

HILL-TRUMBULL MINE  
ANNUAL REPORT  
YEAR 1939

19. WASHING PLANT  
OPERATIONS:  
(Continued)

The rock removed from the pit and placed on the dumps during 1939, together with the analysis, follows:

	<u>TONS</u>	<u>IRON</u>	<u>PHOS.</u>	<u>SILICA</u>
Hill, -----	3,305	33.48	.032	49.05
Trumbull, -----	1,548	14.38	.020	76.38
Total, -----	4,853	27.39	.028	57.77

During mining operations, 162 cubic yards of Trumbull waste ore was removed and placed on the waste dump. Four hundred cubic yards of Hill lean ore and 228 cubic yards of Trumbull lean ore were placed on the lean ore dump.

The weight recovery realized during the 1939 season was 57.75%, which compared with 63.64% in 1937. The Iron content in the crude ore was two and three-tenths higher in 1937.

The iron unit recovery for 1939 was 86.81%, against 91.18% in 1937, the higher grade crude ore treated in 1937 explaining this difference.

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11. ACCIDENTS  
AND  
PERSONAL  
INJURYa. Fatal Accidents

No employee of the Mining Department was accidentally killed while in the discharge of duty. A fatality did occur at the Canisteco Mine but Company officials disclaimed its responsibility. A pumpman, under the influence of liquor, attempted to reach a pump station in the bottom of the pit by climbing down a steep bank at midnight, after the hour he was due on the job. His body was found the next morning and it was apparent that he had stumbled in the darkness and was killed by falling.

Excepting 1932, when the mines were largely inactive, we have not been exempted from a fatality in a calendar year from 1898 to 1938, inclusive. From September, 1922, to December, 1923, a lapse of thirteen and a half months, there was no fatal accident; a record which came to an end when a miner sustained a fractured leg in a fall. This accident was first believed to be one that was not very serious but embolism brought death a week after it occurred.

It is necessary to report the accidental death of an employee of the Cliffs Power and Light Company, the circumstances of which were as follows:

Edwin Merrila was injured July 17 and died July 29. He was an electrician and at the time of the accident was working under the supervision of Arthur Olson, the Cliffs Power and Light Company's electrician in charge of the Negaunee District. Prior to 1926, he had worked for several utility companies and had qualified for electrical work by passing the State's examination.

When the accident occurred Merrila and two assistants were installing a fan ventube in the Maas Mine combination boiler and engine building for the purpose of providing air to cool the motor of the skip hoist. The fan was placed in the boiler room and the job of installing the 12-inch ventube from the fan to the hoist was started. One 50-foot length of the tubing had been hung and the men proceeded to erect another one. Merrila, who was sitting on a crane, had to lean forward in order to pass under a steel member of the roof, as his helpers pulled the crane ahead. He lost his balance and fell to the floor, a distance of 17 feet. The two helpers could offer no explanation for the accident.

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INJURYa. Fatal Accidents (Continued)

The investigating reports concluded that the accident would have been prevented if Merrila had used a safety belt. He was a single man, 31 years old. An inquest was not held.

b. Non-Fatal Accidents

In this report all accidents are divided into two groups, namely, slight accidents and compensable accidents. The slight accidents are the injuries which were treated by doctors but not those which caused men to lose more than six days working time. Of the 405 in this group, nine were lost-time accidents of one to six days each. Employees are continually being instructed to report all slight injuries to the doctors in order to prevent infection cases. The second group comprises the accidents which received compensation payments. There were 44 such accidents and a brief description of each one follows:

COMPENSABLE ACCIDENTS

<u>Mine</u>	<u>Occupation</u>	<u>Description</u>	<u>Days Lost</u>
<u>Athens Mine:</u>	Miner	1. Timber was being pulled in drift with scraper hoist. He stood too close to it & got squeezed as it passed him. Chest contusion.	26
	Miner	2. Bundle of lagging struck his leg. Contusion.	10
	Timberman	3. Landing timber at top of raise and his hand was pulled up against the block. Laceration of hand.	16
	Miner	4. Piece of timber fell out of side of drift, knocked down stage and miner fell with it. Knee ligament injury.	87

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11. ACCIDENTS  
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INJURYb. Non-Fatal Accidents (Continued)

<u>Mine</u>	<u>Occupation</u>	<u>Description</u>	<u>Days Lost</u>
	Shift Boss	5. Helping miners to lift heavy cap and got a finger caught between the cap and a leg. Loss of little finger at second distal joint.	90
	Timber Trammer	6. Picked up a 9½ foot pole & threw it on a pile of poles in the drift. Left inguinal hernia.	59
	Motorman	7. Turning around twisted his knee. Sprain, right knee.	23
	Miner	8. He and three men were lifting a cap. Felt pain. Hernia.	50
<u>Canisteco:</u>	Laborer	1. Slipped off shovel crawler and fell against the clutch lever. Fractured rib.	22
<u>Cliffs Shaft:</u>	Pocket man	1. Small piece of ore glanced off chute and struck his left eye. Ulcer of cornea.	50
	Helper in drill shop	2. Helping to put in crusher bowl and bruised a finger. Injury later became infected.	35
	Miner	3. A slab of ore fell from the back of a stope, struck the footwall and glanced off against his shoulder. Fractured right scapula.	101

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11. ACCIDENTS AND PERSONAL INJURY

b. Non-Fatal Accidents (Continued)

<u>Mine</u>	<u>Occupation</u>	<u>Description</u>	<u>Days Lost</u>
	Trammer	4. Loading cars at a chute and a chunk of ore rolled over the top of a car and struck his left foot. Fractured phalanx.	48
<u>Hill-Trumbull:</u>	Trackman	1. Cutting a switch point with a track chisel and a piece of steel struck his right eye. Loss of eye. (Actually lost 19 days)	600
	Switch-tender	2. Walking over ore bench in pit and stepped into a filled-in test pit. Contusion of knee.	17
	Car Repairer	3. Walking out from under a dump car and bumped his head on the drawbar. Slight concussion.	13
	Drill Helper	4. While lowering a drill rod over side of drill house an end of rod struck his foot. Fractured Metatarsal bone.	17
<u>Lloyd:</u>	Laborer	1. Slipped on a wet plank while walking to work on the 6th level plat. Strangulated hernia.	71
	Miner	2. Chunk of ore fell from side of working place and struck his ankle. Fractured tibia.	125
	Miner	3. A piece of timber fell from the covering in the timber gob and struck his ankle. Incomplete fracture of the malleolus of right foot.	120*

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11. ACCIDENTS  
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PERSONAL  
INJURYb. Non-Fatal Accidents (Continued)

<u>Mine</u>	<u>Occupation</u>	<u>Description</u>	<u>Days Lost</u>
<u>Maas Mine:</u>	Miner	1. While picking room to stand a leg ore fell out of the side and struck his right side. Three fractured ribs.	46
	Timberman	2. In the act of stepping out of the way of an approaching locomotive train he was caught and squeezed between the locomotive and timber. Contusion of chest.	29
	Laborer	3. Barrage ore out of chute and bruised hand, which became infected.	11
	Truck driver	4. Carrying plank and his foot broke through the snow, causing him to fall. Sprained knee.	11
	Motor Brakeman	5. While riding on a locomotive he turned his head to talk to the runner, at the same time swung his leg beyond the side of the locomotive. His leg was caught between a chute and the motor. Contusion of leg.	69
	Miner	6. Digging hitch for timber and a chunk of ore fell from the breast, knocking him down. Bruised chest.	17
	Miner	7. While drilling he slipped and strained his back muscles. Hernia.	45

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11. ACCIDENTS  
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INJURYb. Non-Fatal Accidents (Continued)

<u>Mine</u>	<u>Occupation</u>	<u>Description</u>	<u>Days Lost</u>
	Motorman	8. Stepped into locomotive pit and slipped. Hernia.	51
	Miner	9. Timber got caught under scraper, flew up and struck his jaw. Fracture	16
	Timberman	10. Handling wire rope and strand penetrated his glove. Infection.	23
	Timberman	11. Slipped off ladder and fell 30 feet. Sprained knee joint.	40
	Underground Laborer	12. Not known. Possibly a chunk of ore bounded after falling down raise. No evidence to indicate cause. Fractured tibia and fibula.	300*
	Miner	13. Ran wire in finger when tying rope. Infection	13
<u>Negaunee:</u>	Timber Hoister	1. Hoisting timber and hoist got loose and struck his leg. Fractured fibula.	25
	Miner	2. After blasting he and partner used two bars trying to take down a slab of rock. He then started to pick around the slab and it fell striking him a glancing blow.	8
	Chuteman	3. Ore hung up in chute. Came down suddenly, through the chute opening and partially covered him. Linear fracture of tibia.	153

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11. ACCIDENTS AND PERSONAL INJURY

b. Non-Fatal Accidents (Continued)

<u>Mine</u>	<u>Occupation</u>	<u>Description</u>	<u>Days Lost</u>
	Miner	4. Putting in forepoles and a chunk of ore rolled off the breast. He fell and the ore struck his ankle. Fracture.	114
	Miner	5. Making room for timber and ore fell from side of drift, striking his leg. Fracture.	88
	Timber Hoister	6. Caught in slack rope and pulled up 190 feet through timber slide in raise. Strained knee and thigh.	24
	Miner	7. Cleaning out hitch for timber and a chunk of ore, resting on ore pile, rolled over and fell on his leg. Fractured fibula.	156*
	Miner	8. A piece of bark was forced under his thumb nail while handling timber. Injury became infected.	24
	Miner	9. Scraper caught cribbing, swerved to one side and struck his foot. Fractured toe.	37
<u>Spies-Virgil:</u>	Miner	1. Breaking chunks over grizzly with machine. A chunk broke, the machine slipped forward and a sharp edge of the ore severed a finger. (Actually lost 36 days)	210



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INJURYb. Non-Fatal Accidents (Continued)

<u>Mine</u>	<u>Occupation</u>	<u>Description</u>	<u>Days Lost</u>
	Miner	2. Breaking chunks with machine. While drilling one another rolled down the pile and struck a finger. Fractured finger. (Actually lost 144 days)	270

\* Estimated time that will be lost

The extent to which the element of chance or luck enters the role of the events which establish accident records year after year gives rise to conflicting opinion. We know that each year's experiences are replete with instances of narrow escape from severe if not fatal accidents. In evaluating the effectiveness of safety precautions the fact should be kept in mind that when a large number of men work associated with extremely high hazards the journey from a favorable accident record to a poor one may be reached in a brief time by the occurrence of one or more accidents which cause serious injuries.

All the men who were injured have returned to work, excepting three and they were injured on November 30, December 4, and December 20. It should be noted that among the accidents were four hernia cases and five slight injuries which became infected.

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11. ACCIDENTS AND PERSONAL INJURY

b. Non-Fatal Accidents (Continued)

TABLE I

ACCIDENT CAUSES

Falls of chunks of ore or timber from the back or side at working headings. . . . .	9
Handling and transporting timber. . . . .	8
Falls of persons, including slipping and stumbling. . . . .	6
Slight injuries becoming infected . . . . .	5
Loading cars at chutes. . . . .	4
Haulage trains. . . . .	2
Scraper hoists shifting . . . . .	2
Flying or bounding objects. . . . .	2
Chunks falling down mill chutes . . . . .	2
Drilling machine. . . . .	1
Turning around and twisting ankle . . . . .	1
Bumping against an object . . . . .	1
Falling object other than ore or wood . . . . .	<u>1</u>
Total. . . . .	44

Not one of the hazards appearing in this classification of accident causes is unusual to mining. Falls of loose ore or rock is most prevalent of all hazards. Handling timber was responsible for eight accidents, seven of them occurred underground at the Athens Mine. Heavy crushing in this mine is the explanation. The Negaunee Mine suffered most by falls of loose ore. This Department has given to all superintendents, captains and bosses a resume of their records together with recommendations for improvement.

Tables II and III, which follow, give the accident frequency and severity rates for each of the past five years. The severity rates are at variance with past reports, particularly for the year 1937. Several accidents that year caused fractured leg or ankle bones which have failed to recover within the loss time that was estimated would be required before the injured men would return to work. In the cases of two such accidents at

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the Lloyd Mine it has been necessary to raise the time that probably will be lost from 392 to 2,700 days. A charge of 1800 days has been thought justified in the case of oneman, whose physical condition warrants the conclusion that his full recovery will not develop.

The severity rate for the past year is one worth the efforts that have been spent in accident prevention work. It is hoped that it will not be a record that will stand in future years as a single exception.

TABLE II

FREQUENCY RATES\*All Compensable Accidents

<u>Year</u>	<u>Total Man Days Worked</u>	<u>Number Compensable Accidents</u>		<u>Frequency Rate</u>
		<u>Non-Fatal</u>	<u>Fatal</u>	
1935	393,967	35	2	.094
1936	567,891	33	2	.062
1937	765,701	58	1	.077
1938	491,303	46	3	.099
1939	564,542**	44	0	.078

\* Based on number of accidents per 1000 man days worked.

\*\* Estimated.

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TABLE III

SEVERITY RATES\*All Compensable Accidents

Year	<u>Non-Fatal</u>		<u>Fatal</u>		Rate
	<u>Days Lost</u>	<u>Rate</u>	<u>Days Lost</u>	<u>Total</u>	
1935	3,225	7.93	3,600	6,825	17.70
1936	3,509	6.16	3,600	7,109	12.67
1937	7,881	10.29	1,800	9,681	12.64
1938	6,290	12.80	5,400	11,690	23.66
1939	3,352	5.93	1,800**	5,152	9.13

\* Based on days lost per 1,000 days worked.

\*\* C. P. &amp; L. Company fatality.

TABLE IV

CAUSES OF SLIGHT INJURIES

Using tools and machinery. . . . .	94
Handling material. . . . .	72
Fly <sup>ing</sup> particles or objects . . . . .	61
Falls of persons (including slipping & stumbling). . . . .	51
Falls of ground (mostly chunks). . . . .	46
Handling wire rope . . . . .	14
Loading at chute . . . . .	12
Bumping against objects. . . . .	10
Chunks of ore or rock rolling down pile. . . . .	9
Stepping on nail . . . . .	7
Dumping cars at shaft station. . . . .	4
Miscellaneous . . . . .	<u>25</u>

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INJURYb. Non-Fatal Accidents (Continued)

TABLE V

NUMBER OF ACCIDENTS

<u>Mine or Plant</u>	<u>Slight Accidents</u>	<u>Compensable Accidents</u>
Athens	60	8
Canisteco	13	1
Cliffs Shaft	55	4
C. P. & L. Co.	11	0
Hill-Trumbull	37	4
Holman-Cliffs	2	0
Lloyd	66	3
Maas	69	13
Negaunee	62	9
Spies-Virgil	4	2
Shops & Storehouse	15	0
Tilden	1	0
Miscellaneous	<u>10</u>	<u>0</u>
	405	44

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TABLE VI

Classification of Fatal Accidents 1911 to 1939, inclusive  
by the Central Safety Committee

I	Trade Risks. . . . .	109
II	Negligence of the Company:	
	Violation of Rules . . . . .	4
	Failure to Provide Safety Devices. . . . .	5
	Improper Method of Doing Work. . . . .	10
	Failure to Provide Tools or Safe Place to Work . . . . .	4
	Failure to Instruct Men. . . . .	<u>4</u>
		27
III	Negligence of Workmen:	
A	Injured Men:	
	Improper Method of Work. . . . .	18
	Violation of Rules . . . . .	8
	Failure to Use Tools or Appliances Provided. . . . .	4
	Failure to Use Safety Devices. . . . .	<u>3</u>
		33
B	Other Workmen:	
	Improper Method of Doing Work. . . . .	14
	Violation of Rules . . . . .	4
	Failure to Use Tools or Appliances Provided. . . . .	<u>1</u>
		<u>19</u>
	Total. . . . .	188

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TABLE VII

Classification of Causes of Fatal Accidents  
From December 1, 1898 to December 31, 1939

A	Fall of Ground. . . . .	.97	
	Run of Mud or Sand. . . . .	.60	
	Fall of Chunk of Ore from Chute . . . . .	.2	
	Stray Chunk or Stick down Raise or Stope. . . . .	<u>.3</u>	162
B	<u>Shaft Accidents:</u>		
	Falling down Shaft. . . . .	.14	
	Rock or Timber Falling down Shaft . . . . .	.2	
	Struck or Caught by Cage, Skip, Bucket, Tool. . . . .	.8	
	Falling from Cage, Skip, or Bucket. . . . .	.11	
	Falling from Ladder in Shaft. . . . .	.5	
	Carried or Pushed into Shaft by Car . . . . .	.3	
	Jumping on or Off Cage, Skip, or Bucket . . . . .	.3	
	Struck by Crosshead. . . . .	<u>.5</u>	51
C	<u>Use of Explosives:</u>		
	Explosion of Powder . . . . .	.16	
	Premature Blast . . . . .	.3	
	Fall of Ground or Timber Due to a Blast . . . . .	.4	
	Overcome by Gas . . . . .	.3	
	Miscellaneous Causes. . . . .	<u>.1</u>	27
D	<u>Mine and Railroad Cars:</u>		
	Caught by Haulage Cars. . . . .	.13	
	Riding or Attempting to Ride Cars . . . . .	.6	
	Falling with Car from Trestle . . . . .	.4	
	Run over by Railroad Car. . . . .	.7	
	Miscellaneous Causes. . . . .	<u>.1</u>	31
E	<u>Miscellaneous Causes:</u>		
	Falling in Raise, Stope or Pocket . . . . .	.8	
	Contact with Electric Wire. . . . .	.9	
	Falling from Ladder, Stage, Trestle, etc. . . . .	.8	
	By Moving Machinery . . . . .	.5	
	Mine Fires . . . . .	.3	
	Stockpile Slide . . . . .	.2	
	Miscellaneous Causes. . . . .	<u>.3</u>	38
	Total . . . . .		309

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TABLE VIII

Classification of All Compensable Accidents 1939  
By the Central Safety Committee

I	Trade Risk (Incidental and Non-preventable). . . . .	16	16
II	<u>Negligence of Company:</u>		
	1. Failure to Use Safety Devices Provided. . . . .	0	
	2. Failure to Use Proper Tools or Appliances Provided. . . . .	2	
	3. Violation of Rules. . . . .	0	
	4. Improper Act or Selection of Improper . . . . . Method of Doing Work (By Foreman). . . . .	0	
	5. Failure to Instruct Men as to Method of Doing Work and Hazards Incident Thereto. . . . .	0	
	6. Failure to Provide Safety Devices. . . . .	0	
	7. Failure to Provide Proper Tools, Appliances or Place of Work . . . . .	0	2
III	<u>Negligence of Workmen:</u>		
A	1. Failed to Use Safety Device Provided . . . . .	0	
	2. Failed to Use Proper Appliances or Tools Provided. . . . .	2	
	3. Violation of Rules . . . . .	0	
	4. Improper Act or Selection of Improper. Method of Doing Work . . . . .	23	25
B	<u>Other Workmen:</u>		
	1. Failed to Use Safety Devices Provided. . . . .	0	
	2. Failed to Use Proper Appliances or Tools Provided. . . . .	0	
	3. Violation of Rules . . . . .	0	
	4. Improper Act or Selection of Improper. Method of Doing Work . . . . .	2	2
	Total. . . . .		45



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c. Safety Inspection

The personnel of the Safety Department consisted of four men, namely, T. W. Hill, H. F. Rogers, G. R. Whittington, and the writer.

Mr. Whittington has worked the past two years for Mr. Barber, in the capacity of safety inspector at our Minnesota mines.

Mr. Hill has been with us since 1934 and has been occupied the entire time collecting air samples and counting dust particles.

Mr. Rogers was assigned to this department last January and was given the title of safety inspector. He has been employed by the Company since December, 1912, and has been succeedingly a locomotive runner, miner, shift boss, mining captain and instructor of the last school for the training of prospective bosses in methods of mining. His present position was made with the expectation that more frequent inspections of the mines would be of more value in our accident prevention work than the distribution of cash awards. In addition to inspection work, Mr. Rogers has charge of the oxygen-breathing apparatus; trains workers in fire-fighting methods; distributes first aid supplies; keeps bulletin boards posted and assists in the testing of fire extinguishers.

Frequent inspection of the mines and plants is of paramount importance from a safety viewpoint. A rigid and impartial enforcement of all the safety standards that are embodied in our rule books covers a large field. A mine is unlike a factory or shop. It is a scene where rapid changes in working conditions prevail. Mining is largely work that calls for vigorous muscular effort. Heavy ground movements in the soft ore mines, increasing usage of machines, blasting, handling hundreds of heavy pieces of timber daily, ore trains and skips and cages in rapid transit--all these and other operations that could be enumerated--are not in harmony with individual self-preservation from accidental injury. It is true that the superintendents, captains and bosses are all concerned in efforts to stop accidents but their main objective is a good hoist of ore every operating day. Frequent safety inspections by other men are reminders that enhance the importance of not neglecting safety even at the expense of production.

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INJURYc. Safety Inspection (Continued)

The writer gives close study and attention to the application of a rigid enforcement of our operating standards. This is a part of the work of this department that is of much importance, for in former years a very heavy annual toll in loss of life and severe injuries was due to a few major causes. The proof of this statement is found in citing the comparative record of our soft ore mines for the eight-year period prior to 1911 with the record for the past eight years. During the first period, we lost 70 men by four causes, namely, falls of ground, shaft accidents, explosive and haulage; whereas only one fatality during the past eight years was caused by a fall of ground and none was due to the other three causes. There were fewer men employed during the second period but it produced more ore which came out of mines of greater depths.

Mr. Rogers has rendered valuable service in assisting the bosses, whom he accompanies when inspecting. The writer in recent years has spent most of his time when on inspection duty going through the mines with the captains. There is a disposition to feel that his responsibility to the Manager should not be the reporting of conditions which they are most anxious themselves to correct. Every day the captains and bosses encounter many unsafe working conditions and give instructions for correcting the same. This is to be expected in the course of changing events to which attention has already been cited. The bosses, having less experience and authority than the captains, do not attain an equal efficiency in the application of our mining standards and the enforcement of discipline, and hence it is possible to find more to report when making an inspection in their company than with a captain. Furthermore, inspections made alone, which are taken as spying on the men, are not desirable as they do not promote the state of good feeling which should be maintained between an employer and his employees.

The following tables show the number of failures to maintain standards and the number of safety suggestions and recommendations which were submitted during the year by Mr. Rogers. His reports in duplicate are sent promptly to the superintendents who attach their comments to a copy of each, which goes to the Manager.

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INJURYc. Safety Inspection (Continued)

TABLE IX

<u>Mine or Plant</u>	<u>Violation of Standards</u>	<u>Safety Suggestions</u>	<u>Recommendations</u>	<u>Total</u>
Athens Mine	42	13	6	61
Cliffs Shaft Mine	33	21	14	68
Lloyd Mine	33	21	3	57
Maas Mine	113	25	18	156
Negaunee Mine	84	30	12	126
Spies-Virgil Mine	15	9	3	27
Tilden Mine	2	3	5	10
Miscellaneous	<u>2</u>	<u>9</u>	<u>5</u>	<u>16</u>
Totals	324	131	66	521

The writer spent three days in September inspecting our Minnesota mines, at the same time instructing Mr. Whittington, which was covered in a report to the Manager, who sent a copy to Mr. Barber. Mr. Whittington submitted 135 safety suggestions and recommendations during the year, as a result of 250 inspecting tours of the pits, shops and washing plants. He took charge of all fire extinguishers and their inspections; distributed first aid supplies; posted safety posters and distributed literature; repaired damaged goggles; and checked all tools. He attended twelve safety conferences, which were sponsored by various agencies, and was secretary of the Cliffs Club, which met eight times and which was the means of fostering a friendly attitude on the part of the members toward the Company. He is secretary of the District Safety Committee which started to function late in the year.

Our abandoned properties were inspected during the summer months and needed repairs to fences were made. This work required many new fences at the Republic and North Jackson open pits but elsewhere it was limited to fixing breaks which continue to occur each year due to various causes. The cost of work of this kind should be considerably less during the next few years than it has been in recent years.

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INJURYc. Safety Inspection (Continued)Various Inspection Reports

During the year a total of 2735 reports on inspection of equipment was received at this office, where they were reviewed and filed. To each superintendent is sent monthly a statement showing the number of these reports which have been made at his mines, a list of first aid supplies, a classification of the slight accidents and his dust counts. His attention is called to the failures that may have occurred in complying with our rules and regulations relative to these subjects. The men who are responsible for the maintenance in safe condition of hoists, cages, and skips and cage roads are to be commended for service faithfully rendered.

The number and variety of these reports are shown in the following table:

TABLE X

Hoisting Ropes. . . . .	Daily Report. . . . .	1505
Skip Roads. . . . .	Weekly Report . . . . .	321
Ladder Roads. . . . .	" " . . . . .	318
Skip and Cage Hoists. . . . .	Monthly Report. . . . .	133
Cage Safety Catches . . . . .	" " . . . . .	86
Slack Rope Alarm. . . . .	" " . . . . .	67
Underground Fire Doors. . . . .	" " . . . . .	23
Mine Rescue Apparatus . . . . .	" " . . . . .	24
Fire Extinguishers. . . . .	Semi-Annual Report. . . . .	31
Fire Hose . . . . .	" " . . . . .	26
Fire Prevention . . . . .	Annual Report . . . . .	<u>201</u>
Total . . . . .		2735

The number of individual inspections that was made of fire extinguishers appears in Table XI.

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INJURYc. Safety Inspection (Continued)Various Inspection Reports (Continued)

TABLE XI

Number of Fire Extinguisher Inspections

<u>Mine or Plant</u>	<u>Carbon Tetrachloride</u>	<u>Other Types</u>
Athens Mine	30	5
Canisteco	38	2
Cliffs Shaft	54	9
Central Office	13	6
Gardner-Mackinaw	36	5
Gwinn District	14	6
Hill Trumbull	34	0
Holman	42	0
Hibbing Office	2	2
Ishpeming Hospital	20	9
Ishpeming Residences	29	0
Lloyd	29	5
Maas	46	10
Negaunee	36	10
Negaunee Hospital	2	2
North Lake Residences	18	2
Spies-Virgil	47	4
Spies Location	34	0
Shops, Storehouse & C.P.&L. Co.	41	25
Tilden	46	1
	<u>611</u>	<u>103</u>

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11. ACCIDENTS  
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INJURYc. Safety Inspection (Continued)Bonus for Foremen

The safety cash awards given to foremen and bosses each quarter of the year amounted to \$3,413.50. There were 65 men who participated in the distribution of this sum of money. The individual bonuses ranged from \$5.00 to \$33.38 per quarter and the average per man for the year was \$52.51. A total of 103 penalties was applied which represented a reduction of \$219.93 in bonus payments. The two following tables give the distribution of the money paid and number and occupations of the men who received it.

TABLE XII

Safety Bonuses Paid to Foremen

<u>Mine or Plant</u>	<u>Amount</u>	<u>Men Participating</u>
Athens Mine	\$ 626.44	11
Cliffs Shaft Mine	728.66	13
Lloyd Mine	426.29	8
Maas Mine	710.43	12
Negaunee Mine	613.53	11
Spies-Virgil Mine	97.89	3
General Storehouse	106.77	3
C. P. & L. Company	<u>103.29</u>	<u>4</u>
Total	\$ 3,413.30	65

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INJURYc. Safety Inspection (Continued)Bonus for Foremen (Continued)

TABLE XIII

Occupations of Men Participating in Bonus

Title	Cliffs					S.V.	Gen. Sthse.	C.P.&L. Co.
	Athens	Shaft	Lloyd	Maas	Neg.			
Shift Boss	7	7	4	8	6	2	-	-
Electrician	1	1	1	1	1	1	1	3
Mechanic	1	1	1	1	1	-	2	1
Timber Foreman	1	1	1	1	2*	-	-	-
Surface Foreman	1	1	1	1	1	-	-	-
Track Boss	-	1	-	-	-	-	-	-
Scraper Foreman	-	1	-	-	-	-	-	-
Totals	11	13	8	12	11	3	3	4

\* One substitute timber foreman.

Rules and Regulations

"Underground Safety Rules for Captains, Foremen and Bosses" is the title of a new rule book which was printed in June. They were compiled by this department with the assistance of the superintendents. This book has 27 main subjects which cover 228 rules, each of which is a positive safety precaution. No change in a rule or no new rule<sup>is</sup> printed before being approved by the Manager.

"The Rules for Operating Hoisting Engines" were revised and a new issue printed. All men who work in the hoisting plants were given copies.

The writer assisted Mr. J. D. Preston in formulating a set of safety rules and regulations for the Cliffs Power and Light Company, which will be available in 1940.

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INJURYc. Safety Inspection (Continued)Rules and Regulations (Continued)

Mr. Barber and his assistants drew up a code of twelve rules for open pit trucking. These men have started to revise the present rules for open pits, shops and washing plants.

TABLE XIV

Rule Books Distributed

<u>Mine or Plant</u>	<u>Foremen</u>	<u>Haulage</u>	<u>Hoists</u>
Athens	8	1	8
Cliffs Shaft	12	7	9
Lloyd	6	7	6
Maas	14	4	9
Negaunee	11	7	8
Spies-Virgil	4	2	2
Miscellaneous	<u>8</u>	<u>-</u>	<u>-</u>
Totals	63	28	42

Discipline

When an employee is laid-off because of a failure to comply with a rule or other cause it must be recorded by a written report sent to the Manager, which gives the explanation for such action. The name of the foreman who applied the lay-off and that of the superintendent signifying his approval must appear on each report. This department interviews the mining captains to confirm that the right procedure has been taken. It is important in these days of difficult labor disputes to be positive that all disciplinary action is fully justified and will not react to our disadvantage in dealing with our employees. A summary of the causes which prompted the need for dealing in this manner with workmen is given in the following table.



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c. Safety Inspection (Continued)

Discipline (Continued)

TABLE XV

<u>Causes</u>	<u>Number of Lay-offs</u>
Failure to wear goggles. . . . .	.10
Reporting to work under the influence of liquor. . . . .	9
Willfully mixing rock with ore . . . . .	4
Failure to wear respirators. . . . .	3
Not obeying orders . . . . .	3
Failure to conform to explosive standards. . . . .	2
Failures to conform to other standards . . . . .	<u>5</u>
Total . . . . .	.36

Central Safety Committee

This committee met four times. The mining captains and surface foremen now attend the meetings. Minutes of the proceedings are sent to those entitled to receive them.

Safety Conferences

The entire supervisory force of our Michigan mines, including the mine clerks, met in conference on February 18. There were 112 men present. The Manager stressed the importance of every man doing his utmost to prevent accidents and eliminate waste. The writer reviewed past accident records of the various mines and outlined the safety activities that should be given more attention in order to improve those records.

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INJURYc. Safety Inspection (Continued)Safety Conferences (Continued)

The superintendents held a number of conferences with their bosses but they were short affairs which did not infringe upon the men's time for fear they would conflict with the Federal Labor Act. For the same reason inter-mine conferences were discontinued. Late in the year a ruling was made that conferences of foremen under certain conditions were permissible, and immediately steps were taken to resume general meetings of all the foremen.

An organization of foremen for the promotion of safety was perfected at our Minnesota mines. Mr. Barber acts as chairman of the conferences which were started late in the year. All accidents are reviewed and the recommendations of G. R. Whittington are discussed. A new set of safety rules for the different operations in and about open pit mining are being drawn up. Reports of these conferences are forwarded to the Manager.

Lake Superior Safety Chapter of the National Safety Council

A few members of this Chapter, mostly men of the mining companies in charge of safety organizations, meet in conference quarterly each year for the exchange of safety information. Our Company was host to this conference in March. Arrangements had been made to take many of the delegates underground in the Cliffs Shaft Mine but the worse snow storm of the year appeared at that time and as a consequence all mines were idle and the inspection visit had to be abandoned.

The Annual Conference of this Chapter was held at Duluth on June 22 and 23, with more than 400 men in attendance. Messrs. Gries, Rogers, and the writer represented our local mines but there was a larger representation from our Minnesota mines due to the conference being held at Duluth. Mr. Gries was toastmaster at the banquet and made a very favorable impression. It was an opportunity for him to add many men to his already large number of acquaintances. The writer was assigned the task of writing a paper on the safety activities of our Company, which was read at the conference.

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INJURYc. Safety Inspection (Continued)National Safety Council

Membership in the National Safety Council was renewed. Almost all large mining companies keep their membership in the Council not only for the service it renders but also because of a willingness to aid in promoting safety as a national asset. We received an ample supply of safety posters to supply our bulletin boards with weekly placards. We gave copies of the Safety News, a monthly magazine, to the public schools at Ishpeming and Negaunee, in addition to supplying the Company's officials.

Safety Devices

A progressive step was taken by providing all workmen with safety lens goggles, for they will prove effective in the elimination of costly eye injuries. Almost two dozen pairs, having shattered or cracked lenses, are being attached to a glass cover board, which will be rotated from mine to mine to illustrate the importance of wearing goggles. This department repairs the goggles that can be put in good condition by the replacement of damaged parts.

Hard hats were inspected and those found in defective condition were discarded. Safety belts were checked and those that were not safe to use were brought to the attention of the captains or superintendents. Rubber gloves have not proven a solution for stopping minor injuries in the handling of wire ropes with broken strands, which develop in scraper hoist ropes. Injuries of this nature are infection possibilities.

Safety Flags

All mines floated a Safety Flag under the Stars and Stripes, which had to be lowered for one week immediately after a compensable accident occurred. In 1940, the Tilden Mine, General Storehouse and Shops, and the Cliffs Shaft Mine will fly a Banner Safety Flag. The Tilden Mine brought its perfect record to a duration of more than three years, and the Storehouse and Shops to almost three years. The Cliffs Shaft Mine won this flag for the best underground record for the year, but this award is not granted unless the record has been a favorable one.

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INJURYc. Safety Inspection (Continued)Miners' Safety Bulletin

This Bulletin was distributed to all employees once every two months of the year.

d. Ventilation

The following objectives control our ventilation investigations:

1. Measuring the volume of air that enters a mine and following its course throughout the openings. An annual survey is made to show the air distribution and the amount available on various levels and sub-levels. It indicates where air restrictions should be reduced or eliminated.
2. Air samples are collected regularly at all headings where men are engaged in rock work, for the purpose of preventing atmospheres becoming charged with silica particles beyond a safe limit.
3. Air samples are collected wherever there is work that is apt to be productive of abnormal dust conditions, such as loading and unloading underground haulage cars, crushing ore, etc.
4. Keeping informed relative to the enforcement of our dust preventive standards and also our dust protective standards.
5. Once each year recording the dust conditions that prevail through a cycle of 24 hours for separate jobs, such as drifting, stopping, raising, etc.
6. Keeping superintendents advised of the data being collected and offering suggestions and recommendations relative to dust control work.

The apparatus we have used since starting these investigations is heavy, and cumbersome to carry, especially in raises. A new

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INJURYd. Ventilation (Continued)

machine, called the "midget" impinger was purchased late in the year. It is contained in a strong carrying case and weighs less than ten pounds, complete with nine sampling tubes.

We have been counting dust particles through telescopic slides, which is a slow, tedious process. There is now available a microprojector which was designed for more rapid counting of dust samples. Instead of counting a field of particles through the eyepiece of a microscope, the field image is projected upon a screen. This field makes it possible not only to count samples more rapidly and with less eye strain but it is also easier to distinguish dust particles from pits, bubbles, etc., in the glass. We expect to receive a microprojector within a short time, and then we shall be able to carry on a more comprehensive survey in our investigation of the ventilation conditions within our mines.

TABLE XVI

Number of Air Analyses

<u>Mine or Plant</u>	<u>Number of Light Field Counts</u>	<u>Number of Dark Field Counts</u>	<u>Totals</u>
Athens	63	63	126
Cliffs Shaft	119	119	238
Lloyd	41	41	82
Maas	26	26	52
Negaunee	86	86	172
Spies-Virgil	2	2	4
Tilden	<u>4</u>	<u>4</u>	<u>8</u>
Totals	341	341	682

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e. First Aid and Mine Rescue Work

As we had a considerable number of men trained in first aid work in 1938, it was not necessary to continue training in 1939. We would not have been able to do work of this nature unless we paid the men for their time, which would have been a departure from past custom. In the future, we must depend upon the Bureau of Mines to sponsor this training, if it is given during hours employees receive no wages.

The new oxygen apparatus is proving satisfactory. It has been kept in perfect condition and crews have trained to wear them at frequent intervals throughout the year.

TABLE XVII

First Aid Supplies Distributed

<u>Material</u>	<u>Number Distributed</u>
Mercurochrome Pads . . . . .	10,084
Ounces of Methiolate . . . . .	154
One-inch Roller Bandage . . . . .	516
Three-inch Roller Bandage . . . . .	307
Rolls of Adhesive Tape . . . . .	58
Pads of Picric Acid Gauze . . . . .	190
Pads of Plain Gauze . . . . .	415
Leather Finger Cots . . . . .	245
Antiseptic Applicators . . . . .	708
Tubes of Unguentine . . . . .	18
Ounces of Aromatic Spirits of Ammonia . . . . .	30
Pairs of Scissors . . . . .	5
Ounces of Absorbent Cotton . . . . .	76
Total items . . . . .	12,806

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TABLE XVIII

Mine Rescue Training During 1939

<u>Mine</u>	<u>Number of Men</u>	<u>Training Periods</u>
Maas	27)	
Negaunee	30) Negaunee District	17
Athens	25)	
Cliffs Shaft	40) Ishpeming & North	
Lloyd Mine	<u>33)</u> Lake Districts	<u>16</u>
Totals	155	33

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INJURYf. Department Expenses

Salaries. . . . .	\$7,185.00
Auto Expense. . . . .	406.47
Heat, Light and Power . . . . .	4.66
Insurance . . . . .	5.07
Postage . . . . .	10.74
Repairs . . . . .	99.87
Stationery and Printing . . . . .	.140.25
Supplies. . . . .	.152.53
Travel and Entertainment. . . . .	.345.17
Telephone and Telegraph . . . . .	45.78
Personal Injury Expense . . . . .	.143.70
Unemployment Insurance Tax. . . . .	.216.50
General - Unclassified. . . . .	.322.00
Old Age Benefit Funds . . . . .	64.87
Depreciation. . . . .	<u>.199.84</u>
Total. . . . .	\$9,342.45

Respectfully submitted,



Assistant Superintendent



22. REPORT OF THE GEOLOGIST FOR THE YEAR ENDING DECEMBER 31, 1939

A. STAFF

The staff of the Geological Department for the year 1939 is shown in Table I below. The personnel has remained unchanged throughout the year.

TABLE I

Name	Occupation	Hours Lost		Hours Overtime	Net % Hours Worked
		Sickness	Absence		
E. L. Derby, Jr.	Chief Geologist	-	219 3/4	72 3/4	92.6
Stanley W. Sundeen	Asst. Geologist	38 1/2	55	-	95.3
Gustav Afuhs	Draftsman	244 1/2	5 1/4	-	87.4
E. A. Allen	Assistant	-	65	-	96.7

The year was divided into the factors shown in Table II, below:-

TABLE II

Total Working Days	274 1/2 days (1983-3/4 hours)
Sundays	53 "
Full days resulting from Saturday afternoons	26 "
Holidays	11 1/2 "
Total	365 days.

Table III, below, shows the average number of men regularly employed on a full time basis on the staff of the Geological Department during the past five years.

TABLE III

Year	Average Number of Men
1935	1.0
1936	2.4
1937	4.0
1938	4.0
1939	4.0

**B. GENERAL DESCRIPTION OF THE WORK OF THE DEPARTMENT**

The work of the Geological Department was divided between the various mines, explorations, and miscellaneous items shown in Table IV, below:-

**TABLE IV**

<u>ITEMS</u>	<u>HOURS WORKED</u>	<u>PERCENT</u>
<u>MINES</u>		
Athens.....	110 3/4	1.5
Canisteco.....	98 1/2	1.3
Cliffs-Shaft.....	2609 3/4	35.4
Hill-Trumbull.....	403 1/2	5.5
Holman-Cliffs.....	47 1/4	0.7
Jackson Lease.....	14 1/4	0.2
Lloyd.....	120 3/4	1.6
Maas.....	341	4.6
Morris.....	31 3/4	0.4
Negaunee.....	360	4.9
Tilden.....	61	0.8
Virgil.....	111 3/4	1.5
Total Mines.....	4310 1/4	58.4
<u>EXPLORATIONS</u>		
Cliffs-Shaft Mine.....	327 3/4	4.4
Maas Mine.....	5 1/2	0.1
Negaunee Mine.....	95 1/4	1.3
Negaunee, Section 32, 48-26.....	7 1/2	0.1
Section 2, 47-27.....	969	13.1
Total Explorations.....	1405	19.0
<u>MISCELLANEOUS</u>		
Annual Report.....	47 1/2	0.7
Beneficiation of Iron Ores (General).....	26 3/4	0.4
Depletion Estimates.....	17 1/2	0.3
Engineering Department.....	186 1/2	2.5
Geological Surveys on Company's Mineral Estate.....	280 1/2	3.8
Gold Leases on Company's Mineral Estate...	2	-
Helen Mine Examination.....	46 3/4	0.6
Investigating Mineral Land Offers.....	199	2.7
Investigating Outside Explorations.....	105 1/4	1.4
Lake Superior District Reserve Estimate...	50 3/4	0.7
Michigan Mineral Land Company.....	3	-
Mineville Properties Report.....	25	0.4
Miscellaneous Geological.....	472 3/4	6.4
Refunding Plan.....	150 1/4	2.0
Tax Commission Estimates.....	51	0.7
Total Miscellaneous.....	1664 1/2	22.6
<b>GRAND TOTAL.....</b>	<b>7379 3/4</b>	<b>100.0%</b>

B-1. DESCRIPTION OF WORK BY THE STAFF MEMBERS

E. L. DERBY, JR. Approximately forty-six percent of my time during the year was spent in connection with the geological work at the Company's active mines. Ten percent of my time was spent in planning and supervising diamond drill explorations in the Cliffs-Shaft, Maas and Negaunee Mines, and on the Negaunee Mine surface and the Section 2, Golf Club area, Exploration. The balance of my time, or about 44%, was taken up with the routine work of the office and the numerous miscellaneous duties peculiar to the Geological Department. The geological surveys and explorations are treated separately and in more or less detail later in this report. My activities, in addition to the strictly routine work of the office, may be summarized as follows:

In January, about two-thirds of my time was spent on the Company's refunding program for the New Mortgage. In this connection I made two trips to Madison and worked with Dr. C. K. Leith in the preparation of his certificate covering all of the Company's Mineral Estate on the several iron ranges of Michigan. I also spent a week at the Cleveland office assisting in the preparation of land descriptions covering the Mineral Estate included in the Mortgage. I made one trip to the Mesaba Range in connection with a joint estimate with Mr. Barber of the expected increase in cost of producing Hill-Trumbull concentrates by retreating the leaner ore in this property and spent one day in St. Paul and Minneapolis consulting with Mr. Holt, Chief Engineer of Butler Brothers, and Mr. Wade, Chief Metallurgist at the Mines Experiment Station, preparatory to tests made later on crushed Cliffs-Shaft ore, using both jigs and heavy density methods.

In February, I joined with Messrs. Jackson and Brewer in the annual conference with Messrs. Pardee and Eddy, Engineers representing the Tax Commission, going over the engineer's estimates of the reserves in our active mines for an appraisal by the Tax Commission. The Superintendent and Engineer of each particular property were present as this property was discussed. I spent two days at the Mines Experiment Station, Minneapolis, during preliminary tests on crushed Cliffs-Shaft ore.

In March, I made a trip of inspection to the Helen Mine of the Algoma Steel Corporation in the Michipicoten District, and was accompanied by Messrs. Elliott and C. W. Allen of our Company and Messrs. Rahilly and Greensted of the Algoma Steel Corporation. I witnessed the first of two planned jig tests on Cliffs-Shaft crushed ore at the Mines Experiment Station, Minneapolis.

In April, I joined with Mr. Archibald in the usual annual report on the mineral estate of the Michigan Mineral Land Company, which is submitted each year to Mr. Bush. I accompanied Messrs. Geffine, Kirkwood and Jackson to Lansing where we had the annual conference with Mr. Pardee, State Appraiser of Mines, in connection with the appraised values and estimated ore reserves of the Company's active mines.

In May, I made two trips to the Mesaba Range. Mr. Barber and I had a conference with Messrs. E. C. Congdon and Garver in Duluth on Canisteo Mine matters. While on one of these trips I also witnessed the final jig test on Cliffs-Shaft crushed ore at the Mines Experiment Station,

Minneapolis. On the other trip to the Range, Mr. Barber and I visited the explorations for iron ore being conducted by Canadian interests at Steep Rock Lake, which is located about  $3\frac{1}{2}$  miles North of the village of Atikokan, Ontario. This examination was covered by a special report on the subject. I also attended the public hearing on Occupational Taxes at the Capitol in St. Paul in company with Messrs. Geffine, Barber and Donovan.

In June, I went to the Mines Experiment Station in Minneapolis for a conference with Mr. E. W. Davis, Director of the Station, relative to the Mesabi Iron Company's low grade magnetic taconite deposit at Babbitt, Minnesota, at the extreme Eastern end of the Mesaba Range. This was in connection with an offer to the Company of an interest in the Reserve Mining Company which later acquired this property. I prepared a complete report of the data obtained.

In July, I made a trip to the Mesaba Range. While there, Messrs. Brown, Barber and I met with Messrs. Shallenberger and Calvin of the Great Northern Iron Ore Properties in conference relating to an extension of the Hill-Trumbull lease, minimum tonnage requirements and a revised royalty rate on so-called jig ores. I also went to the Mines Experiment Station in Minneapolis in connection with possible concentration tests on the Tilden Siliceous ores and conferred with Mr. Holt of Butler Brothers relative to the operation of their new heavy density cone concentrating plant at the Harrison mill in Cooley, Minnesota. Our interest in this plant is in connection with the experimental work we are doing on Hill-Trumbull jig ores, anticipating the erection of a heavy density or jig plant at this mine within the near future. I prepared a semi-annual report covering the work done during the first six months of the year by the Calumet & Hecla Company on the property sub-leased to them in the vicinity of the Ropes Gold Mine. This report was submitted to Mr. Bush.

In August, I reviewed orally to several directors of the Company on their annual trip to the District, the results of the drilling thus far completed on our Section 2 Exploration. On my trip to the Mesaba Range during the month I prepared an estimate of the probable additional cost of treating jig ores of the Hill-Trumbull Mine and conferred with Mr. Calvin, Chief Engineer for the Great Northern, on this subject.

In September, I went to Minneapolis and conferred again with Mr. Davis, Director of the Mines Experiment Station, on problems of concentration to be anticipated on the Mesabi Iron Company property located at the East end of the Mesaba Range, since acquired by the Reserve Mining Company. I also discussed with Mr. Davis the procedure to be followed in experimental work to investigate the possible economic concentration of Tilden Mine siliceous ore preparatory to requesting funds with which to carry on such work. I went to the Cleveland office and discussed with officials of the Company the possible merits of acquiring an interest in the Reserve Mining Company mentioned above. I spent two days making an underground examination of the Harmony and Old Bed Mines at Mineville, New York, now being operated by the Republic Steel Corporation, and prepared a complete memorandum of this examination.

I met Mr. Byron M. Bird, Metallurgist of the Battelle Memorial Institute, of Columbus, Ohio, by appointment on the Mesaba Range. I spent three days with him going over our concentrating problems, particularly the retreatment of the so-called jig ores at our Hill-Trumbull Mine. Mr. Bird is credited with being an expert in milling problems. He made several very radical statements concerning developments he had made both experimentally and commercially in the operation of jigs. As a result of this, I conferred both with concentrating specialists of Butler Brothers and Pickands, Mather organizations on the Range as well as with Mr. Davis and his staff of experts at the Mines Experiment Station in Minneapolis. Mr. Bird was employed by Butler Brothers for six weeks during the season of 1935 in a consulting capacity with more less unsatisfactory results, but since he was so highly recommended by Mr. R. C. Allen and sent to the Range by our own executives, it was important to study the problem from all angles, assuming that Mr. Bird might have, as he claimed, developed an improved technique in the use of jigs.

I stopped in Duluth at the request of Mr. R. M. Adams for a conference on Guyana Range and Old Menominee Range properties in which he was interested. It was his thought that the Company might care to join with him in acquiring iron ore reserves on these ranges. I assured him that we were not in this position at present. I went over current depletion estimates of several of our mines at the request of the Cleveland office and made recommendations for the reserve figures to be used on the books of the Company for the current year. I also made a study of an ore production schedule from our operating mines during the future years.

In October, I was present at Butler Brothers' new heavy density concentrating plant located at their Harrison mill, Cooley, Minnesota, during a large scale test made on a five carload lot of washed jig ore from the Trumbull Pit. I also arranged to have additional jig ore sent to the Mines Experiment Station, Minneapolis, for further comparative tests using both the heavy density and jig methods of concentration. I joined Messrs. Elliott and Barber at our Cleveland office for a further discussion with the officials of the Company of the question of acquiring an interest in the Reserve Mining Company being formed to acquire the Mesabi Iron Company's property. The Company finally decided to acquire a 10% interest in the Reserve Mining Company. Messrs. Brown, Elliott, Barber and myself went to Chicago where a conference was held with Messrs. Shallenberger and Calvin of the Great Northern Iron Ore Properties relative to our Great Northern leases and, in particular, the concentration of jig ores on these leases. I went to St. Paul and joined Messrs. Barber and Donovan in attendance at a hearing before Tax Commissioner Spaeth at the Capitol in connection with Canisteco occupational tax matters and also attended a hearing before the Commissioner on Canisteco ad valorem taxes. I conferred with Professor E. M. Lambert of the School of Mines at Minneapolis on the Canisteco reserves and arranged for a review of the reserve estimate of this property during 1940. Mr. Downing, Engineer of the Tax Commission, was present at this conference.

In November, I went to the Battelle Memorial Institute and witnessed a small scale laboratory jig test made by Mr. Byron M. Bird on Trumbull jig ore which I had arranged to have sent to him at the request of the Cleveland office, and went from there to the Mines Experiment Station in Minneapolis, stopping one day enroute at the Cleveland office for a consultation on all of this test work. At Minneapolis, I witnessed a large scale jig test on the ore sent to the Station in October. Later in the month I went again to the Station and witnessed a heavy density test on another lot of the same ore. In this test a drag type machine was used for mixing the ore with the heavy density medium effecting the concentration. Heretofore, a cone had been used. The development of the drag apparatus in this process was the outcome of efforts to treat all sizes of ore in one operation from 1 1/4" down to 48 Mesh which had not been accomplished before. In the cone type machine, the sizes treated were limited to about 1/8", all smaller sizes being treated in a jig. The new drag type machine apparently was entirely successful. Mr. Grover J. Holt, Chief Engineer of Butler Bros., came to Ishpeming and went over the ground at the Cliffs-Shaft Mine preparatory to making a preliminary lay-out for a proposed jig plant to raise the iron content and lower the silica content of our crushed Cliffs-Shaft ore. The consideration of such a plant is the outcome of successful results obtained at the Mines Experiment Station in jig tests made earlier in the year on this ore. Mr. L. G. Moore was also present while Mr. Holt was in Ishpeming and we went over the problem together. Mr. Archibald, together with Messrs. Wahl, Satterley, Olson and Pearson of the Inland Steel Company called at my office and looked over the geological maps and cross-sections of the Virgil Mine in connection with opening the Sherwood property which the Inland Company recently had acquired by assignment of lease from the Republic Steel Corporation.

In December, I witnessed the completion of the heavy density concentration tests and final jig tests on Trumbull lean ore at the Mines Experiment Station, Minneapolis. I attended the annual Minnesota Sectional meeting of the American Institute of Mining and Metallurgical Engineers, also at Minneapolis, and went from there to the Mesaba Range where I spent three days going over a mass of experimental data in connection with the work completed on Trumbull jig ores as well as more or less routine work in connection with our exploring programs at the Canisteo, Hill-Trumbull and Holman properties. I worked with Mr. Elliott in the preparation of a large amount of data for the Cleveland office to be used at conferences in January, 1940, in connection with the Maas and Negaunee Mines and the ore reserves in Sections 1 and 2, 47-27.

STANLEY W. SUNDEEN. Mr. Sundeen continued as Assistant Geologist throughout the year. About 75% of his time was spent on geological surveys and mapping in our operating mines; 4% with the drilling explorations; 11% on surface geological surveys and 10% on miscellaneous duties included in the routine work of the Department. He made periodic underground geological surveys and posted this information on the geological maps of the Cliffs-Shaft, Jackson Lease, Lloyd, Maas, Negaunee and Virgil Mines. The Cliffs-Shaft continues to be our biggest and most important underground geological problem. This property alone required about two-thirds of Mr. Sundeen's entire time. A large number of thin sections were made of specimens from many points in the

mine which were studied under the microscope in the course of correlating geological data. The geology of the current extensions in the operating mines has been posted to date on the geological maps and cross-sections. Further, I am happy to state that at last, geological surveys have been completed in all of the old workings in the Cliffs-Shaft Mine, where years ago, this work was omitted and where, because of this omission, the old data could not be reconciled with our present and more advanced knowledge of the complicated conditions prevailing in this property.

That part of Mr. Sundeen's time spent on surface geological surveys included a continuance of the work which he started some two years ago on a new surface geological map of the Eastern and more important portion of the Marquette Range. We will compile on this map all of the surface geological information in the Company's records and files augmenting it, as time will permit, with field examinations and additional surface geological surveys. In this connection, also, Mr. Sundeen spent several days making a detailed study of the surface outcrops in the Tilden area to enable us to determine more accurately the possible limits of this body of siliceous ore, having in mind the possibility, in years to come, of some process for economic milling and concentration. Our objective is a complete surface geological map of the Marquette Range which can be kept up to date as additional information is acquired in the years to come. This is invaluable for future and deep diamond drilling explorations that will be conducted on the Company's mineral estate.

GUSTAV AFUHS. Mr. Afuhs continued as our draftsman throughout the year. His work, as in the past, has, in part, consisted of preparing cross-sections of all our current drilling, recording all the drill data in our files and copying all exploration data submitted to this office in the form of land offers, outside explorations, etc. About 84% of his time was spent directly in connection with the geology of the current operating mines, posting the information on our geological maps and cross-sections, and making new maps where necessary. In the latter connection he has continued the work of making a new set of geological maps and cross-sections of the Cliffs-Shaft Mine to take the place of the old ones which are in very bad shape after 30 odd years of constant handling. This work was started some three years ago and has been continued as time would permit. About 8% of his time was spent in connection with all our drilling explorations. The balance of his time, about 8%, was spent in general drafting work, and with a variety of small jobs comprising the routine work of the Department.

E. A. ALLEN. Mr. Allen spent about 53% of his time during the year collecting, sampling, labeling and filing diamond drill core and sludge samples from the current explorations and making tests for the dip and bearing of all current drill holes with the Maas Compass, as this data was required. He made thin sections of rock samples and diamond drill core whenever necessary for microscopic study by Mr. Sundeen and me. The rest of his time was spent on routine office duties.

### C. SURFACE GEOLOGICAL SURVEYS

The surface geological surveying during the year was confined to a detailed study of the outcrops in the vicinity of the Tilden Mine, including portions of Sections 23, 24, 25, 26 and 27, 47-27. The purpose of this work was to define the limits of the Tilden siliceous ore formation so far as this is possible from surface evidences. This includes locating of any and all dikes and other intrusive rocks which will affect the mining of the siliceous ore itself. Mr. Sundeen conducted this survey during the fall months and was assisted by Mr. Allen. We have not had the opportunity yet to complete the transfer of this data to our geological map of this portion of the Marquette Range but this will be done shortly. Mr. Sundeen continued to spend some time during the year, as time was available, on the new surface geological map of the Eastern and more important portion of the Marquette Range. Data for this map largely is the reconciliation of a great volume of geological information and records from our voluminous drilling in the past geological surveys. It will be necessary to spend more or less time on surface geological surveys within this area to fill in the gaps and reconcile one old survey with another.

Mr. Sundeen made a superficial examination of Company lands in Section 31, 47-27 North of the Lloyd Mine early in May, in connection with an application by outside parties, through the Land Department, to lease this area and other Company lands in the vicinity, for the mining of asbestos. Asbestos of questionable quality has been found in a number of places in this vicinity but has never supported a commercial operation. I have not heard whether any of these lands finally have been leased for this purpose. Mr. Sundeen also examined lands in Sections 8 and 17, 46-29 South and East of the old Republic Mine where a molybdenum deposit had been reported. He found several occurrences of molybdenite, a sulphide of molybdenum, located in quartz vein fillings of shear zones in granite, but did not consider them of any commercial importance. These were on lands not owned by the Company.

### D. MINE GEOLOGICAL SURVEYS AND OPERATIONS

With minor exceptions, underground geological surveys of all current mining extensions and development work, were made during the past year in all of our operating mines. We made complete geological surveys of the current extensions and balance of the old workings needed for complete correlation of older geological data in the Cliffs-Shaft Mine, and of the new development work, principally on the main levels, in the other underground mines. Geological information was supplied to us by the engineer at the various soft ore properties within the limits of the actual stoping operations and all of this data was posted on the geological maps and cross-sections.

At the beginning of the year, all mines, except the Cliffs-Shaft, were being operated six days a week with each man working three days,- the Cliffs-Shaft Mine was being operated four days per week with a full crew.

Effective January 9th, all mines worked on a schedule giving each employee four days per week. All mines, excepting the Athens, operated 2 - 8 hour shifts per day, four days per week. The Athens Mine operated 3 - 8 hr. shifts per day, five days per week, staggering the crews.



Effective June 12th, all mines went on a schedule giving each employee three days per week. The Lloyd, Maas, Negaunee and Virgil Mines operated one - 8 hour shift per day, four days per week and two - 8 hour shifts one day per week. The Athens operated two - 8 hour shifts per day, four days per week. The Cliffs-Shaft operated one - 8 hour shift three days per week.

Effective September 11th, all mines except the Virgil, went on a schedule giving each employee five days per week. The Virgil remained on the former schedule of three days per week. All except the Virgil operated two - 8 hour shifts per day, five days per week; the Virgil operated one - 8 hour shift per day, four days per week and two - 8 hour shifts one day per week. Each of the Virgil crew worked three days per week.

Effective November 1st, the Virgil Mine was stepped up to a four day per week schedule; the mine operating two - 8 hour shifts per day and the crews staggered so that each employee worked four days per week.

The Tilden Mine open pit operations began May 1st and continued intermittently to and including November 27th. Operations were geared to the schedule of boat shipments. A total of seventy-eight single shifts and four double shifts were worked during the year.

#### D-1. --ATHENS MINE

Most of the production from the Athens Mine continued to come from blocks of ore between the 4th and 6th Levels. The remaining production came from Block 3 above the 7th Level between the two main dikes and from Block 2 above the 8th Level between the same two dikes.

Main level development during the year was confined to the 9th Level, one main drift at this elevation was driven in rock and completed and cross-cut No. 1 is being driven southeasterly from this drift. Three raises were put up from the drift driven through the ore in 1938 and two raises were completed and two are underway from the recently driven rock drift. Three additional raises also were put up during the year from No. 2 cross-cut on the 7th Level. They started in footwall rock and penetrated the ore body. As a result of the 9th Level development during the past year, the estimated ore area on this elevation was reduced in size. This, however, was practically off-set by the development of additional ore in Block 3 above the 6th Level.

#### D-2. - CLIFFS-SHAFT MINE

In "A" Shaft, the production for the year continued to come chiefly from the Bancroft Lease on the North, the main deposit, in both the central part and the areas adjacent to the old Incline and No. 3 Mines on the East, and from the southeast deposit. Approximately 65 $\frac{1}{2}$ % of the total mine production was mined from "A" Shaft deposits.

The important developments in "A" Shaft during the year were as follows:

On the Bancroft Lease, the ore in the large stope on the 10th Level was followed up to above the 7th Level and was still in ore. A drift was driven into this stope on the 8th and another drift is being driven to intercept this ore on the 5th Level elevation. The drift, which was started during 1938 on the 15th Level in a Westerly direction from the main North cross-cut to get under this ore was carried far enough to put up raises into it, but no raising has been done as yet. The drift, which was started Westerly in 1938 on the 10th Level to encounter the ore found in Drill Hole No. 456 partially developed this ore during the year and from this drift a raise has been put up in ore to above the 9th Level.

Stoping continues in comparatively large volume on the fee property to the East of the Bancroft Lease at several elevations. In the drift driven along Hole No. 437 on the 10th Level the ore was cross-cut and a drift driven Easterly for about 200' along this ore.

"B" Shaft deposits produced about 34 1/2% of the total mine production, - the largest proportion from "B" Shaft workings in over ten years. This was due largely to the production from the extreme West end of the 10th Level in the Section 9 deposit. The ore in "B" Shaft continued to come mainly from the floors, raises and stopes in the ore areas already developed on the main levels.

On the 1st Level, a drift is being driven Southwesterly to intercept the ore encountered in Hole No. 467 West of the Lake Superior Iron Company's forty. In the Section 9 deposit at the extreme West end of the 10th Level, the ore development has been very encouraging. A large stope has been started and a raise is already up 75' above the 9th Level elevation still in ore. Drifting continues Westerly in this same ore on the 10th Level elevation. A drift is also going West from the stope at the 9th Level elevation. The development in this deposit will be watched with increasing interest during the coming year.

D-3. - JACKSON LEASE

Operations were carried on in the Jackson Lease and Cambria Mine, through which the Lease is operated by the Republic Steel Corporation, during the first four months of the year, was discontinued the following three months, and carried on again during the balance of the year. Practically no main level development work was done on the Lease during the year with the exception of putting up five new raises. Mining on the sub-levels, however, developed an extension of ore in the East wing of the center deposit somewhat in excess of anticipation. This extension is under development at the present time.

The Cambria shaft was sunk 200' to a skip pit elevation below the 7th Level and the new 7th Level cut out at a point 200' below the 6th Level. Shaft plat and pocket were completed and drifting commenced East for tail track and West towards the ore for haulage during the year. The total production from the Jackson Lease for 1939 was 62,036 tons, but the grade was considerably leaner than the average expected in the future due to mining considerable lean ore in the upper parts of the several ore fingers. This grade as mined was 56.80% Iron dried, .081% Phos. and 11.70% Moisture.

D-4. - LLOYD MINE

All production from the Lloyd Mine came from three areas in the Lloyd East ore body,- namely, from the East end above the 4th Level; the central area between the 650' and 690' Sub-Levels; and the stopes under the hanging wall in the West end of the ore body above the 6th Level. The ore from these stopes ran nearly 80% of Silica grade which was somewhat disappointing. It is anticipated the grade will improve materially with depth.

The only development work above the 4th Level consisted of two raises put up from the 4th about 500' East of the shaft to catch the bottom of the ore in the old Lloyd deposit. Three raises were put up from the 630' cross-cut on the 5th Level, one for ventilation and traveling, the other two for mining. On the 6th Level, the main level footwall drift was completed to the point of the ore body on the East and a cross-cut to the North started from the East end of this drift. Three cross-cuts to the South were completed across the ore body into the South footwall. Two raises were put up in the West end of the ore body from the 6th Level, one from the main drift and the other from the 650' Cross-Cut, both for stoping. No development work was done on the 7th Level during the year.

D-5. - MAAS MINE

Production from the Maas Mine continued to come principally from three areas,- namely, from the East and West footwall pillars above the 3rd Level; the main deposit above the 4th Level, both to the East and South of the Race Course; and from the main deposit above the 5th Level on the Race Course and to the South and Southwest of it. In this latter area, the extension of ore to the West of the Southwest corner of the Race Course and under the hanging wall has proven to be quite extensive which is most encouraging. Only about 10 $\frac{1}{2}$ % of the mine production was of Bessemer grade compared with 16% in 1938. This ore, almost entirely, is confined to the horizon immediately below the hanging wall.

The transfer system to mine the ore in the West footwall pillar on the 3rd Level, was completed on the 200' Sub-Level elevation and two of the three raises planned have been put up. Another transfer system has been opened on the 345' Sub to mine the ore in the East footwall pillar South from Raise 107.

On the 4th Level, the 4000 cross-cut to the Southeast property line, driven in 1938, collapsed entirely, including most of the raises put up from it. It has been reopened, however, as far as the first raise.

On the 5th Level, No. 3 cross-cut was extended Southeasterly and completed with its intersection with the South footwall drift. This cross-cut was all in rock. Three raises have been completed and the 4th is in progress from this drift to tap the main deposit. Also, another raise was put up from the main footwall drift into this same territory.

D-6. - MORRIS MINE

The Morris Mine continued to be operated under lease by the Inland Steel Company. Mining was on a basis of four double shifts per week until September 15th and five double shifts for the balance of the year. Mr. Sundeen, in company with Mr. Satterley, Superintendent, and Mr. Pearson, Engineer and Geologist, made an inspection through the mine in April. He directed his attention chiefly to the geology of the new development work and to the more important stoping and slicing areas with the view of ascertaining whether or not the geological mapping by the lessees was substantially correct. Such observations as he could make in one day appear to agree with the records on the maps of the Inland Steel Company. He also went over the maps with Messrs. Satterley and Pearson at the end of the year, at which time they outlined the work accomplished during the year.

The production during 1939 continued to come principally from Lease No. 9 and the C. C. I. Co.'s fee land to the East and South of this lease. A small amount of ore was mined from Lease No. 24 located immediately to the West of Lease No. 9. During the years immediately preceding 1938, production was about evenly divided between top slicing and sub-level stoping operations. During 1938 about 60 to 70% of the ore came from slicing operations and the balance from sub-level stoping. In 1939, slicing operations contributed approximately 80% of the total production, with 20% coming from stoping. Top slicing likely will supplant stoping to an even greater degree in the future. The topmost workings are on the +160' elevation in the No. 21 deposit which is 80' above the 7th Level. The lowest workings have dropped down to the -110' elevation in the No. 33 or main deposit. This is 15' above the 8th Level.

The development work during the year was confined to the -20' Sub-Level, the 8th and 9th main levels. The ore developed during 1938 in the West end of No. 75 deposit has been mined down to the -10' Sub-Level. Development on the -20' Sub-Level consisted in driving a small East-West drift about 300' long through No. 77 deposit. This had just been opened up in 1938 on the -10' Sub-Level and at that time was thought to offer promise of being the top of a downward pitching ore body increasing in size as depth was attained. Approximately 200' of ore of the grade similar to that of No. 33 deposit was cut in this drift. Two cross-cuts, one extending North and the other South, from a point midway between the East-West limits of the ore body as shown in the East-West drift, limit the width of this ore body to about 60' at its mid-point. All of this development work was carried practically along what seems to be the horizontal bottom of the ore. According to Messrs. Satterley and Pearson, this limit appears to be a nearly horizontal fault plane. The East-West drift penetrates this limiting plane, going from ore to jasper in the West end where the plane rises gradually to the West.

On the 8th Level, development work consisted in extending a drift westerly in jasper to get under No. 77 ore deposit, and in raising into this ore. The raise was in jasper from the Level to the -20' Sub-Level elevation where it abruptly encountered the ore of No. 77 deposit above the so-called fault plane mentioned above.

The main 9th Level drift was extended Southwesterly in footwall slate to a point estimated as approximately 50' from the slate-iron formation contact and then turned due West so as to remain in footwall slate. The total length of this drift, at the end of the year, was approximately 1200' from the shaft. Sumps and pump house also were completed on the 9th Level.

The high sulphur ore, reported last year in the Westerly extension of No. 75 deposit, the past year was found to be only a narrow seam and could not be considered as a distinct high sulphur ore body. The high sulphur ore in No. 33 and No. 79 deposits remains about the same as reported for the year 1938.

D-7. - NEGAUNEE MINE

The production from the Negaunee Mine in 1939 came from four localities, - namely, the main deposit between the 11th and 13th Levels; the footwall pillar above the 11th Level; the area between the two South dikes, also above the 11th Level; and the shaft pillars around old No. 1 and No. 2 Shafts above the 9th Level.

The only development work from the 9th Level consisted of four raises into the No. 1 Shaft Pillar area. On the 12th Level, a new footwall cross-cut was driven and four raises put up from it into the ore area between the two South dikes and above the 11th Level. Another raise was put up into this ore area from the 12th Level in a parallel footwall cross-cut. On the 13th Level, a new footwall drift was driven South of the two South dikes and two parallel cross-cuts through these dikes into the main ore body. Two raises were put up through the ore to the hanging in the main ore body from one of these cross-cuts. On the 14th Level elevation the pockets were completed at the shaft and the work of cutting the shaft plat was started late in the year.

D-8. - TILDEN MINE

The 1939 production all came from previously stripped areas in the East and West Pits. The total production was 170,276 tons, of which 69,559 was mined from the East Pit and 100,717 tons from the West Pit. Of the East Pit production, 27,003 tons was a special Low Phos. grade, averaging .014% Phos.

New development work consisted of stripping North of the East Pit and to the West of the West Pit, and the ore operations in opening up the Lower Bench in the West Pit, 60' below the floor of the Upper Bench. Of the ore produced from the West Pit, 38,269 tons came from this Lower Bench. All of the stripping, as well as the ore operations on the Lower Bench of the West Pit, was accomplished with the new Caterpillar tractor and bull-dozer equipment, used for the first time at this property. It did excellent work and lowered the cost of these operations very materially.

D-9. - VIRGIL MINE

About two-thirds of the production from the Virgil Mine came from the Southwest area between the 6th and 8th Levels and one-third from

the Northwest ore body just above the 8th Level. The only development work from the main levels was the completion of the three raises started in 1938 from the 8th Level in the Southwest portion of the main ore body. The tops of these raises was the -100' Sub-Level and stoping was started at the extreme South limit of this ore body. In the Northwest ore body, the stope adjacent to the Sherwood line was extended about 50' South and was mined from four or five sub-level elevations. Near the end of the year, plans were underway to drive a new cross-cut on the 8th Level North along the Sherwood property.

**E. OPTIONS AND LEASES**

No new options to explore, nor leases, were taken by the Company during the year.

Negotiations for the purchase of the fee of the Minowan Iron Mining Company's property on the Cascade Range, comprising the NE $\frac{1}{4}$  of the SE $\frac{1}{4}$  of Section 28, 47-26, were carried on during 1938. The purchase was made for \$8,000, on December 24th, 1938, but the deed was not recorded until February 16th, 1939.

The fee of the old Standard Mine, comprising the NE $\frac{1}{4}$  of Section 34, 47-30 was purchased for \$2,000 on October 10th, 1939. This property lies along the Southwest bank of the Michigamme River about 3 $\frac{1}{2}$  miles Northwest of the Republic Mine and is crossed by a well-defined belt of Negaunee Iron Formation.

**F. EXPLORATIONS AND COSTS**

Drilling explorations were carried on in 1939 in the following districts and mines:

**F-1. - FROM SURFACE**

<u>DISTRICT</u>	<u>RANGE</u>	<u>MINE</u>
Coleraine	Mesaba	Canisteo
Marble	Mesaba	Hill-Trumbull
Taconite	Mesaba	Holman-Cliffs
Negaunee	Marquette	Negaunee
Ishpeming	Marquette	Sec. 2 Exploration

**F-2. - FROM UNDERGROUND**

Ishpeming	Marquette	Cliffs-Shaft
Negaunee	Marquette	Maas
Negaunee	Marquette	Negaunee.

Table V, which follows, gives the footage drilled, the ore encountered, and the cost per foot of drilling for both surface and underground explorations. It will be noted that the average cost of surface drilling was \$4.06 per foot excluding certain items which are not actual drilling expense but which customarily are charged to these explorations. By including these items, the average cost of surface drilling was \$4.83 per foot. The cost of underground drilling in the same way was \$3.32 per foot and \$3.87 per foot, respectively. By comparison with 1938, the cost of surface drilling in 1939 was considerably less for two reasons. In the first place, a large amount of structure drilling was done at our Mesaba Range properties which is always cheaper than diamond drilling and, in the second place, the cost of drilling at the Section 2 Exploration was materially less in 1939. The underground drilling costs were slightly higher than in 1938 because the cost in the Cliffs-Shaft Mine, where the principal footage was drilled, was somewhat higher due to a continued large amount of very hard ground being encountered. The cost of drilling in 1939, as a whole, however, was materially less than in 1938.

Table VI, also shown below, gives a comparative cost of total drilling for the past five years.

TABLE V.  
SUMMARY OF DRILLING FOR 1939

PROPERTY	DESCRIPTION			STAND- PIPING FT.	GHEBN DRILLING FT.	DIAMOND DRILLING FT.	TOTAL DRILLING FT.	FIRST CLASS ORE FT.	SECOND CLASS ORE FT.	LEAN ORE FT.	TOTAL COST "A"	COST PER FT. "A"	TOTAL COST "B"	COST PER FT. "B"
	SEC.	T.	R.											
<u>SURFACE DRILLING</u>														
Hill-Trumbull Mine	17	56	23 Minn.	112	8,279	-	8,391	850	-	* 3,880	\$ 32,971.15	\$ 3.93	\$ 25,709.34	\$ 3.06
Helman-Cliffs Mine	21	56	24 "	-	724	-	724	-	-	* 467	2,045.58	2.83	1,757.61	2.43
Canistee Mine	29	56	24 "	267	1,557	-	1,824	-	-	* 895	6,877.42	3.77	5,508.43	3.02
Negaunee Mine	32	48	26 Mich.	301	11	-	312	-	-	-	1,177.72	3.77	1,155.43	3.70
Sec. 2 Exploration	2	47	27 "	207	16	5,781	6,004	-	-	80	40,272.41	6.71	35,860.34	5.97
TOTAL SURFACE DRILLING				887	10,587	5,781	17,255	850	-	5,322	\$ 83,344.28	\$4.83	\$ 69,991.15	\$ 4.06

\*This is Crude Wash Ore which, when concentrated by washing, becomes First Class Ore.

<u>UNDERGROUND DRILLING</u>														
Cliffs-Shaft Mine	9 & 10	47	27 Mich.	-	-	1,792	1,792	115	103	72	\$ 7,548.62	\$ 4.21	\$ 6,651.97	\$ 3.71
Maas Mine	6	47	26 "	-	-	212	212	90	5	7	797.99	3.76	396.43	1.87
Negaunee Mine	6	47	26 "	-	-	667	667	210	25	110	1,986.64	2.98	1,824.83	2.74
TOTAL UNDERGROUND DRILLING				-	-	2,671	2,671	415	133	189	\$ 10,333.25	\$ 3.87	\$ 8,873.23	\$ 3.32
GRAND TOTAL DRILLING				887	10,587	8,452	19,926	1,265	133	5,511	\$ 93,677.53	\$ 4.70	\$ 78,864.38	\$ 3.96

Note: Cost "A" includes office expense, engineering, analysis, legal, personal injury, etc.  
Cost "B" excludes " " " " " " " " (To compare with contract price)

The drilling at the Canistee and Helman-Cliffs Mines was done under contract by J. S. Schultze of Grand Rapids, Minnesota.

TABLE VI.  
SUMMARY OF FOOTAGE DRILLED AND COST PER FOOT OF DRILLING FOR THE PAST FIVE YEARS

YEAR	TOTAL FEET DRILLED.	COST PER FOOT "A"	COST PER FOOT "B"
1935	4,321	\$ 3.16	\$ 2.70
1936	12,094	3.46	3.00
1937	21,008	5.32	4.69
1938	15,744	6.16	5.38
1939	19,926	4.70	3.96



### F-3. - DIAMOND DRILL CARBON

We had on hand, January 1st, 1939, a total of 564.74 carats of diamond drill carbon which inventoried at \$56,826.71. No new carbon was purchased. We consumed, during the year, a total of 98.79 carats, having a value of \$9,940.06. This left on hand December 31st, 1939, a total of 465.95 carats which inventoried at \$46,886.65. In addition to this carbon, we used 2.75 carats of Bortz at a cost of \$8.94, leaving a balance on hand December 31st, 1939 of 12.62 carats, having a value of \$41.01. Bortz is used in the place of chipped carbon when we encounter ore or real soft ground in our surface drilling. It is carried separately and not inventoried with the carbon.

### F-4. - DRILL SECTIONS

Cross-section tracings of all diamond drilling, showing analyses and classification of material encountered during the year have been made up and photographic copies, showing the work done during the year, in colors, will be found in the Annual Report books of maps of the Michigan Ranges which are submitted as a part of the Annual Report of the Engineering and Geological Departments.

### G. SURFACE EXPLORATIONS

#### G-1. - EXPLORATIONS ON THE NEGAUNEE MINE SURFACE IN SECTION 32, 48-26, MICHIGAN

Standpiping through the surface overburden to ledge North and East of the Negaunee Mine, which was discontinued for the winter on the completion of Hole No. 7 late in December, 1938, was resumed in May, 1939 with Hole No. 8. The object of this work was to determine the depth of ledge, the ground water level and to classify carefully the surface material passed through in order to plat the ledge contours and locate positions for deep well pumping to catch surface water before it enters the old workings of the mine. Hole No. 8 was located on the 2400E. meridian, 100' North of No. 7. It encountered footwall slate at ledge at a depth of 131' and bottomed in it at 141'. Hole No. 9 was sunk about half way between Holes 6A and 7 and 170' to the West of them. Broken soft ore jasper ledge was encountered at a depth of 169' and the hole was bottomed in it at a depth of 171' about the middle of July. This completed the standpiping with the Armstrong drill rig in this area. During the summer the Layne-Northwest Company stripped this hole for deep well pumping and deepened it in broken ledge to 182½'. This deepening was completed early in December, 1939.

#### G-2. - EXPLORATIONS IN SECTION 2, 47-27, MICHIGAN

Diamond drilling in the Golf Club area was continued until June 8th, 1939. At this time all the work was stopped because of discouraging business conditions. It is expected that drilling will be resumed and the current program completed, during the present year.

Holes 41 and 43 were being drilled at the beginning of the year. These holes were completed and holes 44, 45 and 46 were being drilled when the work was discontinued. The results of this drilling in no way upset our ideas of the major structural features of this area which are based on the work completed at the beginning of the year and covered in my report for 1938. On the other hand, additional minor faulting was demonstrated which has added structural complications. This, perhaps, was to be expected in a district where faulting of great magnitude has taken place, and it is likely that additional complexity will be discovered by fractures and displacements not known to exist at this date. All of these characteristics are favorable for the concentration of large important ore bodies. From the work done to date, the most conservative estimate of developed ore can be placed at approximately 7,000,000 tons. We anticipate, by completing the holes already partially drilled, that this estimate will be very materially increased and, furthermore, that possible ore may be indicated which will run into very large figures.

Hole No. 41 was drilling in the thicker member of the main greenstone intrusive horizon at a depth of 1044' on the first of the year. This hole was located on the 12650 W. meridian and just a short distance South of the estimated ledge position of the major East-West fault. The fault itself was cut during 1938 at a depth of between 240 and 250'. This fault dips to the South. At a depth of approximately 1500', the drill cut a minor fault which, from any logical correlation of data to date, must have a steep dip to the North. The movement along the latter has displaced the block to the North downward thus forming a crotch in the footwall slate. It is this feature that we believe explains the existence of the ore encountered in the bottom of hole 38, drilled in 1938, about 600' to the North of No. 41. Had 41 maintained its initial vertical dip or had deflected to the North, it should have cut the Southerly dip extension of the ore encountered in Hole 38. Instead of this, Hole 41 deviated slightly to the South and encountered the main footwall slate at a depth of 2465', at an estimated 130' South of this minor fault and in the block which had been elevated in relation to the footwall below the ore encountered in Hole 38. This, we think, explains the fact that Hole 41 did not encounter a concentration on top of the slate. The hole was bottomed in footwall slate at a depth of 2562'.

Hole No. 43 was drilling in intrusive greenstone at a depth of 263' on the first of the year. This hole was located on the 11,400 W. meridian approximately 300' South of the estimated ledge position of the major East-West fault and was drilled with a dip of  $-62^\circ$  to the North. This was the second and Southerly incline hole which was drilled to determine the approximate angle of dip of the major fault. The fault was crossed at a depth of approximately 360'. Hole 42, drilled in 1938, and located 225' to the North of 43, crossed the fault at about 100'. By crossing the fault at two points it is possible to determine its approximate dip. This proved to be  $64^\circ$  to the South. It was important to determine this dip as nearly as possible without spending too much time or money in order to more intelligently locate Hole No. 45, discussed below. Hole 43, after crossing the fault, was continued into the block dropped down on the North until it had penetrated the thicker

greenstone intrusive. This was done in order to correlate the greenstone horizon with its position in the fault block farther North and to eliminate any possible doubt that we cut the major fault. The hole encountered the objective greenstone at 770' and bottomed in it at 789'.

Hole No. 44 also was located on the 11,400 W. meridian. It was drilled vertically from a point 1600' South of Hole No. 43 far enough South, we believe, to strike the main footwall slate in the block South of the intersection of the major fault with the slate and where the slate has been faulted up in comparison with the blocks to the North of the major fault. The object of this hole is to explore ground favorable for the location of an operating shaft, a location, if possible, that will not encounter a body of ore on the slate. The hole had reached a depth of 1975' when work was discontinued on June 8th. It was in unoxidized magnetic siderite at that point but most of the footage drilled was in intrusive greenstone, which first was cut at a depth of 375'. This great thickness of greenstone probably is due to one or more faults through which the hole must have passed. Displacements along such fracture or fractures would magnify by repetition the true thickness of this intrusive sheet. Additional drilling will be necessary to define the exact cause of such a thickness of greenstone at this point. From the information to date, the slate-footwall contact should be cut in the neighborhood of 400' below the present bottom of this hole but additional faulting indicated in this hole may have changed the position of this contact materially.

Hole No. 45, likewise, was located on the same 11,400 W. meridian. It was drilled vertically from a point about 950' North of hole 44 and 650' South of hole 43. The object of this hole is to drill into the center of the large crotch formed in the footwall slate by the intersection of the major East-West fault with this slate. This is the largest structure known to date in the district and, so far, has not been explored. As mentioned above, in discussing Hole 43, it was important to determine the dip of this fault as closely as possible in order to locate hole 45 so that it would reach this objective. The hole passed through a succession of greenstone sheets with narrow seams of soft ore jasper and unoxidized magnetic grunerite and siderite between. It had reached a depth of 1355', and had just cut into unoxidized sideritic chert when drilling was discontinued on June 8th. As near as we can estimate, the hole will have to be drilled an additional 1400 or 1500 feet before reaching its objective.

Hole No. 46 was located on the 13,250 W. meridian about 600' West of Hole 41 and 70' North of it. As explained above, Hole 41, in deviating to the South failed to reach the downside of the fault block which contains the ore encountered in Hole 38. The object of Hole 46, therefore, is to reach the slate footwall within this block and prove, if possible, that the ore discovered in Hole 38 continues West and South. If this is found to be the case, the estimate of proven ore will be increased very materially. Hole 46 was drilled vertically and had reached a depth of 630' when drilling was discontinued on June 8th. From 2000' to 2100' remains to be drilled in this hole before its objective will be reached.

G-3. - HILL-TRUMBULL MINE, SECTION 17, 56-23, MINNESOTA

One hundred and eight structure drill holes were drilled in the Hill-Trumbull Pit during the year 1939, with a total footage of 8,391'. All holes were located within the present pit limits. Eighty-two of these holes were drilled on the Hill Lease for a total of 5,018' and twenty-six holes on the Trumbull Lease for a total of 3,373'. Two drill rigs were used in this work and it was done by the Mesaba-Cliffs Mining Company's own men and equipment.

This drilling had three objectives; one, to sample the grade of ore in the known ore layers for future grading in mining them; two, to more completely explore the ore limits both in depth and horizontal area within the present pit limits; and three, to outline the reserve tonnage of so-called "Jig" ore. The classification of jig ore is materially aided and confirmed by glass classifier tests of the drill cuttings in our research laboratory located at the Hill-Trumbull Mine. All of our drill samples are handled by the staff at this laboratory, including the hand-washed tests on all concentrating ores.

This 1939 drilling campaign resulted in an addition of 882,300 tons of direct ore and wash ore concentrates to the reserves of the Hill lease and a decrease of 36,100 tons in the reserves of the wash ore concentrates in the Trumbull lease. Actually the volume of crude ore in the Trumbull was increased but it was found that much of this material yielded a much lower recovery on a concentrated basis than formerly was estimated. Based on actual operating results, a recovery of 62% formerly was used, whereas the current drilling indicates a recovery of only 50% in a large portion of the area explored on this lease. The actual recovery on all concentrates produced during the operating season of 1939 was 57.75%. We have not had time to make a revised estimate of the jig ore reserves in this property but we do not believe that last year's drilling effected any material change in the previous estimate. It is likely, however, that the drilling campaign in 1940 will warrant a new estimate of this class of material.

G-4. - HOLMAN-CLIFFS MINE, SECTION 21, 56-24, MINNESOTA

A total of six structure drill holes were drilled during the year 1939 on the Brown No. 1 Lease, the SW $\frac{1}{4}$  of the NE $\frac{1}{4}$  of Section 21, 56-24, for a total of 724'. These holes were drilled, with a single rig, under contract, by J. S. Schultze of Grand Rapids, Minnesota. All were located on top of the North bank of ore just South of the North Star property which previously had been stripped. The object of this drilling was to completely sample the ore in this bank and outline its limits. The results will add some tonnage to the previously estimated reserves, but a revised estimate has not been completed.

G-5. - CANISTEO MINE, SECTION 29, 56-24, MINNESOTA

A total of seven structure drill holes were put down in the Southwest corner of the Hemmens Lease, the SW $\frac{1}{4}$  of the SW $\frac{1}{4}$  of Section 29, 56-24, during the year 1939 with a total of 1824'. These holes were drilled from the old stripping bench by J. S. Schultze of Grand Rapids,

Minnesota, under contract, using one drill rig. The object of this drilling was to check the results of some old drilling and to fill in gaps where no drilling had been done so that stripping limits could be determined for the current year's mining from the South ore bank of this lease. A total of 895' of wash ore was encountered and resulted in the addition of 468,900 tons in the estimated reserves of wash ore concentrates on this lease.

#### H. UNDERGROUND EXPLORATIONS

##### H-1. - CLIFFS-SHAFT MINE

One diamond drill operated continuously in the Cliffs-Shaft Mine throughout the year. During this time, nine holes were completed and the tenth started, for a total of 1,792'. These holes were numbered from 463 to 472, inclusive, and all were drilled horizontally from "B" Shaft levels.

Holes 463 and 464 were drilled from the Southwest end of the 7th Level, the first hole due North to explore a crescent-shaped area on the hanging side of the level between the present workings and the unknown position of the hanging wall contact, and the second hole S. 65° E. to explore the faulted footwall zone of the hard ore horizon at this elevation. Although some enrichment of the iron formation was found, no high grade ore was encountered in either hole.

Hole No. 465 was drilled North 33° East from the 4th Level about 350' North of "B" Shaft in order to cross-cut an area immediately below the hanging wall hitherto unexplored. Here again some enrichment was found but no first class ore.

Holes 466 and 467 were drilled from the 1st Level, both of them from the South side of the level, in order to explore for possible ore on the South limb of an anticlinal fold which had carried ore on the North limb and at higher elevations. In drilling hole No. 466, it was anticipated that the ore horizon might not be cut until the hole had crossed the South boundary of the Cliffs-Shaft property on to Oliver Iron Mining Company property, the SW $\frac{1}{4}$  of the NW $\frac{1}{4}$  of Section 10, 47-27. Consequently, permission was requested of and granted by the Oliver Company to complete this hole on this description. The hole crossed the boundary at a depth of 105' and encountered high grade ore from 125'-10" to 151'. This ore averaged 59.11% Iron and .126% Phos. The hole was bottomed in hanging wall slate and graywacke at a depth of 178'. Hole No. 467 was drilled South 30° West from a point about 125' West and 270' North of hole 466 to explore for a possible Northwesterly continuation of this ore on Cliffs-Shaft property, the NE $\frac{1}{4}$  of the NE $\frac{1}{4}$  of Section 9, 47-27. Here again our efforts were successful and we encountered this extension from a depth of 356'-6" to 384'. This ore averaged 63.70% Iron and .111% Phos. Previous to this, the hole cut a narrow seam of high grade ore from 293'-6" to 300', averaging 63.58% Iron and .196% Phos. The hole was bottomed in hanging wall slate at a depth of 426'.

Hole No. 468 was drilled from the South side of the 5th Level in order to explore the South fault zone in areas where ore bodies have been found in a corresponding position on other levels in the mine. Nine feet of high grade Bessemer ore was cut, which averaged 62.52% Iron and .031% Phos. The hole was bottomed in footwall siderite at a depth of 137'. Hole No. 469 was drilled due South from the Southwest side of the 2nd Level to explore the main South footwall area at this elevation. Three feet of high grade Bessemer ore was cut from 2' to 5', averaging 59.42% Iron and .020% Phos. This was followed by 6' of dike and then by high grade ore again, from 11' to 17'-6", which averaged 63.78% Iron and .118% Phos. The hole was bottomed in footwall sideritic magnetic chert at a depth of 155'.

Hole No. 470 was drilled S.  $4\frac{1}{2}^{\circ}$  W. from the South side of the 1st Level to cut a hitherto unexplored area of the footwall zone at this elevation. No enrichment was encountered and the hole was bottomed in footwall magnetic chert at a depth of 75'.

Hole No. 471 was drilled due South from the 9th Level to make one additional test of the footwall side of the ore horizon at this elevation. The hole encountered high grade Bessemer ore almost immediately which extended to a depth of 15'. This averaged 61.58% Iron and .036% Phos. After passing through 5' of hard ore jasper, second class ore was cut from 20' to 69', averaging 53.56% Iron and .030% Phos. Although this material, as a whole, is lower than standard grade ore, I believe much of it eventually will be mined and mixed with higher grade ore. Following this, from 69' to 80', 11' of high grade ore was cut averaging 58.92% Iron and .057% Phos. The hole was bottomed in footwall dike at a depth of 106'.

Hole No. 472 is being drilled due North from near the extreme West end of the 10th Level "B" Shaft, in the so-called Section 9 ore area. The object of this hole is to explore the ground from the main level drift to the hanging wall contact on the North. It is all virgin territory. Eleven feet of high grade ore was encountered between the depths of 184' and 195' which averaged 63.45% Iron and .186% Phos. This was followed by 15' of 47% lean ore and, at 210', by hard ore jasper. The hole was still drilling in the latter material at a depth of 224' on the last of the year.

#### H-2. - MAAS MINE

Early in December, 1939, a drill was started underground in the Maas Mine to accomplish two things. First, it was desired to get additional information on the ore lens on the North side of the mine between the 3rd and 4th Levels, in order to facilitate its development and mining from the 4th Level. Secondly, several holes were planned to be drilled downward below the 5th Level, both in the main ore body and in this North ore body, more particularly to sample the grade of the ore, especially its Sulphur content. Because the Sulphur in the Maas ore largely is in the form of gypsum, calcium sulphate, which is soluble in water, it is necessary in this drilling to sample the drill water itself for its Sulphur content.

Hole No. 30 was started about the middle of December and was drilled horizontally and S. 45° W. from the 200' Sub-Level, which is about half way between the 3rd and 4th Main Levels. After passing through 50' of soft ore jasper, including two narrow seams of lean ore, high grade ore was encountered from 50' to 140', having the following analyses:

<u>From</u>	<u>To</u>	<u>Footage</u>	<u>Iron</u>	<u>Phos.</u>	<u>Sul.</u>
50	62	12'	58.60	1.156	.011
62	95	33'	63.77	.197	.033
95	105	10'	58.80	1.431	.019
105	135	30'	61.73	.184	.037
135	140	5'	58.77	.621	.035

Beyond this ore the drill encountered soft ore jasper, interrupted by dike from 143 to 154', and was still drilling in it at a depth of 212' on the last of the year.

H-3. - NEGAUNEE MINE

Hole No. 29 was drilled horizontally and S. 69° E. from the 220' Sub-Level, approximately 24' above the 13th main level, to continue outlining the bottom contours of the ore bodies on the Negaunee Mine property as they approached the Northwest property line. This hole was drilling in soft ore jasper at a depth of 164' on the first of the year. Fifteen feet of good Bessemer ore was encountered from 240' to 255', averaging 58.65% Iron and .041% Phos. This was followed by lean and second class ore to 295' and then by unenriched soft ore jasper in which the hole was bottomed at 317'. Hole No. 30 was also drilled horizontally from the 220' Sub-Level but to the Southwest of Hole 29 and on a course of S. 9°25' E. The object of this hole was more particularly to follow the ore encountered in Hole 28, as it rises to the East in its pitch above the 13th Level, to facilitate its development and mining. Forty-five feet of high grade Bessemer ore was encountered from 150' to 195', averaging 62.77% Iron and .021% Phos. This was followed by lean and second class ore to 235' and then by soft ore jasper in which the hole was bottomed at a depth of 239'. Originally it was intended to continue this hole to the South contact of the footwall slate, expecting to encounter additional ore at this contact. The ground was found to be very heavy, however, and considerable trouble was experienced in keeping the hole open so that it was finally abandoned.

Hole No. 31 was drilled with a dip of -45° due South from the Southwest end of the 13th Level in order to more completely outline the bottom limit of the ore along the 800 West meridian and thus aid in planning the lay-out of the 14th main level in this area. Thirty feet of high grade ore was encountered from 40' to 70', averaging 63.91% Iron and .094% Phos. The hole encountered footwall transition jasper and slate at 145' and was bottomed in it at 163'.

Hole No. 32 was drilled horizontally and due South from the 13th Level on approximately the 300 W. meridian in order to cross-cut one of the main ore bodies and facilitate its development. Forty-five feet of high grade ore was cut from 15' to 60'. The first 20' was of Bessemer grade, averaging 63.22% Iron and .033% Phos.; the next 25' averaging 61.90% Iron and .077% Phos. This was followed by unenriched soft ore jasper in which the hole was bottomed at a depth of 112'. This hole was completed the latter part of February and no additional drilling was done in the Negaunee Mine during the balance of the year.

#### I. EXPLORATIONS AND NEW DEVELOPMENTS BY OTHER COMPANIES

The following activities on the Iron Ranges, that may be of especial interest, have come to my attention during the past year:

##### I-1. - MARQUETTE RANGE

The Inland Steel Company, at its Greenwood Mine, continued to produce a limited tonnage of hard ore in stringers along the quartzite hanging wall extending between the 1st and 4th Levels. The principal development, during the past year, was the extension of the 4th Level to the West. Some drifting was done to the East at this elevation. This was in rock and was discontinued until a similar rock drift being driven to the East on the 3rd Level had been completed. The ore mined is about 50% hard hematite and 50% magnetite. The total production in 1939 was 72,360 tons and the shipments 61,870 tons. This is a larger tonnage in both cases than any previous year in the history of the mine. Mr. Olson, Superintendent, tells me that the mine is looking better than at any time previously. Preparations are being made at present to sink the shaft another 200' to open up a 5th Level.

The North Range Mining Company, R. S. Archibald and associates, commenced producing ore from the old Mary Charlotte Mine during the year. They had taken a lease in 1937 and have kept it unwatered since that time. A campaign of drilling has just been started by this company on the lands just West of the Blueberry Mine along the belt of the Negaunee Iron Formation in the NE $\frac{1}{4}$  of Section 4, 47-28. This description lies between the Blueberry Mine on the East and the 80 acres owned by the Company described as the N $\frac{1}{2}$  of the NW $\frac{1}{4}$  of Section 4, 47-28. This work is being done under contract by the E. J. Longyear Company with one drill rig.

The Ropes Gold Mine continued to be inactive throughout the year but pumping was continued to keep the workings drained. Two men have been employed continuously on the Company's property in Section 30, 48-27, digging test pits and trenches in search for shear zones favorable for further exploration. This is in accordance with conditions of the lease from the Company to Bjork & Lundin, now assigned to the Calumet & Hecla Company. Lack of sufficient capital has continued to prevent any operating activity at the Michigan Gold Mine, located in the N $\frac{1}{2}$  of Section 35, 48-28. The workings, however, have been kept unwatered and, it is rumored, some refinancing is being done at present in order that active operations may be resumed.



#### I-2. - GOGEBIC RANGE

I understand that developments on the new bottom level at the Newport Mine have been very disappointing; that the ore is very limited and much of the formation unoxidized. Sinking of the main shaft is under-way to open a new level to determine if this unfavorable condition is progressive in depth and, of course, to get underneath what ore has been developed on the present bottom level. Pickands Mather & Company also, since November, 1938, have been sinking a 17" churn drill hole from surface at the old Tilden Mine to intercept an old main level. Pumping from this well will drain the water from the old Tilden workings to a point where it will not flow back into the Palms Mine. This hole is being put down under contract by the Layne-Northwest Company.

#### I-3. - MENOMINEE RANGE

The North Range Mining Company completed scrambling the remaining ore from the Forbes Mine during the past year and abandoned the property.

Since 1938, the M. A. Hanna Company has secured the Arenson, Minkler and Wauseca properties in the Mineral Hills Section of the Iron River District, lying between the Homer Mine on the West and the Sherwood Lease on the East. The Arenson and Minkler are drilled reserves, and the Wauseca was opened as a producing mine in 1906 but has been inactive since 1929. A shaft now is being sunk on the Minkler property and a drift is being driven from the Homer shaft to intersect it at 1000' below the surface.

The Inland Steel Company has acquired the Sherwood Lease, held since 1912 by the Republic Steel Corporation. One drill hole is being put down on the property at a proposed shaft site under contract by Ira Odgers of Crystal Falls. It is anticipated that this hole will be from 1200' to 1600' deep. It is rumored the Layne-Northwest Company will be employed to sink several large diameter churn drill holes for deep well pumps to drain the surface over the ore body on this lease.

The Globe Iron Company continued to operate its siliceous ore pit on the Cornell property near Iron Mountain and forwarded 51,018 tons during 1939. At the Bradley Mine, near the old Ludington shaft of the Chapin, Mr. Bradley, under contract, mined and delivered to the Jackson Iron & Steel Company a total of 46,310 tons of siliceous ore. Mr. John F. Spencer of Iron Mountain shipped in the neighborhood of 3,000 tons of self-fluxing lean ore from the stockpile at the old Davidson Mine property in Commonwealth, Wisconsin. All this ore was trucked to Florence and shipped from there by rail to the Wells Furnace Company.

#### I-4. - MESABA RANGE

The new cone plant of Butler Brothers located at their Harrison Mill in Cooley, Minnesota, and operated as an auxiliary to this mill, was started early in the shipping season of 1939 and operated the balance of the season with successful results. The two 7½' cones, using

ferro-silicon as a heavy density medium, were able to treat some 350 tons of washed feed per hour. The material treated was crushed to about 1 1/2" and sized at 1/4", the oversize going to the cones and the undersize to jigs.

Pickands Mather & Company finally decided on constructing a new concentrator to treat the lean ore in the Danube and Orwell properties and to be located near the present Danube mill. It is to be a jig plant using six, 5' x 8' "Conset" air-pulsating jigs. It is planned to have this plant in operation during the operating season of 1940.

I-5. - CUYUNA RANGE

The M. A. Hanna Company conducted a campaign of drilling to check-drill the old Arko property West of the Hillcrest Pit. This work was done under contract by S. E. Atkins of Duluth. At last accounts no decision had been reached as a result of this work.

J. EXAMINATION OF MINERAL LAND OFFERS

A total of 45 land offers were received by this office during the year 1939. Thirty of these were mineral land offers. Of the remaining fifteen offers, fourteen were of surface property and real estate in the City of Negaunee, and the remaining one of surface property and real estate in the City of Ishpeming. The offers and their numbers are as follows:

<u>Offer No.</u>	<u>Description</u>	<u>Remarks</u>
2039	Iron ore lands, part fee and part minerals only, near the East end of Lake Michigamme	Declined
2040	22 forty acre iron ore claims in Thunder Bay District, Northern Ontario, Canada	"
2041	Part of Lot 1, Block 6, Jackson Iron Company's Addition, Negaunee	"
2042	S 1/2 of Lots 1 and 2, Block 3, Pioneer Iron Co.'s Second Addition, Negaunee	"
2043	1150 acres of molybdenite lands in Quebec, Canada	"
2044	Several thousand acres of iron ore lands in Alabama	"
2045	Part fee and part surface only of various descriptions in 46-29, 47-29 and 47-30, Marquette County	"
2046	W 1/2 of Lot 2, Block 5, Pioneer Iron Co. Plat, Negaunee	"
2047	NE 1/4 of SE 1/4 of Section 10, 47-29, Marquette County	"
2048	Manganese ore lands 150 miles North of San Francisco	"
2049	Lot 17, Block 36, Pioneer Iron Co. Plat and Lot 5, Blk. 1, Corbit Addition, Negaunee	"
2050	Iron ore lands on West Vermillion and Cuyuna Ranges, Minnesota	"
2051	10% stock interest in Reserve Mining Co. (mineral lands of old Mesabi Iron Company)	Purchased
2052	Lot 10, Block 2, Maitland Addition, Negaunee	Pending
2053	Hartford-Cambria Mine Lease, Negaunee	Pending
2054	House and Lot at 115 Oak Street, Ishpeming	Declined.

Offer No.	Description	Remarks
2055	622 acres of low grade iron lands in Virginia	Declined
2056	100 acres of Vanadium lands in Nevada	"
2057	4 square miles of Manganese lands, Canada	"
2058	27 miles of Manganese ore lands, Panama	"
2059	Billodeau parcel on Harvey Lot 11, Negaunee	"
2060	Fuller's Earth property at Harrietta, Michigan	"
2061	House and Lot at 127 E. Case Street, Negaunee	"
2062	House on Lot 6, Block 11, Pioneer Iron Co. 2nd Addition Negaunee	"
2063	SW $\frac{1}{4}$ of Section 5, 39-29, Menominee Range, Dickinson County, Michigan	"
2064	Iron, tungsten and copper in Dickinson County, Michigan	"
2065	Lot 37, except East 8', Iron Plat, Negaunee	Pending
2066	Iron ore lands in Central and Southern New Mexico	Declined
2067	35,000 acres of iron ore mineral rights, location unknown	"
2068	House on Lot 5, Block 10, Pioneer Iron Co. Plat, Negaunee	"
2069	House and Lots 6 and 7, Block 31, Pioneer Iron Co. Plat, Negaunee	Purchased
2070	Manganese ore in Arkansas	Declined
2071	Float iron ore in Chippewa County, Michigan	"
2072	NE $\frac{1}{4}$ of SW $\frac{1}{4}$ of Sec. 34, 47-29, Cuyuna Range, Minnesota	"
2073	Property at Corner Main & MacKenzie Streets, Negaunee	"
2074	Lot 29, Block 2, Corbit's Addition, Negaunee	"
2075	Iron ore lands in Missouri	"
2076	Magnetite iron ore lands, Ontario, Canada	Pending
2077	Cobalt lands in Kehoe Township, Ontario, Canada	Declined
2078	Manganese ore lands in Idaho	"
2079	Iron ore lands in Meagher County, Montana	"
2080	Iron ore lands, location unknown	Pending
2081	15 claims of iron ore lands in Mississagi Reserve, Ontario, Canada	"
2082	529,000 acres of manganese and oil lands in Tennessee	Declined
2083	House and Lot 3, Block 30, Pioneer Iron Co. Plat, Negaunee	Pending

#### K. RESEARCH AND EXPERIMENTS

During the past year exhaustive experimental concentration tests were made on crushed Cliffs-Shaft ore and on lean ore, commonly called "Jig ore", from the Hill-Trumbull Mine. These tests were made under my supervision at the Mines Experiment Station, University of Minnesota, Minneapolis. Jig tests were made with the Wade-Gleason pneumatic pulsating jig, now called the "Conset" jig, by the regular staff at the Station. Other tests were made with the ferro-silicon heavy density method by Butler Brothers' engineers assisted by the staff at the Station.

In addition to these experimental tests at the Mines Experiment Station, five carloads of Trumbull jig ore, after a preliminary washing in our Hill-Trumbull plant, were put through the new heavy density cone concentrator at the Harrison Mill of Butler Brothers, Cooley, Minnesota. The results of all tests were highly successful and are set forth in special reports.

Mr. George H. Beasley has continued to make glass classifier tests at our Hill-Trumbull research laboratory on all crude ore recovered from structure drilling in possible jig ore horizons. This was done in connection with the drilling at all three properties, - namely, the Canisteo, Hill-Trumbull and Holman-Cliffs Mines. This is necessary to aid in classifying jig material for future reserve estimates.

In my report for 1938, I mentioned the work we were doing at the Ishpeming office in experimenting with heavy density liquids for making sink and float tests on certain rock forming minerals. We anticipated the development of a method to distinguish the sedimentary slates in the Cliffs-Shaft Mine from the altered and decomposed basic intrusive rocks often associated with these slates. After alteration has progressed beyond a certain point, it has been difficult and, at times impossible, to distinguish their respective characteristics even in thin sections under the microscope.

This work now has been carried on to a point where we have developed a technique that we believe will accomplish such results. The heavy minerals are separated from the lighter in a finely powdered aggregate by mixing the sample with a heavy density liquid and treating in a centrifugal separator, much the same as cream is separated from milk by centrifugal force. A slide, for microscopic examination, then is made of the heavy minerals. We have found, in every test made so far, that where the mineral zircon (which is a heavy density mineral) is present, the rock is of sedimentary origin. This mineral does not occur in basic intrusives. It comes originally from acid intrusives such as granite which, on weathering and going through the erosion cycle, supplies part of the material found in sedimentary rocks. Although in minute quantities, zircon is a widely distributed mineral in the sedimentary rocks of the district. Some means was necessary to segregate it from other minerals, which tend to obscure it, in order to be sure of determining its presence or absence under the microscope.

We are not equipped to make these centrifuge slides ourselves but have them made either at the University of Minnesota or the University of Wisconsin, at a reasonable cost.

#### L. EXPENSE STATEMENTS

Tables VII and VIII, which follow, show a detailed statement of charges to Geological expense for the year 1939 and a comparative statement of these charges for the last three years. They are self-explanatory.

TABLE VIISTATEMENT OF CHARGES TO GEOLOGICAL EXPENSE FOR THE YEAR 1939

Salaries	\$ 13,068.50
Travel & Entertainment	1,882.88
Operating Automobiles	683.81
Supplies & Office Expense	1,235.07
Personal Injury	262.16
Unemployment Insurance Tax	337.87
Old Age Benefit Tax	99.32
Unclassified	7.18
<b>TOTAL</b>	<b>\$ 17,576.79</b>

TABLE VIIICOMPARATIVE STATEMENT OF CHARGES TO GEOLOGICAL DEPARTMENT  
FOR LAST THREE YEARS

	<u>1939</u>	<u>1938</u>	<u>1937</u>
Salaries	\$ 13,068.50	\$ 12,344.00	\$ 12,867.15
Travel & Entertainment	1,882.88	1,405.75	1,120.35
Operating Automobiles	683.81	438.44	546.40
Supplies & Office Expense	1,235.07	873.39	1,101.89
Personal Injury	262.16	258.15	249.08
Unemployment Insurance Tax	337.87	391.82	249.08
Old Age Benefit Tax	99.32	93.91	124.53
Unclassified	7.18	152.32	29.42
<b>TOTAL</b>	<b>\$ 17,576.79</b>	<b>\$ 15,957.78</b>	<b>\$ 16,288.00</b>

Respectfully submitted,

*E. L. Derby, Jr.*  
Geologist

ELD:DWC  
2-17-40

**ANNUAL REPORT OF THE MINING ENGINEERING DEPARTMENT FOR THE YEAR ENDING  
DECEMBER 31, 1939**

The usual books of photographic maps, showing the areas mined on the various sub-levels in the operating mines during 1939, accompany this report. Some of these books are bound and some are loose-leaf with stiff covers. These books contain views of some of the properties and maps or sections of the mines that were operated during the year. The maps show in red the work done since last year's report and the sections show in color the geological structure adjacent to the ore body. Books have been prepared for the different companies interested in the various mines, the following list showing the companies for which books have been prepared and the mines included therein:

Company	Mines
<b>The Cleveland-Cliffs Iron Company</b>	<b>Athens, Canisteo, Cliffs-Shaft, Hill-Trumbull, Jackson Lease-Cambria Mine, Lloyd, Maas, Morris, Negaunee, Spies-Virgil, and Tilden.</b>
Bethlehem Steel Company	Negaunee.
Canisteo Mining Company	Canisteo.
Hanna Ore Mining Company	Hill-Trumbull.
Inland Steel Company	Hill-Trumbull.
Jones & Laughlin Steel Corporation	Hill-Trumbull.
Otis Steel Corporation	Hill-Trumbull.
Pickands, Mather & Company	Athens.
Pillsbury Steel Corporation	Hill-Trumbull.
Republic Steel Corporation	Hill-Trumbull and Lloyd.
Wheeling Steel Corporation	Hill-Trumbull.

There were two bound copies of The Cleveland-Cliffs Iron Company book made, one for the Cleveland office and one for the Engineering Department at Ishpeming. Five loose-leaf books of the Canisteo Mine were made for the Canisteo Mining Company at their request. Four loose-leaf books were prepared for the Republic Steel Corporation, two of the Hill-Trumbull and two of the Lloyd Mine. One copy of the other books were made in loose-leaf form.

There were similar books prepared for fee-owners and superintendents. Those for Mr. Barber were bound while the others were in loose-leaf form.

Person	Mines
Arthur Iron Mining Company, Fee Owner	Hill-Trumbull.
M. H. Barber, District Superintendent	Canisteo and Hill-Trumbull.
H. C. Bolthouse, Superintendent	Canisteo and Hill-Trumbull.
W. W. Graff, Superintendent,	Athens and Negaunee.
H. O. Moulton, Superintendent,	Maas.
C. W. Allen, Superintendent,	Lloyd and Spies-Virgil.
C. J. Stakel, Superintendent,	Cliffs-Shaft Mine.

B. MAP REPORTS

Two sets of blue-prints of the mine maps, scale 1" = 50', were made at the end of each month, showing in red the areas mined during that month. One of these sets was for the General Superintendent and the other for the Mine Superintendent. Similar maps were made of the Cliffs-Shaft Mine at quarterly intervals. This mine is so extensive and the headings advance so slightly that it is impossible to survey the mine oftener than three months. Two sets of the maps of this mine were also prepared for the General Superintendent and the Mine Superintendent following each survey. For the past two years it has been the policy to preserve these monthly sets of maps prepared for the General Superintendent. These maps are boxed and stored in case they are ever needed as evidence in Workman Compensation suits.

Besides the above map reports, other sets of maps were prepared for outside parties as follows:

ATHENS MINE

Two sets of monthly report blueprints of the Athens Mine were sent to the Cleveland office for the Pickands, Mather & Company, colored to show the areas mined during the month.

A set of blue prints of the mine maps, scale 1" = 50', showing in color the work done on the Mitchell Lease, Harvey Lots 8, 9 and 11, for the year, were forwarded to Dr. R. E. Drake, Ann Arbor, Michigan.

CLIFFS-SHAFT MINE

Two sets of blueprints, scale 1" = 50', of the geological maps of the Bancroft lease, showing in red the work done since the previous report, are sent after each survey. One set goes to the local office of the Oliver Iron Mining Company and the other to our Cleveland office. At the end of the year, a set is sent to the Duluth office of the Oliver Iron Mining Company, showing in color the work done on the Bancroft Lease during 1939.

MAAS MINE

Blueprints of those portions of the Maas Mine workings in the Roman Catholic Cemetery were sent monthly to Mr. R. S. Archibald, Negaunee, Michigan, showing in red the areas mined during that period.

NEGAUNEE MINE

Fourteen sets of Annual Report maps of the Third, Fourth, Ninth, Eleventh, Twelfth, Thirteenth and Fourteenth Levels were sent at the end of the year to the fee-owners of the property. A set of blueprints, scale 1" = 50', of the North-South cross-sections of the Negaunee Mine were sent at the end of the year to Mr. W. L. Cummings, Geologist, of the Bethlehem Steel Company, Bethlehem, Pennsylvania.

SPIES-VIRGIL MINE

Five sets of blueprint maps, scale 1" = 50', were sent to the fee-owners quarterly, showing in red the areas mined during the previous three months.

MICHIGAN STATE TAX COMMISSION

Estimates of ore reserves of the Athens, Cliffs-Shaft, Lloyd, Maas, Negaunee and Spies-Virgil Mines were made as of December 31st, 1939. Two books of Annual Report maps were prepared, showing the areas included in compiling the estimates and general geological features. One of these books was sent to the Michigan State Tax Commission through the Cleveland office in January, the other book remaining on file in the Engineering Department.

C. REMARKS ON MISCELLANEOUS DOCUMENTS AND ABSTRACTS

All documents affecting the Company's lands and holdings pass through the Engineering Department for recording and approval irrespective of the Department from which they originate. These documents receive the approval of both the Engineering and Geological Departments and are entered on the records and initialed by Mr. Brewer and by Mr. Derby if necessary. Where sales of land are concerned, careful consideration is given of the economic value from the mining and geological standpoints before being approved. These documents are initialed by Mr. Brewer and by Mr. Derby, if necessary. Copies of those documents which affect the mineral lands are kept on file in the Engineering Department.

The following table shows the number and classification of such documents as have passed through the Department during the year and have been initialed:

CLASSIFICATION	Number Received	Last File Number
Mining Leases	0	70
Miscellaneous Documents	8	1359
Easements	5	409
Rights of Way	0	221
Water Rights	0	59
Surface Leases	88	4703
Applications for Sale	4	174
Sales	77	1586
Tax Histories	0	702
Legal Opinions	0	195

The following comments cover the various documents, etc. that were placed on the Department records, during 1939:

MINING LEASES

There were no changes in the status of mining leases during the year, there being no new leases or cancellations.

MISCELLANEOUS DOCUMENTS

This classification covers all documents of every nature and involving the transfer of rights affecting mineral lands. Five of these documents had to do with acquisition of Negaunee city lots and two were copies of old documents needed for title purposes.



EASEMENTS

These documents cover rights of way acquired by the Cliffs Power & Light Company. Three of the documents covered the telephone line to the Escanaba River power plant, one was a railroad crossing and one was for a right of way near Chatham.

RIGHTS OF WAY

This file covers railroad and highway right of way across mineral lands. There were no documents of this nature received during the year.

WATER RIGHTS

These are permits granting rights for mine water discharge, etc. across lands adjacent to mines. There were no changes during the year.

SURFACE LEASES

The surface leases cover all sorts of permits for the use of Company lands and all originate in the Land Department. There were 31 renewals, 17 lot leases for residence and the balance for gardens and camp sites.

APPLICATIONS FOR SALE

These also originate in the Land Department and are the preliminary report covering the area to be sold and are issued for lands off the mineral formation.

SALES

This classification covers sales of all kinds. Most of these sales originate in the Land Department and are sent to the Mining Department for approval. There were three sales of land to the U. S. Government, six highway rights of way and eight other rights of way for miscellaneous purposes. The balance covered sales of lands for farms, residences, etc.

TAX HISTORIES

There were no tax histories added to the Engineering Department files during the year. Several tax histories were received in connection with the purchase of platted lots in the City of Negaunee but these histories were forwarded to the Cleveland Office along with the documents of purchase.

LEGAL OPINIONS

This file is for ready reference of legal opinions as to the title of lands. There were no additions to the Engineering Department files during the year although legal opinions were received in connection with the title of lots purchased in the City of Negaunee. These opinions were also sent to the Cleveland office for filing without being copied for our records.

ABSTRACTS

A few of the documents passing through this office were abstracted for reference purposes but no work has been done toward bring up to date the abstract records on file. All of our records are so far in arrears that it would require the employment of a special person for this job.

#### D. THE FORCE

The personnel of the Engineering Department was reduced by one person during the year with his being transferred to another Department. There was one helper employed during the summer in connection with stockpile estimates.

The following table shows the personnel of the Department during the year, their position and the period employed during 1939:

Name	Position	Entered	Left	1939 Employment
C. Brewer	Chief Mining Engineer			12 months
J. Trosvig	Engineer			12 "
F. J. Haller	"			12 "
O. Marjama	"			12 "
W. R. Atkins	"			12 "
W. A. Richards	"			12 "
A. Minnear	Draftsman	March 1st		10 "
A. Koski	Helper			12 "
D. W. Carlson	Stenographer			12 "
A. H. Tillson	Draftsman		Jan. 9th	5 days.
R. E. Magnuson	Helper	Aug. 28th	Sept. 23rd	21 days.

The next table shows the length of service of the men now employed in the Engineering Department:

Name	Date Entered	Length of Service
C. Brewer	August, 1906	21 years, 3 months.
J. Trosvig	June, 1911	22 " 10 " (1)
F. J. Haller	June, 1930	5 " 7 " (2)
O. Marjama	September, 1936	3 " 3 $\frac{1}{2}$ "
W. R. Atkins	November, 1936	3 " 1 $\frac{1}{2}$ "
W. A. Richards	March, 1937	2 " 10 "
A. Minnear	June, 1917	17 " 5 $\frac{1}{2}$ " (3)
A. Koski	January, 1936	4 " "
D. W. Carlson	August, 1936	3 " 4 $\frac{1}{2}$ "

(1) Not employed by Company from October 15, 1914 to December 1, 1915, also from June 1, 1932 to November 9, 1936.

(2) Not employed by Company from February 1, 1932 to January 6, 1936.

(3) Not employed by Company from February 1, 1932 to March 1, 1935 and from June 10th, 1938 to March 1, 1939.

The above "Length of Service" only covers the period that the men were employed in the Engineering Department and does not necessarily cover the entire length of service with the Company. Several of the men have been in other departments either before or at intervals since first entering this department.

The following table shows the total days worked, days overtime, sick and absent for the year:

Name	Days Worked	Days Overtime	Days Sick	Days Absent
C. Brewer	261 $\frac{1}{2}$	$\frac{1}{2}$	3	10 $\frac{1}{2}$
J. Trosvig	265 $\frac{1}{2}$			11
F. J. Haller	256	1	8	11 $\frac{1}{2}$
O. Marjama	262 $\frac{1}{2}$	$\frac{1}{2}$	2 $\frac{1}{2}$	10
W. R. Atkins	263 $\frac{1}{2}$			11
W. A. Richards	259	$\frac{1}{2}$	$\frac{1}{2}$	14
A. Minnear	217 $\frac{1}{2}$		3	10
A. Koski	265 $\frac{1}{2}$			9
D. W. Carlson	267			7 $\frac{1}{2}$
A. H. Tillson	5			
R. E. Magnuson, Jr.	21			

The distribution of the time spent underground, in the field and in the office during 1939 is shown in the following table, together with the total percentages. This statement includes overtime.

Name	Underground	Field	Office	Total
C. Brewer	6 $\frac{1}{2}$	26 $\frac{1}{2}$	228 $\frac{1}{2}$	261 $\frac{1}{2}$
J. Trosvig	52 $\frac{1}{2}$	24 $\frac{1}{2}$	186 $\frac{1}{2}$	263 $\frac{1}{2}$
F. J. Haller	71	45	140	256
O. Marjama	104 $\frac{1}{2}$	10 $\frac{1}{2}$	147 $\frac{1}{2}$	262 $\frac{1}{2}$
W. R. Atkins	99	24	140 $\frac{1}{2}$	263 $\frac{1}{2}$
W. A. Richards	46 $\frac{1}{2}$	66	146 $\frac{1}{2}$	259
A. Minnear	16	52	149 $\frac{1}{2}$	217 $\frac{1}{2}$
A. Koski	88 $\frac{1}{2}$	62 $\frac{1}{2}$	114 $\frac{1}{2}$	265 $\frac{1}{2}$
D. W. Carlson	5	3 $\frac{1}{2}$	258 $\frac{1}{2}$	267
A. H. Tillson	-	-	5	5
R. E. Magnuson, Jr.		14 $\frac{1}{2}$	6 $\frac{1}{2}$	21
<b>TOTAL</b>	<b>489<math>\frac{1}{2}</math></b>	<b>329</b>	<b>1523<math>\frac{1}{2}</math></b>	<b>2342</b>
<b>%</b>	<b>20.9</b>	<b>14.0</b>	<b>65.1</b>	<b>100.0</b>

The following is a resume of the work done by the various men in the Department during the year:

CARL BREWER, Chief Mining Engineer, had charge of the Engineering Department and exercised general supervision over all of the work. All of the documents placed on file passed through his hands and were initialled by him and he made such reports as were necessary concerning them. He compiled the Annual Report books, estimates of ore reserves and maps for the Michigan State Tax Commission, stockpile estimates, etc. During the spring he spent a large amount of time in connection with the delinquent tax situation on Cliffs Power & Light Company transmission line lands. He visited all of the various Boards of Review to make such changes on the tax rolls as had been

decided in order to take care of the delinquency. He completed the report on surface rights on lands in which the Arctic Iron Company had a mineral interest, the date of this report being August 1st, 1939. He has also spent a large amount of time studying the surface water conditions at the Company's mines, more especially at the Morris and Maas-Negaunee properties. He also supervised the boundary line calculations of the Company's properties for permanent record. He prepared the 1939 tax list for the Mining Department and also for the Cliffs Power & Light Company.

The following table shows the distribution of his time for the year:

Property	Underground	Field	Office	Total	%
General Engineering	$\frac{1}{2}$	18	216 $\frac{1}{2}$	235	89.8
Athens Mine	$\frac{1}{2}$			$\frac{1}{2}$	.2
Cliffs-Shaft Mine	1 $\frac{1}{2}$	$\frac{1}{2}$		2	.8
Lloyd Mine			$\frac{1}{2}$	$\frac{1}{2}$	.2
Maas Mine	2	3 $\frac{1}{2}$	6	11 $\frac{1}{2}$	4.4
Negaunee Mine	2	4 $\frac{1}{2}$	4 $\frac{1}{2}$	11	4.2
C. P. & L. Co.			1	1	.4
<b>TOTAL</b>	<b>6<math>\frac{1}{2}</math></b>	<b>26<math>\frac{1}{2}</math></b>	<b>228<math>\frac{1}{2}</math></b>	<b>261<math>\frac{1}{2}</math></b>	
<b>%</b>	<b>2.5</b>	<b>10.1</b>	<b>87.4</b>		<b>100.0</b>

JOHN TROSVIG, Engineer, has had charge of the engineering work at the Cliffs-Shaft Mine during the entire year. He made the quarterly map reports and did considerable underground surveying during the year as was necessary for the development work. He also ran surveys into the available portions of the old No. 3 and Incline Mines. These surveys will be continued next year. There are large areas that it is impossible to reach but the extension of the Cliffs-Shaft workings make it advisable that the opening in these two properties be checked wherever possible. He also made inspections at the Jackson Lease in the Cambria Mine throughout the year, preparing monthly map reports and a written report covering the grade of the ore extracted as shown by mine samples. During the latter part of April and the early part of May, he spent 11 days in Cleveland, estimating the ore in stock at the Otis Steel Company plant. He made the estimates of ore reserves of the Cliffs-Shaft Mine early in the year and in the fall made the estimate of ore in stock at this property. He made all of the calculations for boundary lines of the Maas, Negaunee and Athens properties, including the various parcels under lease at these mines. This was in connection with the preparation of the boundary line maps.

The following table shows the distribution of his time for the year:

Property	Underground	Field	Office	Total	%
General Engineering		9	11	20	7.6
Cliffs-Shaft Mine	46	4 $\frac{1}{2}$	152 $\frac{1}{2}$	203	77.0
Jackson Lease	6 $\frac{1}{2}$		14	20 $\frac{1}{2}$	7.8
Maas Mine			9	9	3.4
Otis Steel Company		11		11	4.2
<b>TOTAL</b>	<b>52<math>\frac{1}{2}</math></b>	<b>24<math>\frac{1}{2}</math></b>	<b>186<math>\frac{1}{2}</math></b>	<b>263<math>\frac{1}{2}</math></b>	
<b>%</b>	<b>20.0</b>	<b>9.3</b>	<b>70.7</b>		<b>100.0</b>

F. JOSEPH HALLER, Engineer, has taken care of the engineering work at the Maas and Tilden Mines throughout the year. He made weekly inspections of the underground workings at the Maas Mine and prepared the monthly map reports. Following each underground inspection, he made a written report to the Mine Superintendent, H. O. Moulton, regarding the underground operations, paying special attention to safety in extraction of ore, to prevent the miners from running ore and producing a hazardous situation under the hanging or old workings. Underground, he gave lines as were necessary for development especially on the new transfer on the 200' Sub-Level. On surface, he gave grade stakes for the extension of the stocking ground to the Southeast and also to the Southwest. He made the estimate of ore reserves early in the year and the ore in stock in the fall. At the Tilden Mine, he estimated stripping, gave grades for the incline to the lower bench of the West Pit and supervised the blasts made during the year. He assisted the carpenters in planning the new garage for housing the tractor equipment and did such other engineering work and supervising as was necessary. He spent one day with Mr. C. W. Allen at the Helen Mine, Ontario, Canada. He also conducted a test with the representative of the Ingersoll-Rand Company on types of detachable bits for the purpose of determining the best cutting edges for the ore and jasper encountered in the Maas Mine.

The following table shows the distribution of his time for the year:

Property	Underground	Field	Office	Total	%
Maas Mine	71	10 $\frac{1}{2}$	106	187 $\frac{1}{2}$	73.2
Tilden Mine		34 $\frac{1}{2}$	31 $\frac{1}{2}$	66	25.8
General Engineering			1 $\frac{1}{2}$	1 $\frac{1}{2}$	.6
Negaunee Mine			1	1	.4
<b>TOTAL</b>	<b>71</b>	<b>45</b>	<b>140</b>	<b>256</b>	
<b>%</b>	<b>27.7</b>	<b>17.6</b>	<b>54.7</b>		<b>100.0</b>

ONNI MARJAMA, Engineer, has taken care of the engineering work at both the Athens and Negaunee Mines. Owing to the fact that the Negaunee Mine has demanded increasing attention, during the coming year he will only look after the engineering work at this property. The continued development above the 9th Level and the opening up of more mining areas in this locality has demanded a great deal of attention. Furthermore, the development of the 13th and 14th Levels has necessitated a considerable amount of study and engineering. He made the estimate of ore reserves at both properties early in the year and the estimates of ore in stock in the fall.

The following table shows the distribution of his time for the year:

Property	Underground	Field	Office	Total	%
Athens Mine	40 $\frac{1}{2}$	3 $\frac{1}{2}$	61 $\frac{1}{2}$	105 $\frac{1}{2}$	40.2
Negaunee Mine	64	7	86	157	59.8
<b>TOTAL</b>	<b>104<math>\frac{1}{2}</math></b>	<b>10<math>\frac{1}{2}</math></b>	<b>147<math>\frac{1}{2}</math></b>	<b>262<math>\frac{1}{2}</math></b>	
<b>%</b>	<b>39.8</b>	<b>4.0</b>	<b>56.2</b>		<b>100.0</b>

WILLIAM R. ATKINS, Engineer, has had charge of the engineering work at the Lloyd and Spies-Virgil Mines throughout the year. At the Lloyd Mine, he has run surveys for the development of the 6th Level and subs above and the development work between the 6th and 8th Levels at the Spies-Virgil property also demanded a lot of attention. He made a few trips to the Gardner-Mackinaw Mine in connection with the underground pumping and shaft repairs. At Gwinn, he has supervised the installations of new water lines to replace the old wooden pipes. He made the estimates of ore reserves in the Lloyd and Spies-Virgil Mines early in the year and in the fall made the estimates of ore in stock. At the Francis Mine, he supervised the cleaning up of the sollar and made estimates of ore in stock for the Shipping Department during the summer.

The following table shows the distribution of his time for the year:

Property	Underground	Field	Office	Total	%
Lloyd Mine	63	10 $\frac{1}{2}$	76 $\frac{1}{2}$	150	56.9
Spies-Virgil Mine	32	3	53 $\frac{1}{2}$	88 $\frac{1}{2}$	33.6
Mackinaw Mine	4	3	8 $\frac{1}{2}$	15 $\frac{1}{2}$	5.9
General Engineering		3	3	3	1.1
Francis Mine		2	1	3	1.1
Gwinn District		2 $\frac{1}{2}$	1	3 $\frac{1}{2}$	1.4
<b>TOTAL</b>	<b>99</b>	<b>24</b>	<b>140<math>\frac{1}{2}</math></b>	<b>263<math>\frac{1}{2}</math></b>	
<b>%</b>	<b>37.6</b>	<b>9.1</b>	<b>53.3</b>		<b>100.0</b>

WILLIAM A. RICHARDS, Engineer, has assisted in the various underground and surface surveys throughout the year, especially in giving lines for development and in the stockpile surveys in the fall. He assisted Mr. Trosvig in the calculation of the Maas, Negaunee and Athens boundary lines and prepared most of the boundary line maps. In December, he took over the engineering work at the Athens Mine and will take care of this in the future.

The following table shows the distribution of his time for the year:

Property	Underground	Field	Office	Total	%
General Engineering		7 $\frac{1}{2}$	25	32 $\frac{1}{2}$	12.5
Athens Mine	6 $\frac{1}{2}$	3 $\frac{1}{2}$	26 $\frac{1}{2}$	36 $\frac{1}{2}$	14.1
Cliffs-Shaft Mine	7	4 $\frac{1}{2}$	3 $\frac{1}{2}$	15	5.8
Mackinaw Mine			$\frac{1}{2}$	$\frac{1}{2}$	.2
Lloyd Mine	6 $\frac{1}{2}$	5 $\frac{1}{2}$	13	25	9.7
Maas Mine	13 $\frac{1}{2}$	26 $\frac{1}{2}$	37	77	29.7
Negaunee Mine	9	3 $\frac{1}{2}$	23	35 $\frac{1}{2}$	13.7
Spies-Virgil Mine	4	3	5 $\frac{1}{2}$	12 $\frac{1}{2}$	4.8
Tilden Mine		8 $\frac{1}{2}$	12	20 $\frac{1}{2}$	7.9
Francis Mine		1	$\frac{1}{2}$	1 $\frac{1}{2}$	.6
Geological Dept.		2 $\frac{1}{2}$		2 $\frac{1}{2}$	1.0
<b>TOTAL</b>	<b>46<math>\frac{1}{2}</math></b>	<b>66</b>	<b>146<math>\frac{1}{2}</math></b>	<b>259</b>	
<b>%</b>	<b>17.9</b>	<b>25.5</b>	<b>56.6</b>		<b>100.0</b>

ARCHIBALD MINNEAR, Draftsman, re-entered the Department on March 1st and has spent most of his time during the balance of the year in the office, making maps and tracings. He assisted in some of the underground surveys and more especially in connection with the stockpile surveys in the fall. A great many new sub-levels were opened during the year, which required new mounted maps and tracings. Furthermore, many of the older maps had become badly worn and he made the replacements of these.

The following table shows the distribution of his time for the year:

Property	Underground	Field	Office	Total	%
General Engineering		6	24 $\frac{1}{2}$	30 $\frac{1}{2}$	14.0
Athens Mine	1	1 $\frac{1}{2}$	13	15 $\frac{1}{2}$	7.1
Cliffs-Shaft Mine	1 $\frac{1}{2}$	8	20 $\frac{1}{2}$	30	13.8
Lloyd Mine	5	6 $\frac{1}{2}$	10 $\frac{1}{2}$	22	10.1
Lucky Star Mine		1 $\frac{1}{2}$		1 $\frac{1}{2}$	.7
Maas Mine	3	17	38	58	26.7
Negaunee Mine	4 $\frac{1}{2}$	3 $\frac{1}{2}$	30	38	17.5
Spies-Virgil Mine	1	3	9 $\frac{1}{2}$	13 $\frac{1}{2}$	6.2
Tilden Mine		4	3 $\frac{1}{2}$	7 $\frac{1}{2}$	3.4
Geological Dept.		1		1	.5
<b>TOTAL</b>	<b>16</b>	<b>52</b>	<b>149<math>\frac{1}{2}</math></b>	<b>217<math>\frac{1}{2}</math></b>	
<b>%</b>	<b>7.4</b>	<b>23.9</b>	<b>68.7</b>		<b>100.0</b>

ALFRED KOSKI, Helper, has assisted in the underground and surface surveys throughout the year. In the office has done most of the blueprinting, both for the monthly map reports and the annual reports. He has looked after the automobiles of the Department and has assisted in making tracings and also other work.

The following table shows the distribution of his time for the year:

Property	Underground	Field	Office	Total	%
General Engineering		9 $\frac{1}{2}$	98	107 $\frac{1}{2}$	40.5
Athens Mine	3	3	1 $\frac{1}{2}$	7 $\frac{1}{2}$	2.8
Cliffs-Shaft Mine	39 $\frac{1}{2}$	6 $\frac{1}{2}$	4	50	18.8
Lloyd Mine	11 $\frac{1}{2}$	7	1	19 $\frac{1}{2}$	7.3
Maas Mine	12 $\frac{1}{2}$	15	3	30 $\frac{1}{2}$	11.4
Negaunee Mine	15	5 $\frac{1}{2}$	4 $\frac{1}{2}$	25	9.4
Spies-Virgil Mine	3		1	4	1.5
Tilden Mine		3 $\frac{1}{2}$		3 $\frac{1}{2}$	1.3
Geological Dept.		$\frac{1}{2}$		$\frac{1}{2}$	.2
Jackson Lease	4		1 $\frac{1}{2}$	5 $\frac{1}{2}$	2.2
Otis Steel Company		10 $\frac{1}{2}$		10 $\frac{1}{2}$	4.0
Francis Mine		1		1	.4
Lucky Star Mine		$\frac{1}{2}$		$\frac{1}{2}$	.2
<b>TOTAL</b>	<b>88<math>\frac{1}{2}</math></b>	<b>62<math>\frac{1}{2}</math></b>	<b>114<math>\frac{1}{2}</math></b>	<b>265<math>\frac{1}{2}</math></b>	
<b>%</b>	<b>33.3</b>	<b>23.6</b>	<b>43.1</b>		<b>100.0</b>

DONALD W. CARLSON, Stenographer, has worked for both the Engineering and Geological Departments. He also has helped on some of the underground and surface surveys

The following table shows the distribution of his time for the year:

Property	Underground	Field	Office	Total	%
Stenography			259½	259½	96.9
Athens Mine	1	1		2	.7
Cliffs-Shaft Mine	1			1	.4
Maas Mine	2	1½		3½	1.3
Spies-Virgil Mine	1	1		2	.7
<b>TOTAL</b>	<b>5</b>	<b>3½</b>	<b>259½</b>	<b>267</b>	
<b>%</b>	<b>1.8</b>	<b>1.3</b>	<b>96.9</b>		<b>100.0</b>

A. H. TILLSON, Draftsman, was only in the Department five days when he was transferred to the Timber Department on January 9th.

The following table shows the distribution of his time for the year:

Property	Underground	Field	Office	Total	%
General Engineering			5	5	100.00
<b>TOTAL</b>			<b>5</b>	<b>5</b>	
<b>%</b>			<b>100.0</b>		<b>100.00</b>

R. E. MAGNUSON, JR., Helper, was employed during the month of September and assisted in the stockpile surveys at the various mines.

The following table shows the distribution of his time for the year:

Property	Underground	Field	Office	Total	%
General Engineering			4	4	19.0
Lucky Star Mine		1		1	4.8
Tilden Mine		3½		3½	16.7
Spies-Virgil Mine		3	1½	4½	21.5
Athens Mine		2		2	9.5
Cliffs-Shaft Mine		1	½	1½	7.1
Maas Mine		1½	½	2	9.5
Negaunee Mine		2½		2½	11.9
<b>TOTAL</b>		<b>14½</b>	<b>6½</b>	<b>21</b>	
<b>%</b>		<b>69.0</b>	<b>31.0</b>		<b>100.0</b>



E. DISTRIBUTION OF TIME

Practically all of the engineering work during the year was in connection with the various operating mines. The increase of working schedules at the mines during the year did not appreciably increase the demands on the Engineering Department although the employment of more contracts toward the end of the year did increase the demands somewhat. The weekly inspections of the soft ore mines has resulted in a much closer contact between the engineers and the captains and shift bosses but it has also curtailed the amount of time available for planning and estimates that are necessary in connection with the operation of the mine. The increased operating schedule has demanded more attention to future development, which in turn calls for more underground surveying such as giving lines, etc. All work in connection with the different mines has been charged to that property, while other work such as miscellaneous reports, blueprinting, drafting, etc. that is not chargeable to a mine, has been classified under General Engineering. For payroll purposes, the time under General Engineering has been distributed proportionately to the operating properties.

The following table shows the distribution of time for the entire department that was spent underground, in the field or office for the various mines and departments:

Property	Underground	Field	Office	Total	%
General Engineering	$\frac{1}{2}$	53	385 $\frac{1}{2}$	439	18.7
Athens Mine	52 $\frac{1}{2}$	14 $\frac{1}{2}$	102 $\frac{1}{2}$	169 $\frac{1}{2}$	7.2
Cliffs-Shaft Mine	96 $\frac{1}{2}$	25	181	302 $\frac{1}{2}$	12.9
Francis Mine		4	1 $\frac{1}{2}$	5 $\frac{1}{2}$	.3
Gardner-Mackinaw Mine	4	3	9	16	.7
Lloyd Mine	86	29 $\frac{1}{2}$	101 $\frac{1}{2}$	217	9.3
Lucky Star Mine		3	3	3	.1
Maas Mine	104	75 $\frac{1}{2}$	199 $\frac{1}{2}$	379	16.2
Negaunee Mine	94 $\frac{1}{2}$	26 $\frac{1}{2}$	149	270	11.5
Spies-Virgil Mine	41	13	71	125	5.3
Tilden Mine		54	47	101	4.3
Jackson Lease	10 $\frac{1}{2}$		15 $\frac{1}{2}$	26	1.1
C. P. & L. Co.			1	1	.1
Geological Department		4	4	4	.2
Otis Steel Company		21 $\frac{1}{2}$		21 $\frac{1}{2}$	.9
Gwinn District		2 $\frac{1}{2}$	1	3 $\frac{1}{2}$	.2
Stenography			258 $\frac{1}{2}$	258 $\frac{1}{2}$	11.0
<b>TOTAL</b>	<b>489<math>\frac{1}{2}</math></b>	<b>329</b>	<b>1523<math>\frac{1}{2}</math></b>	<b>2342</b>	
<b>%</b>	<b>20.9</b>	<b>14.0</b>	<b>65.1</b>		<b>100.0</b>

F. COSTS

The next table shows a comparison of costs for the Engineering Department for the last three years:

	1937	1938	1939
Salaries	\$17,469.54	\$16,107.77	\$15,753.16
Auto Expense	575.69	460.07	680.87
Furniture and Fixtures	22.18		5.00
Heat, Light and Power	175.59	224.23	196.91
Insurance	171.53	99.54	145.85
Postage	18.33	24.05	28.08
Repairs	1,449.93	134.98	344.72
Stationery and Printing	115.59	58.14	92.27
Supplies	1,812.10	1,254.51	1,653.50
Taxes	44.67	47.52	45.82
Travel and Entertainment	88.40	119.52	60.28
Personal Injury Expense	368.93	326.45	317.52
Telephone and Telegraph	103.80	94.66	91.09
Papers and Publications	2.25	1.30	3.83
Janitor and Cleaning	204.79		
Unemployment Insurance Tax	368.93	536.40	521.36
General - Unclassified	38.06	59.69	20.54
Old Age Benefit Tax	176.36	155.24	157.74
<b>TOTAL</b>	<b>\$23,206.67</b>	<b>\$19,704.07</b>	<b>\$20,118.54</b>

H. AUTOMOBILES

The Ford Station Wagon and Chevrolet Coupe have been operated steadily throughout the year. Both cars have been serviced by the Company garage and have given good service. The following table shows the mileage covered by these cars in 1939, the total mileage and the date purchased:

Car	Miles		Date Purchased
	1939	Total	
Ford Station Wagon	3,117	34,693	November 10, 1930
Chevrolet Coupe	6,238	20,356	July 1, 1937.

## I. MINES

The following summary covers the work done by the Department in connection with the various mines:

### GENERAL

Throughout the year, weekly inspections of soft ore mines were made by the engineer doing the engineering work at that property. These inspections were made in company with one of the mining captains or a shift boss and every working place in the mine was visited on each inspection. The advances and geology as noted during these inspections were posted at the end of the month when the regular monthly map report was made. Frequent consultation with the superintendent and mining captain after these inspections has increased the efficiency of the mining operations. The engineers have assisted the mine superintendents in writing their monthly and annual reports.

### ATHENS MINE

The opening of new subs adjacent to the 6th Level in Block 3, by raises from the 7th Level has been the principal new work during the year. The new drifts on the 9th Level and raises in Block 2 are also a feature of the development work in 1939. Mining is now being conducted on the 780' Sub-Level North of the Dike and as the 9th Level is extended and additional raises put up, the area South of the dike in Block 2 will be mined.

On July 12th, the 13th annual inspection of experimental treated timber was made by Mr. F. S. Crawford of the U. S. Bureau of Mines. These timbers were placed in the mines in 1926 and have been inspected annually ever since. The summary of the report on this inspection is as follows:

Preservative	Number of Timbers Placed	Good	Condition Partly Decayed	Badly Decayed	Removed	
					Decay	Crushed
Borax	12	-	1	3*	5	3
Sodium Fluoride	27	-	-	-	21	6
Zinc-Chloride	13	6	-	-	3	4
Untreated	12	-	-	-	12	-

\* Decrease of one as reported in 1938.

The average life of Sodium Fluoride treated timber was 7.7 years.

The average life of untreated timber was 3.8 years.

It is interesting to note that nearly one-half of the zinc chloride treated timbers are still in good condition after 13 years of service, whereas practically all of the others are either crushed or eliminated by being badly decayed.

### CLIFFS-SHAFT MINE

Quarterly surveys were made in February, May, September and November, from which the map reports were prepared. During the year the various drill holes were located and surveyed as necessary. When the shaft timbers in "B" Shaft, between the 5th and 6th Levels, were replaced, sketches were made for

the timber cutters for framing the sets. During the summer, surveys were run into the old workings of the No. 3 and Incline Mines and those portions of the 1st, 2nd and 3rd Levels of the latter mine, to which there was ready access, were mapped. It has been found that while the old maps were quite correct, it was advisable to make these surveys as it was found that some pillars and stopes had been mined of which we had no record. Furthermore, as the regular Cliffs-Shaft workings were approaching this territory, it was necessary to be sure that our maps were correct and to secure more relative elevations.

#### FRANCIS MINE

Prior to loading out the last of the ore in stock at this property, contracts were let for cleaning the sollar by hand. This work was supervised by Mr. Atkins. Also some intermediate estimates of ore in stock were made prior to shipment, for the Shipping Department.

#### GARDNER-MACKINAW MINE

This property was idle throughout the year but occasional inspections were made to watch the pumping and to supervise some repairs in the upper part of the incline shaft.

#### JACKSON LEASE-CAMBRIA MINE

Regular inspections of the operations on the Jackson Lease at this property were made and monthly map reports prepared showing the extension of workings. The analyses of the ore mined by the various contracts on the leased ground were tabulated so that the iron content of the ore extracted by each gang was known. This was done to make sure that all the ore was being mined. As the stoping method of mining was used, it was often difficult to determine whether or not all the ore was being taken. The Cambria Mine was closed down during the months of May, June and July.

#### LLOYD MINE

The principal development at this property was the 6th Level, which was extended through the ore body and several cross-cuts were also driven. Lines were given for this development as necessary. Also, a complete check survey was run from the shaft early in the year. The development of sub-levels above the 6th Level was also watched carefully and surveyed.

During the summer it was noted that the surface was caving over the ore body toward the West and approaching the water main that supplies the North Lake Location. An additional line of grade stakes was put in across the formation upon which semi-annual levels will be run so that any ground settlement will be noted in time to make such changes in the water line as may be necessary. Also a search was made for the surface location of some of the old drill holes in this locality in hopes that they might be plugged from surface and shut off water coming into the workings. This, however, was found to be impractical.

#### LUCKY STAR MINE

During August, September and October the shaft timber of the upper 50' of the Lucky Star shaft was repaired at the request of the Jones & Laughlin Ore Company. The old sets had rotted and settled and it was necessary to plumb and line in the new timbering. Nineteen sets of timber were put in.

MAAS MINE

Most of the development work at this property was confined to raising from the 4th and 5th Levels. Surveys were run to new subs in new territory as required. A check survey was run from the 4th to the 3rd Level through No. 300 Raise. The old survey stations on the 3rd Level had disappeared and it was advisable to re-establish them. On surface, grades were given for the extension of the stockpile to the Southwest and Southeast. Also, lines and grades were given for the installation of the discharge of Surface Well No. 2.

NEGAUNEE MINE

The opening up of additional territory on new sub-levels in No. 1 and No. 2 Shaft Pillars above the 9th Level required a great deal of surveying. It was found that the position of the old square set rooms did not quite coincide with the maps turned over to us when this Company took the lease. Inasmuch as the raises from the 9th Level go up in the old pillars, it was found very advisable to have more accurate information as to the location of the old stops. The diamond drilling done in the vicinity of the West end of the 13th Level early in the year disclosed a continuation of the ore body lying South of No. 2 Dike. This territory was studied very carefully and plans for the extension of the 13th Level in this direction, and the future development of the 14th Level, were made. Lines were given on the 13th Level as necessary and temporary lines on the 14th for cutting the plat.

In the spring, churn drilling was resumed at the East end of the mine for locating a surface well pump. These holes were located and surveyed and before the well pump was installed, lines and grades for discharge were given.

SPIES-VIRGIL MINE

The development of the Southwest deposit above the 8th Level was the principal new work during the year. The raises and development drifts were planned and geologized. They were surveyed carefully to make sure that no unexpected opening would be made to the old workings that had been sealed off above the 6th Level.

TILDEN MINE

Plans and estimates of stripping at both the East and West Pits were made during the summer. These were carefully watched so that accurate cost figures could be secured on the work done by the Caterpillar bull-dozer. All the blasts in the two pits were planned and supervised by the engineer in charge. The operation of the tractor and Athey wagon in the lower bench was also carefully watched in order to secure cost figures for this operation. Lines and grades were given for the garage to house the tractor equipment.

J. MISCELLANEOUSCENTRAL OFFICE

On the night of March 21st, the roof of the Central Office Building caught fire. The tremendous amount of water used drenched the entire

building and it was necessary for the occupants to move into the Engineering Building. The Geological and Engineering Departments were confined to the large drafting room. The Administrative, Accounting, Shipping, Purchasing and Timber Departments were scattered around in the various rooms on the two floors of the Engineering Building. Repairs to the Central Office were so far along that all the Departments moved back into that building on April 18th.

#### VENTILATION

In February and August the regular map reports of the operating mines were prepared showing the volume and direction of air currents. A special report was made on the situation at the Maas-Negaunee Mines with definite recommendations for additional raises and drifts to secure better ventilation at these mines. Other recommendations were made for the Lloyd and Spies-Virgil Mines.

#### SHAFT RUNNERS

The shaft runners of the various mines were gauged during May and reported to the various superintendents. The increase in working schedule from four to five days in September made it difficult to have access to the shafts for the second gauging in the fall.

#### STOCKPILES

The engineer's estimates of ore in stock at the various mines were made during September and October with the exception of the Francis, Princeton, Gardner-Mackinaw and Stephenson properties. The estimate at the Francis Mine was made earlier in the summer at the request of the Shipping Department. Shipments from the Princeton, Stephenson and Gardner-Mackinaw Mines were not large enough to re-estimate these piles. The following table shows a comparison of ore in stock at the different mines between 1938 and 1939:

Mine	Nov. 1, 1938	Nov. 1, 1939	Difference
Athens	246,995	167,579	-79,416
Cliffs-Shaft	335,792	183,505	-152,287
Francis	9,951	0	-9,951
Gardner-Mackinaw	159,392	127,251	-32,141
Lloyd	293,174	159,652	-133,522
Maas	395,686	388,141	-7,545
Negaunee	302,810	118,524	-184,286
Princeton	126,338	126,136	-202
Stephenson	65,466	60,035	-5,431
Spies-Virgil	110,799	210,558	+99,759
<b>TOTAL</b>	<b>2,046,403</b>	<b>1,541,381</b>	<b>-505,022</b>

During the latter part of April and the early part of May, Messrs. Trosvig and Koski made the estimate of ore in stock at the Otis Steel Company plant in Cleveland. This was reported directly to the Cleveland office.

### SURFACE CAVES

Early in the summer it was noted that there was a ground settlement over a large area of the Maas-Negaunee Mines that included the Race Course cave of 1937. This settlement had been anticipated and has been watched for each year. This settlement is slow and had no appreciable effect on the underground workings. New fences were built to keep persons away from that area. The outline of the new cave was surveyed.

There was also a considerable extension of the Athens Mine cave to the Northeast which encroaches on the area used for the timber treating plant. The extension of this cave was surveyed.

Mention has already been made of the caving ground at the Lloyd Mine. On March 12th the first cave to surface at the Morris Mine occurred.

### TAXES

Prior to the sale in May of lands by the State for delinquent taxes, Mr. Brewer checked over all of the lists, not only of the Mining Department lands but those of the Cliffs Power & Light Company. There were, of course, no mineral lands on these delinquent tax lists but there were some lands listed where the Cliffs Power & Light Company had transmission line rights of way. Where necessary, these taxes were paid.

In 1931, the State Legislature passed a law protecting transmission, telephone and similar lines where easements had been given by the land owner, from the effects of sale on account of delinquent taxes. Under this law, the Legal Department recommended that the Cliffs Power & Light Company remove all its rights of way from the assessment rolls of the various townships where the Company only had transmission line rights and did not own the land. This decision reversed previous procedure as formerly we had placed on the various assessment rolls metes and bounds descriptions covering Cliffs Power & Light Company rights of way across lands that would year after year go delinquent. Mr. Brewer and Mr. Stanford, therefore, attended all the meetings of the Boards of Review in June and made the request in accordance with the Legal Department's recommendations. In most cases the request was granted and the descriptions were removed and the following wording inserted on the rolls for personal property:

Power lines, sub-stations and equipment, including wires and supports, also communication lines used in operation of company's facilities, also rights of way and easements or other interests in land by virtue of which said supports and wires are erected and maintained.

It will take, however, another year before this situation is entirely cleared. The including of transmission line rights of way under personal property and having them exempt from future difficulties on account of sale for delinquent taxes will simplify the work entailed looking after Cliffs Power & Light property.

### MINERAL BOUNDARY LINES

The accurate location of mineral boundaries is an exceedingly important matter. The records of these boundaries in the Engineering Department has not been entirely satisfactory. Previous attempts have been made to correct this situation but owing to the fact that the engineers did not have sufficient time outside their regular work to undertake this, it has been, in the past, neglected. Last year a determined effort was made to put these records in proper form. Last spring new mounted maps for boundary lines only, scale 1" = 50', were made for the Maas, Negaunee, Athens and Cliffs-Shaft Mines. On these were plotted the boundary lines of all the various parcels comprising these mines together with the courses, distances and coordinates. The Maas Mine has eight separate parcels, the Negaunee Mine has two, the Athens five and the Cliffs-Shaft two. The boundaries of each of these different parcels were calculated as closed surveys and separate calculation for each parcel are being made in quadruplicate. Two copies are to be kept in the Engineering Department, one sent to the Cleveland office for filing and the other to the Land Department. The fire in the Central Office last spring emphasized the necessity of such duplicate records. If our new boundary line maps should be lost for any reason, they could be duplicated by the records that will be filed as above mentioned.

The preparation of these boundary lines have brought to light the advisability of additional work in the City of Negaunee where the Cleveland-Cliffs Iron Company, the Arctic Iron Company and Athens Iron Mining Company have joint ownership. In anticipation of this, a check survey was run from established survey points in the Maas and Negaunee Mines around the boundaries of the Pioneer & Arctic lands in the City of Negaunee. From the data of this survey the boundaries of the Pioneer & Arctic lands will be established and, it is hoped, an agreement can be made between the Cleveland-Cliffs Iron Company and the Arctic Company, establishing this boundary prior to any mining operations being conducted adjacent thereto.

Furthermore, in the City of Ishpeming, the matter has been discussed informally with the Oliver Iron Mining Company toward a similar agreement for establishing the boundary lines between the Cleveland-Cliffs Iron Company and Oliver Iron Mining Company lands adjacent to the Cliffs-Shaft and Lake Superior Mines. Next summer joint surveys will be made to establish these boundaries.

There has been no question raised by any party as to our mineral boundaries but we want to anticipate the situation so that there will be no reason for disagreement when the time arises.

Plans are being made for checking our surveys between Negaunee and Ishpeming by triangulation. The present surveys are satisfactory for mapping purposes but need the check to establish mineral boundaries. The possible future development of a mine in Section 2, 47-27 makes it advisable that the surveys of this territory be checked.

### UNDERGROUND WATER

The study of the problem to determine the source of water entering our underground mines was started in the fall of 1936 when eight test holes were put down Northeast of the Maas Mine ore body to find a suitable location



for a surface well. This problem has not been as simple as we first expected. The first well, called Maas No. 1, was located about 300' Southwest of the Maas Shaft. Although the work of drilling was started in January, 1937, the well was not turned over to us for operation until February, 1938 and has run only about half the time since, pumping between 200 and 300 gallons per minute while operating. As no appreciable results were noticed in underground pumping, additional test holes were drilled in the fall of 1938 and the spring of 1939. Five of these were for the Maas Mine, to the Northwest of the ore body, and six for the Negaunee Mine, Northeast of No. 2 shaft. Maas Well No. 2 was started in November, 1938 and has been in operation since August of this year. No. 1 well Negaunee, located about 1000' North of No. 2 Shaft, was begun last July and at the end of the year was not in operation. In November, 1939, additional holes were started on a general North-South line West of the Maas ore body.

The purpose of all of these holes and wells was to intercept the water in the overburden before it entered the mine. Careful studies of the occurrence of water underground showed that approximately three-fourths of the water entered along the North footwall of the mine and practically all of the balance from the West along the line of cave. All the test holes and drilling has shown that the overburden is exceedingly fine sand mixed with clay through which water does not flow readily. Northeast of the Maas-Negaunee ore body there is more gravel and it is hoped that a great deal of water will be cut off when the Negaunee well is in operation.

In most of the test holes, 4" pipes have been left, in which the level of ground water can be determined. Beginning with November 4th, 1939 regular weekly readings are being taken on the water levels in these holes by the Engineering Department and careful record will be kept of the variations of ground water as shown by these readings.

To facilitate the study of the source of ground water, early last year weirs were installed on all the main levels of the Maas and Negaunee Mines and almost daily readings have been kept of the volume of water flowing on each level. This information has been valuable in determining not only the locality where most of the water was entering the mine but also will reflect whatever benefits are derived from the surface pumping. In fact, these weir readings will show whether or not the surface pumping is accomplishing what we hope. So far we have not sufficient information to arrive at any conclusions. From present indications, to intercept water before entering the Maas-Negaunee Mines, a number of small surface pumps will be needed to the West and North of the ore body, although Negaunee No. 1 and Maas No. 1 wells may show results when they are operating continuously.

The following table shows the ground water elevations in the various test holes at the end of the year. These records have not been kept long enough to show any appreciable change other than that from natural causes.

Hole:	Maas							Negaunee	
	W1	W2	W5	W9	W11	W13	W14	6A	7
Original	1317.0	1318.8	Dry	Dry	1313.4	1340.0	1323.8	1197.0	1195.1
11/25/39	-	-	-	1282.8	1305.5	1343.4	-	-	-
12/30/39	1267.8	1267.8	1323.1	1282.6	1306.9	1343.0	1321.1	1189.4	1196.2

A method of determining the source of underground water is to introduce a substance into the incoming water and by determining the presence (or absence) of this substance in samples taken at various places underground. In April, 300 lbs. of common salt were washed into test hole No. 11, located about 2000' Northwest of the edge of cave. For four days following, three samples daily were taken from 19 different places underground. These samples were analyzed for chlorine hoping to find by an increase of this element, where the water from No. 11 hole was entering the mine. The results were negative as the amount of the chlorine in the water from each place varied too greatly to prove anything. In December, a similar test was made by introducing Uranine dye into the Negaunee Well No. 1. On December 14th, three charges of a half a pound each of the dye was put in the well at four hour intervals. For 72 hours after the first introduction of the dye, samples were taken underground at four hour intervals on the 9th and 10th Levels, Negaunee Mine and the 3rd and 4th Levels, Maas Mine. Traces of this dye were found in samples taken on the 9th Level, Negaunee, 24 hours after the first and last charges. No trace was found in the samples taken from the other localities. However, the use of this dye was an experiment and it is probable that more than a half a pound of dye per charge should be used. Additional experiments will be made early next year.

#### OFFICE HOURS

The office hours during the year were as follows:

	A. M.	P. M.	Saturday
From January 1st to January 7th	8:30-12:00	1:15-5:00	-
From January 7th to December 31st	8:30-12:00	1:15-5:00	8:30-12:00

#### HOLIDAYS

The following holidays were granted during the year:

January 2nd	New Years Day
February 22nd	Washington's Birthday
April 3rd	Election Day
April 7th	Good Friday
May 30th	Memorial Day
June 24th	Midsummer Day
July 3rd ( $\frac{1}{2}$ day)	Independence Day
July 4th	Independence Day
September 4th	Labor Day
November 11th ( $\frac{1}{2}$ day)	Armistice Day
November 23rd	Thanksgiving Day
December 25th and 26th	Christmas Holidays.

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CLIFFS SHAFT MINE:

On January 18th. the crack in the #8 McCully crusher lengthened considerably. Repairs were made by installing two reinforcing bolts. On April 7th. the mine was closed down so that the necessary repairs could be made to the crusher and also to replace some badly decayed shaft timber. This crusher was in very poor condition. It was necessary to replace the concave section with a section from the old Jackson crusher stored at the Cliffs Shaft mine. After a close inspection of the main frame it was decided to repair instead of replacing it and the following repairs were made. The discharge spout and main frame were built up by electric welding and a steel band was added just below the dust collar to raise the collar up to its normal position. Repairs were completed on the 17th. and the crusher is now in good condition.

The pan sections of the picking belt which were badly worn were replaced with a spare set (which was on hand for this purpose) during the time the crusher was being repaired. On May 12th. the motor coupling on the picking belt in the crushing plant broke and it was replaced with a new one. A timber under the bearing was also replaced with steel. The pans on the picking belt were again repaired on October 8th. as they were worn out. A new set of pans, complete with the necessary chain and rollers, has been ordered for a spare.

A small crack developed in the discharge nozzle on the water cylinder of the #2 Prescott pump. Repairs were made by shrinking a band around the flange.

New doors were installed on the "A" shaft cage to replace the old ones which were badly warped. The new spare skip box was installed in the "A" shaft skip to replace the old one which has been in service from November 1934 to April 7, 1939.

A loaded top tram car between the crushing plant and "B" shaft got out of control on May 1st. and was badly wrecked. It was replaced with a spare car and the accident caused only a three hour delay.

On May 6th. the cushion cylinder on the Lilly hoist control air brake was changed to get better braking effect, and the overwind was completely overhauled on the "A" shaft hoist.

The intake on the #2 air compressor caved in. A new steel intake was built at the General Shops and installed in September.

The counterweight rope at "B" shaft wore a hole through the 12" counterweight pipe. The head sheave was moved 4" to the east and a plate patch was clamped over the hole.

A new double truck lump ore stocking car is being built at the General Shops to be used as a spare.

A new D.C. feeder cable was installed in "B" shaft to care for the additional haulage and slusher load and to reduce losses in this service. This cable is #4/0 Anhydrex concentric, 1500' long. Due to the continued increase in load it seems necessary to anticipate an increase in the size of the motor-generator set supplying this service. This should be on the order of a 250 kw unit.

A proposal was received from the Edison Storage Battery Company to supply a new type of this battery for use for one year without charge. This was so favorable that it was accepted, allowing us to make running tests under operating conditions without expense.

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TILDEN MINE:

All winter repairs were completed in March. Operations started on May 1st. and shipping was completed on November 18th.

The #3 locomotive which was at the General Shops for repairs was delivered at the mine on May 1st. The repairs consisted of new side plates in the fire box from just above the grate line down to the mud ring. These plates were welded in place and riveted to the mud ring.

It was necessary to make some changes to the receiving pocket at the crusher plant to dump the Athey wagon. A new model R.D.8 caterpillar and a 13 cubic yard Athey Truss Wheel Company trailer was purchased to haul the ore from the lower bench in the west pit. We also purchased a LaPlant-Choate Mfg. Company trail-builder to do some stripping. All of the above equipment operated very satisfactorily.

One of the 10" McCully fine reduction crushers, serial #8347, developed trouble on May 31st. On close inspection it was found to have a very bad crack in the base section. This was too far gone to repair by welding so it was replaced with a base section taken from the old Empire Mine, crusher #8095, which is a duplicate machine. This change was started on June 2nd. and completed on June 7th.

The idler pulley on the head end of the belt conveyor broke on June 10th. A new pulley was made at the General Shops and installed without causing any delay in shipment of ore.

A new set of 5 1/2" concaves were installed in the Traylor crusher on August 6th. The old concaves were completely worn out and the product was too large for the 10" crushers to handle without slowing up production.

A crack developed in the boom of the #31 shovel. This crack extended almost all the way around the boom. Repairs were made without causing any delay to shipments. The dipper sticks also broke on this shovel and were replaced with a spare set on hand. The old sticks are being rebuilt at the General Shops this winter.

ATHENS MINE:

A complete set of rubber lined idler sheaves were installed for both the skip and cage ropes.

A new stack was erected for the dry and shop heating plant. The old stack was put up on March 22, 1932 and discarded April 15, 1939 after about seven years service.

In November repairs were made to a crack on one of the underground pumps by shrinking a ring around the flange and electric welding the crack. About 400 feet of the 10" discharge pipe in the shaft is in very poor condition. It has been necessary to patch this pipe at several places by electric welding. New pipe has been ordered to replace the top 400 feet.

The cooling pond at the engine house has been rebuilt.

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ATHENS MINE: (Continued)

A No. 75 Maastoker was installed in the engine house heating boiler. This machine has a capacity of 2500 sq. ft. radiation and was purchased from Thomas Trevithick for \$357.00 installed. A new stack which was built at the General Shops was installed on this boiler.

Necessary additional shovel cable was secured and the usual overhaul of the electric shovels was made.

MAAS MINE:

In January the 10" pump discharge line in the shaft started to give considerable trouble. After patching the line several times it was decided to inspect and test this pipe from surface to the pump house. It was found in good condition. On February 18, 19 and 20th. supporting clamps were installed and the line straightened. A broken flange near the bottom was removed and the pipe welded together at this point. The lower length, which was split about 24", was welded and appears to be in good condition. However, we have a spare length to replace this piece if it becomes necessary.

On February 15th. the crankshaft on the Aldrich quintuplex pump broke doing considerable damage. It was necessary to get a new A frame. The repair parts for this pump were received on April 6th. and installed at once. A new forged steel crankshaft which was in stock replaced the broken cast steel one. A new pinion and gear purchased from the Farrell Machinery Company was installed to replace the old gears which were very badly worn. A new "A" frame was installed to replace the broken one. The babbitt in the main bearings was removed and renewed and all brass bushing and bearings were replaced where necessary. All plungers were packed with metallic packing which was made at the General Shops. The pump has been completely rebuilt and is in first class condition.

Weir tests on the plunger pumps since they were repaired show them to be pumping full capacity.

On April 8th. the 350 H.P. General Electric motor on the Alberger centrifugal pump burned out and was replaced with a duplicate rotor from a pump at the Negaunee Mine.

On May 8th. the gear on the skip hoist was found loose on the shaft. Repairs were started on May 19th. and completed May 22nd. This gear was taken off, a new key fitted and the gear was replaced and welded to the shaft.

A new motor was installed in the skip hoist motor to replace one that had several coils burned out.

A new set of intercooler tubes was installed in the #1 air compressor as the old tubes were in bad condition. The heating plant boiler developed a bad leak in the fire box and repairs were made by welding. Some repairs were made to the #7 $\frac{1}{2}$  McCully crusher. The ring gear was raised  $\frac{1}{4}$ " and a new heavy dust collar was installed to stop the fine ore from getting into the ring gear. A new set of grizzly bars were installed to replace the old bars that were completely worn out.

The brake band on the cage hoist cracked and was repaired by electric welding.

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MAAS MINE: (Continued)

The skip hoist motor burned out and was repaired, with forced ventilation installed to keep the temperature within safe operating limits. Due to the persistent heavy demand on this unit it was decided to secure a new rotor. This is now in operation.

The larry car equipment, consisting of three cars, was installed and after certain changes in apparatus on the control and replacement of solenoid brakes with larger units, it is now in satisfactory operation. Apparently this new and original equipment is meeting our conditions in a proper manner. It is thought that this may now be considered as proper for any future tramming conditions for stocking.

NEGAUNEE MINE:

Some bearing trouble was experienced with the ventilating fan on January 10th. The bearings were rebabbitted and put in good condition.

Due to band wire trouble the skip hoist motor-generator set was out of commission in August for four days. Repairs were made at the General Shops. A new breeching was put on the heating boiler stack.

The motor on the motor-generator set driving the hoists, broke a band wire and a following fire nearly destroyed the motor. The mine was operated at limited capacity with the old set while repairs were made. This unit operated well for several months and then a weakness developed in the repaired unit. This was reported to the Westinghouse Elec. & Mfg. Company and in co-operation with our men was put in good condition. We billed and collected for the extra repair expense from the Westinghouse Company.

LLOYD MINE:

An extra section of grizzly bars were added to the old set to get better separation of the ore.

An 8' rubber lined sheave for the top tram plant was badly warped and was replaced with one formerly used at the Stephenson Mine.

The idler stands were equipped with rubber lined sheaves.

An addition was built to the cooling pond to give us a little more capacity and better cooling effect on the water.

The increased load and condition of the haulage sets clearly indicates the necessity for a new haulage set in the near future. This is important and should be cared for without delay.

SPIES-VIRGIL MINE:

A little trouble developed on the #8 crusher as the fine ore was getting into the gears. The head was taken out and the shaft retreaded for a new type nut. The center opening in the main frame was built up to get a new and higher bearing for the dust collar, which stopped the fine ore from getting in on the gears. The motor was a little out of alignment and this was taken care of at the same time.

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SPIES-VIRGIL MINE: (Continued)

The compressor intercooler was leaking badly. This was replaced with a spare from Ishpeming. There were some leaks in the cylinder head gaskets, the gaskets being replaced with new ones.

The heating plant boiler was in poor condition. This boiler was scrapped and a 50 H.P. boiler from the Hill-Trumbull Mine was installed in the heating plant.

The top tram cars were in very poor condition. They were rebuilt and are now operating without any trouble.

The idler stands were equipped with 20" rubber lined sheaves.

The top 300 feet of 8" discharge pipe in the shaft was in poor condition. It was replaced and is now in good condition.

MACKINAW MINE:

This mine has not been in operation for the entire year. Pumping water was the only activity at this mine.

The main hoist drum spider spokes were cracked. Repairs were made and this should be satisfactory for some time. ✓

GWINN DISTRICT:

A second booster pump was purchased for the Princeton location water supply and the booster pump station moved to a new location near the Escanaba River.

GENERAL:

The steam shovels operated very satisfactorily during the season, with very little trouble from break downs. There is considerable repairing to be done this winter to get them in condition for next season.

Further changes and developments have been made in the protective equipment for slusher motors and we now feel that a proper solution has been reached. The limited amount of serious trouble and delay in this apparatus and relatively low maintenance is worthy of note.

HILL-TRUMBULL MINE:

Repairs at the washing plant and on pit equipment were completed by May 1st. and ore operations started May 8th. The only heavy expenditure for new machinery was the caterpillar track equipment for the 350-ton steam shovel. This cost \$10,000 but reduced the number of pit men from six to one.

Besides a new chemical laboratory at the washing plant, a new change house was installed for sixty men, consisting of a steel building 20' x 40' equipped with showers and lockers.

The washing plant completed operations October 23rd. with total concentrates as follows:

Hill	119,841
Trumbull	664,446
	784,287

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HILL-TRUMBULL MINE: (Continued)

At the close of the ore season overhauling of mill equipment got under way immediately and requisitions made covering necessary repair material. The heavy production season filled the south dyke with tailings and the dragline was needed to rebuild the banks to normal height.

HOLMAN MINE:

This mine was idle until October, when it was decided to recondition tracks and lower the pit water ready to do some stripping. A 7000 G.P.M. pump from the Canisteo Mine was installed on a scow in the pit and started operating November 24th. Pumping continued to the end of the year.

The No. 32 4-yd. shovel was shipped from the Canisteo Mine to the Brown pit and started stripping November 27th, completing the job in December with three new 15-ton Euclid trucks recently purchased for the Hill-Trumbull Mine. The trucks were returned to the Hill-Trumbull for additional winter stripping to continue into 1940.

CANISTEO MINE:

In April a contract was made with Congdon Brothers for our company to operate the pit for this year and the following equipment was purchased.

- 1 D-8 Caterpillar tractor complete with angledozer
- 1 Model 99 motor grader
- 6 Euclid 15-ton trucks equipped with 150 H.P. Cummins deisel engines

The first two trucks were received May 9th. and the last of the six on May 22nd. This fleet was busy all season either on stripping or hauling ore to ramp in pit, where it was loaded in 30 yd. cars and hauled to washing plant with the steam locomotives.

Ore operations started June 23rd. and were completed October 13th. Total tons of concentrates was 217,088.

To eliminate the long crude ore haul to washing plant it was decided to pile the rock in the pit and move the washing plant about 2 miles near the pit bank, with a belt conveyor bringing the ore from pit bottom to top of washing plant. The Worden-Allen Co. was given a contract to raze the washing plant and to rebuild it on foundations poured at the new location during October and November. Work of tearing down the plant was completed in December and moving was completed ready for re-erection to start in January 1940.

A new three flight 36" conveyor layout totalling over 1,000 feet long was laid out and the necessary steel machinery purchased from the Link-Belt Company.

Due to the fill required by the Great Northern Ry. Co. to complete concentrates tracks at new washing plant site it was necessary to abandon the company tracks into the pit. Before these were removed in December the 80-ton 40" x 42" jaw crusher was hauled to pit location and set on its foundation. The remainder of the screening and crushing plant in pit will be erected with the 3/4-yard gas shovel.

After trying for 10 years to get a satisfactory water supply well for location and shops a 3" pipe line was run from Coleraine and completed in November.