, when he was named assistant superintendent of the Ashland division. On July 29, 1907, he again resumed the duties of dock agent and continued in that capacity until August 3, 1936, when he died.

JOHN UNO SEBENIUS

John Uno Sebenius was born in Sweden on September 10, 1862, and was educated in Stockholm. At the age of 24 he emigrated to the United States as assistant superintendent for Witherbee, Sherman & Co., at Port Henry, New York.

In 1892 he went to Duluth and started out as a consulting engineer. In 1894 he became affiliated with the Rouchleau-Ray interests on the Mesabi Range and he was one of the first to recognize the geological structure of that range. He also took a leading part in developing a process for the commercial concentration of Western Mesabi Range iron ores. This made available many millions of tons of ore previously unmarketable.

The Rouchleau-Ray properties were taken over by the Lake Superior Consolidated Iron Mines, and in 1901 Consolidated was taken over by the Oliver Iron Mining Company. Mr. Sebenius was placed in general charge of exploration and mining engineering duties for the Oliver Company. He was known as the discoverer of the Fayal mine, at Eveleth. He retired July 1, 1930.

Mr. Sebenius died in Rochester, Minn., December 18, 1932. He left two sons, William, of Duluth, and Carl Harold, of Pasadena, California.

HORACE W. SHELDON

Dr. Horace W. Sheldon was for 40 years a practicing physician in Negaunee and for many years at the head of the Cleveland-Cliffs Iron Company's hospital staff in that city.

After his retirement he went to live in Berkeley, California, and it was in that city that he died March 12, 1934, at the age of 81. Burial took place in Berkeley.

He was survived by Mrs. Sheldon and one son, Ward, of Berkeley.

MYRON J. SHERWOOD

Myron J. Sherwood, attorney, was born April 11, 1860, in Mansfield, Tioga County, Pennsylvania, the son of Mr. and Mrs. John Sharp Sherwood.

He received his early education in the schools of Sunbury, Pennsylvania, and St. Louis, Missouri. In 1876 he entered the preparatory department of Bucknell College, Lewisburg, Pennsylvania. He left there to go to Texas, where his father was employed as a railroad superintendent. His aim was to study law, so he went to Hamilton College, New York, and was graduated in 1886 with high honors.

Mr. Sherwood went to Marquette in 1887 to accept a position as telegraph editor on the Marquette Mining Journal. He resigned in 1890 to become principal of the Marquette high school. In 1892 he opened a law office. He served as city attorney in 1894-95 and in 1895 became attorney for John Munro Longyear, who had vast mineral and timber holdings. He was also counsel for the Keweenaw Land Association.

Mr. Sherwood was interested in several mining properties, owning a controlling interest in the Sherwood mine near Iron River, Michigan, and an interest in the Dean mine near Ironwood.

For 12 years Mr. Sherwood represented the Third Ward in his home city on the Marquette County Board of Supervisors.

He left a wife and one son, Lee Sherwood, of Detroit.

Mr. Sherwood died March 19, 1935.

D. E. SUTHERLAND

D. E. Sutherland was born in Glengarry, Ontario, Canada, November, 19, 1859, and worked briefly in a saw mill at Ford River, Michigan, before taking up mining as a career.

He advanced from the position of underground timekeeper to the post of assistant general superintendent of operations for the Oliver Iron Mining Company on the Gogebic Iron Range. For 50 years he was in the employ of this Company and cherished the 50-year medal that was presented to him. He was one of the last of the old school of mining men who was connected with early day mining in the Lake Superior district.

After working for the Lumber Company at Ford River Mr. Sutherland went to work as shipping clerk at the Curry mine in Norway, which was operated by Solomon B. Curry. Shortly after he became underground timekeeper in a mine at Metropolitan and in the spring of 1884 went to the Norrie mine at Ironwood as clerk. Two years later he opened the East Norrie mine and became mining captain there. When the Oliver Iron Mining Company acquired the Ironwood properties, he became assistant superintendent of local operations to John H. McLean. He later became assistant general superintendent under O. C. Davidson, which position he held until his retirement.

Mr. Sutherland served two years as treasurer of Gogebic County and he was for a time an alderman in Ironwood. For 13 terms he was mayor of the same city.

On May 1, 1931, Mr. Sutherland retired from active work.

He died January 1, 1936, in Ironwood and burial took place there.

CHARLES TREZONA

Charles Trezona, like so many others who became prominent in mining circles on the Lake Superior ranges, was born in Cornwall, England, September 8, 1863. His father was a miner, and at the age of 10 Charles Trezona began his mining career.

He came to this country in 1885 and for a year worked in one of the copper mines in the Michigan Copper Country. For the next four years he was employed in the iron mines in Hurley, Wis., and in 1890 went to the Vermilion Range, where he remained for a brief time.

From 1892 to 1894 he was shift boss in a mine at Wakefield, then went to the Franklin group of mines on the Mesabi Range. In 1898 he went back to the Vermilion Range to accept the captaincy of the Pioneer mine at Ely. In 1900 he was promoted to superintendent and two years later named general superintendent. He served as mayor of Ely, president of the Board of Education, president of the Rotary Club, president of the Ely Commercial Club and the Vermilion Range Old Settlers' Association.

Mr. Trezona died June 21, 1931.

WILLIAM D. VanDYKE

William D. VanDyke was a native of the City of Milwaukee and was born in 1856, the son of John H. VanDyke, president of the Northwestern Mutual Life Insurance Company.

He was educated at Markham's Academy in Milwaukee and later attended Princeton University, from which he was graduated in 1878. Subsequently he studied law and was admitted to the bar, gaining distinction in practice.

Mr. VanDyke was a member of the law firm of VanDyke & VanDyke from 1880 to 1909. In 1904 he was elected a trustee and made a member of the finance and executive committee of the Northwestern Mutual Life Insurance Company. In 1909 he was elected a vice-president of the same company and in 1919 elevated to the presidency.

Mr. VanDyke had extensive business interests outside of the insurance and legal businesses. He was director of the Chicago, Milwaukee, St. Paul & Pacific Railway Co., secretary and treasurer of the Pewabic Company, Mineral Mining Company and VanDyke Land & Investment Co.

He married Gertrude H. Goodrich, of Milwaukee, who died in 1930. He left two daughters, Nancy VanDyke Scribner, of Winnetka, Illinois, and Mary Douglas VanDyke, and one son, William D. VanDyke, Jr., of Milwaukee.

Mr. VanDyke died in Milwaukee June 7, 1932.

CAPTAIN JOSEPH T. VICKERS

Captain Joseph T. Vickers went on the Bethlehem Steel Corporation pension list on the first of January, 1937, and died Friday night, January 8.

He contracted a severe cold that developed into pneumonia, and was rushed to the Penn Company hospital where he passed away. Captain Vickers was 66 years of age and during his early days was a bombardier in the Royal Garrison Artillery, seeing foreign service in India. He was a man of giant physique, having been born in the border country of England and Scotland.

He came to America in the 90's to enter the mining industry and became a valued employe of the Pickands-Mather Corporation. He went to Vulcan from Biwabik, Minn., in 1923, holding the position of Captain under Superintendents David Cavin and Harold J. Richards, who is still in charge of the Vulcan properties.

He has left a widow, Rose, three sons, Matthew, Joseph and Arthur, a brother, William T., of Biwabik, Minn., and a sister, Mrs. Richard Chappell, of Houghton, Mich.

After services at Holy Trinity Church, Iron Mountain, the body was placed in a mausoleum, to be interred in the spring at Houghton.

Past Master Errol Williams of the Norway Masonic lodge, conducted the ceremonies at the Vulcan home, and Shriners of Iron Mountain also attended the funeral. Captain Vickers was also a Scottish Rite Mason, having attained the 32nd degree.

WILLIAM WEARNE

William Wearne, former manager of iron ore mines for the Inland Steel Company, died in San Diego, Calif., where he had made his home for fourteen months.

He spent his boyhood in the Michigan Copper district and was graduated from the Michigan College of Mining & Technology. He was engaged in mining work in Colorado for a time before going to the Mesabi Range, in Minnesota. In 1906 he took over the superintendency of the LaRue mine for the Inland Steel Company. This was the Inland's first venture into the iron mining business. Later the same company came into possession of other mines on the Mesabi and Cuyuna Ranges, and still later developed the Greenwood mine and acquired the operation of the Morris mine, both on the Marquette Range.

Between 1932 and the fall of 1935, when he retired, Mr. Wearne spent considerable of his time in Ishpeming. He was succeeded as manager by R. L. Wahl, of Ishpeming.

Mr. Wearne was survived by Mrs. Wearne, a son, William, Jr., and a daughter, Mrs. Howard Bertram. A brother, Ed. Wearne, of Ishpeming, is master mechanic for the Inland Company.

Burial was in San Diego. His age was 63.

FRANCIS J. WEBB

Francis J. Webb was born June 11, 1873, at Potosi, Wisconsin, and received his secondary school education in Lancaster, in the same state. Later he attended Northwestern University, where he received an A. B. degree.

In 1892 Mr. Webb was employed at the Sunday Lake mine, Wakefield, and the following year taught school in Lancaster. From 1893 until 1896 he taught in the Calumet, Michigan, schools. He then went to the Michigan College of Mining & Technology for special work and later spent another year at Northwestern University. From 1900 until 1902 he was a professional stage actor, and never lost interest in the profession.

In 1903 Mr. Webb went to the Fayal mine, on the Mesabi, and later was with tile engineering department of the Oliver Iron Mining Company at Eveleth. From 1907 to 1908 he served as superintendent of the LaRue mine at Nashwauk and then a year as mine inspector for St. Louis County, Minnesota.

Mr. Webb was named general superintendent of mines for the Republic Iron & Steel Co., in 1909, with headquarters in Gilbert, and from 1910 on was general manager for the

Company's Lake Superior mines, with headquarters in Duluth. In 1923 he was president of the Institute.

He died December 3, 1933, at Duluth. Burial took place in Lancaster.

RICHARD P. ZINN

Richard P. Zinn was a native of Marinette, Wis., and the year of his birth 1887. He spent practically all of his life in Ironwood.

In 1900 he was employed in the office of the Scott & Howe Lumber Co., and left there to become secretary to the manager of the Newport mine, at that time operated by the Schlesinger interests. On the first day of January, 1914, he was named assistant superintendent and in April, 1920, superintendent.

Later Mr. Zinn was promoted to the position of manager of mines of Pickands, Mather & Co., in the Michigan area, which included properties on the Gogebic, Menominee and Marquette Ranges.

Mr. Zinn was deeply interested in the affairs of the Upper Peninsula and for two years was president of the Upper Peninsula Development Bureau. He also served as chairman of the Gogebic County Board of Supervisors.

He left a wife and two children, Eugene and Mabel.

Death took place on July 22, 1935.

BIOGRAPHICAL LIST OF BIOGRAPHIES PUBLISHED IN PREVIOUS VOLUMES.

Names—	Year	Volume
George H. Abeel	1925	XXIV
Francis W. Anthony	1908	XXIV
John F. Armstrong	1925	XIII
John N. Armstrong	1925	XXIV
D. H. Bacon	1923	XXIII
Clarence Morton Boss	1928	XXIV
Frank Philip Botsford	1930	XXVIII
George Brewer	1922	XXII
Edmund D. Brigham	1922	XXII
D. D. Brockway	1908	XIII
A. C. Brown	1922	XXII
John L. Buell	1925	XXIV
William A. Burt	1908	XIII
Donald W. Cameron	1911	XVI
Frank Carbis	1929	XXVII
James Clancey	1925	XXIV
A. B. Coates	1923	XXIII
Francis Harvey Cohoe	1929	XXVII
James B. Cooper	1914	XIX
Robert W. Creer	1929	XXVII
George P. Cummings	1911	XVI
Soloman S. Curry	1929	XXVII
J. D. Day	1908	XIII
Alton L. Dickerman	1929	XXVII
W. H. Dickinson	1908	XIII
John Duncan	1908	XIII
Murray Morris Duncan	1929	XXVII
Adelbert D. Edwards	1929	XXVII
Guy B. Edwards	1929	XXVII
P. M. Everett	1908	XIII
Austin Farrel	1926	XXV
Joseph Fay	1926	XXV
Henry Fisher	1926	XXVI
Richard C. Flannigan	1928	XXVI
John H. Forster	1908	XIII
Michael H. Godfrey	1928	XXVI
Martin Goldsworthy	1923	XXIII
Silas W. Goodale	1908	XIII
Alexander M. Gow	1922	XXII
John C. Greenway	1926	XXV
C. H. Hall	1910	XV
John Luther Harris	1929	XXVII

Samuel B. Harris	1929	XXVII
Charles T. Harvey	1913	XVIII
George Hayden	1908	XIII
W. H. Hearing	1908	XIII
Nathaniel Hibbert	1914	XIX
John H. Hickok	1929	XXVII
Thomas Hoatson	1929	XXVII
Douglas Houghton	1908	XIII
Jacob Houghton, Jr.	1910	XV
Edwin J. Hulbert	1913	XVIII
Nelson P. Hulst	1923	XXIII
J. D. Ireland	1922	XXII
Walter M. Jeffery	1908	XIII
Gilbert D. Johnson	1910	XV
William H. Johnston	1928	XXVI
John Tyler Jones	1928	XXVI
Alfred Owen Jopling	1929	XXVII
James Brooks Knight	1928	XXVI
Dr. George Koenig	1913	XVIII
E. Leslie Laing	1930	XXVIII
Charles D. Lawton	1909	XIV
W. B. Linsley	1914	XIX
J. M. Longyear	1922	XXII
Alfred Martin	1930	XXVIII
Amasa S. Mather	1923	XXIII
Dr. M. F. McCabe	1910	XV
John McEnroe	1913	XVIII
William A. McGonagle	1930	XXVIII
Fred Walter McNair	1926	XXV
Donald McVichie	1908	XIII
Frank D. Mead	1914	XIX
Alfred Meads	1914	XIX
Frank P. Mills	1923	XXIII
Frank P. Mills, Sr.	1910	XV
Anson B. Miner	1913	XVIII
Peter Mitchell	1925	XXIV
Sam Mitchell	1908	XIII
Elisha Morcom	1909	XIV
George A. Newett	1928	XXVI
Fred W. Nichols	1929	XXVII
Edmund Ninness	1909	XIV
A. Lanfear Norrie	1913	XVIII
Harlow Olcott	1908	XIII
Thomas Oliver	1911	XVI
William Alfred Paine	1930	XXVIII
Horace Bushnell Patton	1929	XXVII
Graham Pope	1913	XVIII
Louis W. Powell	1913	XVIII
Fred M. Prescott	1929	XXVII
W. A. Rankin	1929	XXVII
W. J. Richards	1922	XXII
Frederick William Ridley	1929	XXVII
Harry Roberts	1925	XXIV
Spencer S. Rumsey	1928	XXVI
Frank Scadden	1929	XXVII
William H. Selden	1930	XXVIII
Joseph Sellwood	1914	XIX
Amos Shephard	1908	XIII
W. P. Snyder	1923	XXIII
Frederick William Sperr	1930	XXVIII
John Stanton	1908	XIII
George A. St. Clair	1926	XXV
E. G. St. Clair	1922	XXII
J. N. St. Clair	1922	XXII
George C. Stone	1911	XVI
H. B. Sturtevant	1911	XVI
A. P. Swineford	1910	XV
J. H. Taylor	1914	XIX
William Thomas	1908	XIII
J. R. Thompson	1922	XXII
James H. Trebilcock	1908	XIII
William Trebilcock	1908	XIII
Gideon Trevarthen	1908	XIII
Paul H. Tweed	1930	XXVIII
William J. Uren	1926	XXV
J. H. Van Dyke	1922	XXII
James G. Vivian	1930	XXVIII
Johnson Vivian	1909	XIV
W. J. West	1922	XXIII
Lewis Y. Whitehead	1909	XIV
Peter White	1908	XIII
John Wicks	1909	XIV
James Wood	1914	XIX

(Index for 1930, Vol. XXVIII, page xvii)

GENERAL INDEX.

VOLUMES I TO XXVII (1893-1929)

(NOTE:—In addition to the Index by Volumes, which has been published in each number and which form is to be continued, there has been prepared a General Index which gives the title of each paper in italics and the name of the author in small capitals. This shows the volume, page and year.)

- ABBOTT, C. E.: *Iron Ore Deposits of the Ely Trough, Vermilion Range, Minnesota*, XII 116, 1906.
- ABEEL, GEORGE H.: *Iron and Steel Consumption*, X 27, 1904.
- Acetylene As An Underground Light* (SLAUGHTER), XIII 205, 1908.
- Accidents in the Transportation, Storage and Use of Explosives* (HURTER), XVI 177, 1911.
- Accident Prevention Through Standardization of Mining Operations* (MEYERS), XXVIII 148, 1930.
- Accident Prevention Work at the Copper Range Company Mines.* (MENDELSON), XXVII 219, 1929.
- Active Mining Companies in Lake Superior Copper District*, XVII 48, 1912.
- ADAMS, C. L.: *Copper Concentrating Practice at the Mohawk Mill*, XXVII 98, 1929.
- ADAMS, R. N.: *Amygdaloid Tailings*, XXVIII 192, 1930.
- Additional Pumping Data* (MILLS), III 63, 1895.
- A Description of the Electric Power System Supplying the Iron Mines of Minnesota* (RICE), XXVIII 127, 1930.
- ADGATE, FREDERICK W.: *Sinking Reinforced Concrete Shafts Through Quicksand*, XIV 55, 1909.
- Advance Planning of Mining Operations in Open Pit and Underground Iron Ore Mines* (YAUCH), XXVII 105, 1929.
- ALDRICH, H. R. AND BEAN, E. F.: *Recent Work of the State Geological Surveys in Huronian and Keweenaw Areas: (b) Wisconsin Geological Survey*, XXVII 173, 1929.
- ALLEN, R. C.: *Michigan Iron Ore Reserves; Methods of Appraisal for Taxation*, XIX 229, 1914.
- Amygdaloid Tailings* (ADAMS), XXVIII 192, 1930.
- A New Aid to Exploration in the Lake Superior District* (PEARL), XXVIII 85, 1930.
- Application of Mining Machines to Underground Mining on the Mesabi Range* (MARTIN-KAISER), XVIII 187, 1913.
- ARCHIBALD, R. S.: *Exploration for Iron Ore in Lake Superior District*, XXIV 280, 1925.
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- ARMSTRONG, RAY W.: *Compound Steam Hoist Installation of the Quincy Mining Company*, XXII 39, 1922.
- Athens System of Mining* (ELLIOTT), XXII 135, 1922.
- A Two-Ton Experimental Reverberatory Furnace at the Michigan College of Mining and Technology* (EDDY), XXVII 68, 1929.
- AUSTIN, L. S.: *Sampling of Iron Ores*, XIII 225, 1908.
- Automatic Throttle Closing Device for Hoisting Machinery* (RUMSEY), XIII 183, 1908.
- Balancing Bailers* (KELLY), VI 54, 1900.
- Balancing Rock Crushers* (HOOD), XVII 162, 1912.
- BARBER, G. S.: *New Stockpile Trestle, Colby Iron Mining Company, Bessemer, Michigan, Gogebic Range*, XX 65, 1915.
- BARRETT, L. P.: *Copper Production in Michigan by Years, to 1924*, XXIV 349, 1925.
- BARRETT, L. P.: *Michigan Iron Mining Industry*, XXIV 182, 1925.
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- BAXTER, C. H.: *Method of Mining at the Loretto Mine, Menominee Range*, XXI 29, 1917.
- BAXTER, C. H., ERICSON, RUDOLPH and RICHARDS, M. E.: *Mining Methods on the Menominee Iron Range*, XXI 8, 1917.
- BAXTER, J. C.: *The New Cascade Tunnel for the Great Northern Railway*, XXV 112, 1926.
- BAYLISS, WILLARD, McNEIL, E. D. and LUTES, J. S.: *Mining Methods on the Missabe Iron Range*, XVIII 133, 1913.
- BEAN, E. F. AND ALDRICH, H. R.: *Recent Work of the State Geological Surveys in Huronian and Keweenaw Areas: (b) Wisconsin Geological Survey*, XXVII 173, 1929.

- BELL, ARNOLD A.: *Federal Government Improvement of the St. Mary's River Canal—Michigan*, XXVIII 215, 1930.
- BENEDICT, C. H.: *Calumet & Hecla Reclamation Plant, Copper Range*, XXIV 68, 1925.
- Beneficiation of Iron Ores from the Blast-Furnace Viewpoint, With Discussion by T. T. Read (SWEETSER)*, XXVIII 74, 1930.
- BERTLING, JOHN F.: *Notes on Mining the North Palms Orebody*, XXV 52, 1926.
- BEST, BYRON G.: *The Gogebic Range Mines of the Oliver Iron Mining Company*, XXV 75, 1926.
- Biography—Index will be found in each Volume.*
- Birmingham District—Institute Trip, March, 1917 (HISTORICAL)*, XXI 280, 1917.
- Bisbee, Arizona, Copper Camp (NEWETT)*, X 127, 1904.
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- BJORK, DEWEY: *Safety Work at the Bristol Mine*, XXVI 110, 1928.
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- Block Caving and Sub-Stope System at the Tobin Mine, Menominee Range (ROBERTS)*, XVI 218, 1911.
- Block Testing of Drill Steel and Experiments With High Air Pressure (POTTER)*, XXVII 84, 1929.
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- BONNELL, E. S.: *Surface Equipment for Iron Mines*, XXIII 56, 1923.
- BOWEN, R. A.: *Method of Mining at the Montreal Mine*, XXV 146, 1926.
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- Brier Hill Concrete-Lined Shaft, Menominee Range (KELLY)*, XIV 140, 1909.
- Brief Description of the Distillation of Hardwood As Practiced by the Cleveland-Cliffs Iron Company, Marquette, Michigan (HUDSON)*, XXII 168, 1922.
- Brief History of the Cuyuna Range (VAN EVERA)*, XXIII 85, 1923.
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- BURR, FLOYD L.: *Method of Survey for Secondary Mine Openings*, XI 164, 1905.
- BURR, FLOYD L.: *Square Set Mining at the Vulcan Mines, Menominee Range*, XVI 144, 1911.
- BURR, FLOYD L.: *New Change House at Vulcan Mine, Menominee Range*, XVIII 211, 1913.
- BURR, FLOYD L.: *Crushing Plant at Brier Hill Shaft, Menominee Range*, XXI 125, 1917.
- BUTCHER, E. W. R.: *Development of Underground Ore Loading*, XXVI 279, 1928.
- BUTTERWORTH, ALLAN C.: *The Haulage System at the Volunteer Mine*, XXVII 142, 1929.
- Calumet & Hecla Reclamation Plant, Copper Range (BENEDICT)*, XXIV 68, 1925.
- Capillary Attraction in Diamond Drill Test Tubes (JOPLING)*, XIV 131, 1909.
- Card System for Mine Supply Accounts (DENTON)*, IX 114, 1903.
- Card System of Accounting for Mining Supplies (JEFFERY)*, XI 152, 1905.
- Cargo Sampling of Iron Ores Received at Lower Lake Ports—Including the Methods Used in the Analysis of the Same (RATTLE & SON)*, XI 173, 1905.
- CARNAHAN, A. L.: *Geological Notes of the Lake Superior Copper Formation, Copper District*, XVII 9, 1912.
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- Caving System of Mining in Lake Superior Iron Mines (CHANNING)*, XIX 245, 1914.
- Certain Advances in Geological Information Relative to the Lake Superior Iron Deposits (ROYCE)*, XXIV 149, 1925.
- CHABOT, JR., L. S.: *Field Blasting at the Volunteer Mine*, XXVII 259, 1929.
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- CHANNING, J. PARKE: *Curvature of Diamond Drill Holes*, II 23, 1894.
- CHANNING, J. PARKE: *Address of Retiring President*, III 34, 1895.
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- Charcoal Furnaces of Michigan (JOPLING)*, XXV 249, 1926.
- Charcoal Humor (CLANCEY)*, XXV 252, 1926.
- Charcoal Iron Industry of the Upper Peninsula of Michigan (MATHER)*, IX 63, 1903.
- CLANCEY, THOMAS: *Charcoal Humor*, XXV 252, 1926.
- Code of Mine Signals—The Cleveland-Cliffs Iron Company, Marquette Ranges (McCLURE)*, XIV 147, 1909.
- COLE, THOMAS F.: *Single Hoisting Plant*, IV 81, 1896.
- College View of Mining Graduate (McNAIR)*, VII 101, 1901.
- Color and Luster As a Basis for Concentration (SWEET)*, XXVI 42, 1928.
- Company Surgeon (LIBBY)*, XV 195, 1910.
- Comparative Tests of Bracing for Wooden Bents (KIDWELL)*, IV 34, 1896.
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