Safety Department

Annual Report

Year 1953

11. ACCIDENTS AND PERSONAL INJURY

c. Safety Inspection (Continued)

Central Safety Committee (Cont'd)

JUNE 23 - whether he should be at the front or back of locomotive. Members to investigate and report.

Lost time injuries and "return-to-work" slips came in for discussion. Opinion was, there was sometimes too much delay after attending Doctor had discharged his patient. Dr. Waldie to check.

JULY 17 - Report on cage accidents at the Cary and Geneva Mines by Safety Department. Cary Mine cage accident caused a short strike and Geneva Mine accident caused fatality.

Discussion on authority of State Health Department employees. They do have authority. Employees of Labor Commission inspect above the surface elevators.

Report on first Safety Foreman's meeting was good and these meetings will continue.

Decided that all powder magazines must be kept locked when there is no attendant.

After shaft gauging at mines, Superintendents must report to Manager and Safety Department what action is taken if necessary.

AUGUST 18 - Considerable discussion on blasting accident which occurred at the Athens Mine. Some believe that it was faulty fuse but tests have proven over the years, that fuse has always been good. Tests are made of several pieces cut from each roll and none have been under the minimum limits. Decided that probably spitting fuse ignited a powder train left in the hole. This is usually the case.

Lake Superior Mines Safety Council will make up new safety posters which are more applicable to our mines. Mr. Stromquist was elected Chairman of the committee which will pay ten dollars to any employee of Lake Superior Mines who presents an acceptable poster. All employees are interested in posters such as put out by Anaconda Copper Company and made up by Mr. Jack Powers.

Cleaning rock drills with flammable "Stanisol" should

(Continued On Next Page)

Safety Department

Annual Report

Year 1953

11. ACCIDENTS AND PERSONAL INJURY

c. Safety Inspection (Continued)

Central Safety Committee (Cont'd)

AUGUST 18 - be stopped. Mr. Stromquist has information on a solvent called "Penolene" which is non-toxic and non-flammable. It is expensive but can be used safely and can take the place of some toxic and flammable solvents. Mather "B" will use it in place of naptha or white gas to clean conveyor belts before vulcanizing.

Safety rules to be revised as soon as possible. All supervisors to help with this job.

SEPTEMBER 12 - Discussion on medical aid for employees who live in out-of-way places such as Baraga and L'Anse.

Compulsory wearing of eye protection - No action taken. To check all conditions with supervisors.

Employees who quit the employ of the Company must report to Dr. Waldie for examination, otherwise quit slips should not mention illness.

Discussion on action of "Lilly Controls" on hoist engines. Man injured slightly at Cambria-Jackson Mine when cage stopped suddenly. Cage apparently was over-speeding. Speed controls always act quickly.

OCTOBER 14 - Stench warnings at each property must be checked. Because of volume of compressed air used on surface much of the stench is lost there. Must consider placing smaller stench devices on each level. Also small opening or valve must be provided to release stench into ventilation currents because victaulic couplings on pipe lines do not allow leaks.

Again subject of 100% wearing of eye protection was brought up without a decision.

NOVEMBER 11 - Safety Department to investigate placing a quick acting valve on Eimco Loaders, also to ask manufacturer to incorporate the valve and dead man controls in manufacture of loader including safety chains for the compressed air feeder line.

Committee appointed to investigate 100% wearing of eye

(Continued On Next Page)

11. ACCIDENTS AND PERSONAL INJURY

c. Safety Inspection (Continued)

Central Safety Committee (Cont'd)

NOVEMBER 11 - protection with exceptions.

DECEMBER 18 - Pulling ore from end of slice again discussed. More time required before decision can be made whether guarding is efficient enough to prevent injury.

A new guard to keep drill rods from dropping from drill hole when adding more lengths of rod seems to be another good safety device. A print will be sent to all mines.

11. ACCIDENTS AND PERSONAL INJURY

c. Safety Inspection (Continued)

Lake Superior Mines Safety Exchange

We are charter members of the Exchange which has proved very useful. The exchange, which permits each of the eleven companies to submit questions to other members, gives us a chance to get answers to problems which are new in our field. This has been especially useful since opening up our new pits and plants. No special meetings are called for the Exchange but is generally held either before or after Sectional meetings of the Lake Superior Mines Safety Council.

Lake Superior Mines Safety Council

January 8, 1953	-	Virginia, Minnesota
February 12, 1953	-	Caspian, Michigan
March 12, 1953	-	Ironton, Minnesota
April 9, 1953	-	Ironwood, Michigan
May 7, 1953	-	Duluth, Minnesota
May 21-22, 1953	-	Duluth, Minnesota
July 16, 1953	-	Duluth, Minnesota
August 14, 1953	-	Duluth, Minnesota
September 17, 1953	-	Ely, Minnesota
November 12, 1953	-	Grand Rapids, Minnesota
December 9, 1953	-	Ishpeming, Michigan

The following employees of The Cleveland-Cliffs Iron Company took part in programs presented by the Council:

T. W. Hill, Safety Engineer - "Review of Accidents In The Lake Superior District".

Walter Gries, Toastmaster.

C. R. Sundeen, Superintendent, Maas Mine - "Deepening The Negaunee Shaft".

A. G. Hurley, Safety Inspector - Chairman, Grand Rapids meeting.

Orin R. Bell, General Pit Foreman - "Open Pit Safety".

M. A. Swanson, Senior Foreman - "Safety In Sub-Level Caving" Panel Discussion.

A. J. Stromquist, member of following committees - Chairman, Poster Committee - Executive Committee - Program Committee and Publicity Committee.

(Continued On Next Page)

Safety Department

Annual Report

Year 1953

11. ACCIDENTS AND PERSONAL INJURY

c. Safety Inspection (Continued)

National Safety Council

We have been getting good service from this organization and the Mining Section is doing a much better job of providing better posters and visual aids. Strip films have been made up for Heavy Duty Trucking which we have already used and "Barring In Mines"which should be ready for distribution this spring.

The Mining Section has been separated from Coal Mining for a number of years and has a very large membership of which about one-third is from Canada. This has proven to be of great help because our programs each year are not dominated by Coal Mining.

I was General Chairman for the 1952-1953 period and also am on the Executive Committee and Poster and Visual Aids Committee.

The annual meetings are held in Chicago, usually during October month. Attendance last year at the Mining Section meetings attracted over one hundred persons each day and will now require larger quarters for the meetings.

Our company has been well represented at the annual meetings each year. Dana Cory gave a paper last year on "Underground Communication" which was very well received.

Safety "Banner Flag"

The Lloyd Mine won the flag for 1953 with a frequency rating of 19.10 and a severity rating of 0.202 for underground mines. This was a close race with the Spies-Virgil Mine which finished the year with a frequency of 19.13 and severity of 0.225.

For open pit operations, the Tilden finished first with no-lost-time injuries. The Tilden has operated 58 months without a compensable accident. The Wanless has operated 29 months without a compensable injury.

Of the independent units, the Cliffs Power & Light Company (now Electrical Department) is winner of the "Banner Flag" by not having a lost time injury.

Safety Department

Annual Report

Year 1953

11. ACCIDENTS AND PERSONAL INJURY

d. Ventilation

Ventilation is one of the most important functions in safety and efficiency in underground mining. Many mines could not be operated without mechanical or forced ventilation.

All of our mines in Michigan are equipped with main mine fans. In addition, some have booster and auxilliary fans depending on size of the mine and method of mining. Most of our supervisors are ventilation minded because they realize that ventilation must be provided in order to clear smoke and dust rapidly from work places and keep favorable temperatures for men to work in.

Briefly the ventilation at each underground mine is as follows:

AGNEW MINE

Natural ventilation is assisted by many auxilliary fans of various sizes. This is a shallow mine and has a number of openings to surface besides the main shaft. In the Allworth area a raise has been put up to surface and a small fan located at surface. This raise provides ventilation and a means of travel to surface in case of emergency. Ventilation of the old mining area is good but the Allworth area cannot be considered more than fair.

ATHENS MINE (BUNKER HILL)

Because of the changes and development work being done in this mine the ventilation has varied. The main mine fan will be relocated and replaced so that the Athens Shaft will be downcast and the Negaunee Shaft will carry the return air. The fan has handled between 80,000 and 85,000 c.f.m. which is sufficient for this mine. Booster and auxilliary fans are used extensively and have provided good conditions throughout the mine. When the new ventilation plan is in effect the mine will be operating on a number of splits which is as it should be for the large area which has been developed.

CAMBRIA-JACKSON MINE

The main mine fan is located on the Mather Mine, "A" Shaft 3rd level at the Cambria boundary line. This fan, a Jeffery Aerodyne, is forcing 54,000 c.f.m. to the bottom level of the Cambria-Jackson through a connecting raise. Exhaust is through the Cambria-Jackson shaft and some through the old caves in the West end of the property. Ventilation is good throughout the mine.

CLIFFS SHAFT MINE

The main mine fan is a Jeffery Aerodyne, Jr. located on the East end of the 6th level at the bottom of the old Incline Shaft. It

(Continued On Next Page)

Safety Department

Annual Report

Year 1953

11. ACCIDENTS AND PERSONAL INJURY

d. Ventilation (Continued)

CLIFFS SHAFT MINE (Cont'd)

forces 130,000 c.f.m. into the mine at one inch water gauge. Ventilation is very good. Small booster fans are sometimes required for certain areas when a break-through is made between stopes.

LLOYD MINE

Because the life of this mine has been doubtful, no extensive work has been done to keep ventilation up to our standards. At the present time, two fans of 18,000 c.f.m. capacity are in use just above the working area. A third fan located on the 4th level at Section Six Shaft is idle but can be used in an emergency. The second outlet is now on the 7th level to the Morris Mine by agreement with Inland Steel instead of through the Section Six Shaft. This eliminates long travel and repairs required to keep a travel and airway open. Because only recently the Lloyd shaft has been used for both intake and return air it is not known how well the system will work during warm weather but a constant check will be kept and air samples taken.

MAAS MINE

The main fan is located on surface at Negaunee #2 Shaft. This is a Jeffery 8-H-72 fan and is capable of handling 125,000 c.f.m. in the #7 blade position. In its present #4 position it is handling 80,000 c.f.m. The mine has two splits, one from the Negaunee 13th level to the Maas 4th level and the other from the Negaunee 14th level to the Maas 6th level. Ventilation is very good.

MATHER MINE, "A" & "B" SHAFTS

These two mines are on the same ventilation system using a LaDel H-56-36 fan on the 6th level between the two shafts, handling 97,000 c.f.m. and a booster fan on the 7th level handling 31,000 c.f.m. for a total of 128,000 c.f.m. For the most part, the ventilation is very good in the mine but because of fast changing conditions a continuous check must be made to keep good ventilation in all sections of the mine.

SPIES-VIRGIL MINE

The Spies-Virgil is ventilated with a Jeffery 8-H-42 fan capable of handling about 60,000 c.f.m. It is operated in a low blade position to handle only 30,000 c.f.m. which is sufficient for the mine. The ventilation system is very simple here because air can be taken down the Spies Shaft to the bottom level, forced to the bottom of the stopes, then up through the stopes to the exhaust air shaft. Ventilation is very good.

Safety Department

Annual Report

Year 1953

11. ACCIDENTS AND PERSONAL INJURY

d. Ventilation (Continued)

Dust Sampling & Analysis

Most of the dust samples we have taken are from operations where we suspect the poorest conditions. Time does not permit sampling all work places and is hardly necessary. The man taking the samples reports to the superintendent or mining captain any condition which needs immediate attention such as better ventilation, wetting down or wet drilling in rock.

Analysis of dust samples are made the same day as taken if only a morning trip is made. In other cases the analysis are made the following day and report submitted. Three month averages of various operations are reported to show comparison and where corrections are to be made. Test samples of new operations are not always reported in the annual report because in most cases they are not representative of the operation.

During the past year the average dust counts have been better than any previous year. This can be attributed to the fact that supervisors recognize dust hazards better than in years past and know how to prevent poor conditions. Many miners also realize the need of preventing dust in their work places and resist the temptation of starting drill holes dry.

Ventilation, wet drilling, wetting down and water misting curtains are the main means of allaying dust and this is very well done at most properties.

The use of a portable steel scraper slide at the Maas Mine has always been a source of dust because of the grinding action of the chunks as they are pulled up the apron of the slide. I recommend that the steel scraper slide be replaced with the conventional loader so that wetting down and ventilation can be used effectively.

The combination of scraping ore and breaking chunks has been given much attention because of some high counts. No effective method, outside of a strong ventilation current, can eliminate this source of dust.

The following tables are self-explanatory showing where our counts are good or too high. Noticable is that counts on an average are higher in raising than in drifting. This is mainly because there is a tendency to start holes dry. Also at times it is difficult, because of the confined area, to bring good ventilation to the breast of the raise.

The overall picture I believe is very good.

Safety Department

Annual Report

Year 1953

11. ACCIDENTS AND PERSONAL INJURY

d. Ventilation (Continued)

The tables on this and following pages give location and various occupations where dust counts were taken; also, total averages of counts since 1933, when the first counts were taken.

TABLE XXI

DUST SAMPLES COLLECTED - ROCK AND ORE WORK

Mine Or Plant	1953 In Ore	1953 In Rock	1953 Total	1933 - 1953 Total
ATHENS	9	20	29	843
CAMBRIA-JACKSON	19	8	27	366
CLIFFS SHAFT	49	54	103	1920
HUMBOLDT	0	4	4	4
LLOYD	7	8	15	762
MAAS	34	19	53	822
MATHER MINE "A" SHAFT	11	20	31	851
MATHER MINE "B" SHAFT	18	24	42	366
NEGAUNEE SHAFT	0	18	18	830
PRINCETON *	0	0	0	85
RESEARCH LABORATORY	12	0	12	39
SPIES-VIRGIL	15	0	15	189
TILDEN	11	0	11	91
MISCELLANEOUS	0	0	29	191
TOTALS	185	175	389	7,359

* Now Closed Down

Safety Department

Annual Report

Year 1953

11. ACCIDENTS AND PERSONAL INJURY

d. Ventilation (Continued)

TABLE XXII

VARIOUS OCCUPATIONS WHERE DUST SAMPLES WERE COLLECTED

Occupation	ATHENS	CAMBRIA-JACKSON	CLIFFS SHAFT	HUMBOLDT	LLOYD	MAAS	MATHER MINE "A" SHAFT	MATHER MINE "B" SHAFT	NEGAUNEE SHAFT	RESEARCH LABORATORY	SPIES-VIRGIL	TILDEN	TOTAL
DRILLING	16	16	53	4	6	22	16	15	13		14		175
SCRAPING	8	9	20		5	31	9	10	3		1		96
LOADING CARS (USING LOADERS)	1	2	6		4		4	7	2				26
TIMBERING	2					2	1						5
HAND SHOVELING								2					2
BARRING BACK			1				2						3
GENERAL MINE AIR	4	1			1	4	3	4		2			19
CHARGING HOLES							1		1				2
CRUSHING ORE			23							7		8	38
LAYING TRACK					1								1
UNDERGROUND ENGINE HOUSE (ASBESTOS DUST)						8							8
SURFACE CONVEYOR GALLERIES								8					8
SCREENING PELLETS										3			3
LOADING CARS (AT POCKET)												3	3
TOTALS	31	28	103	4	17	67	36	46	19	12	15	11	389

Safety Department

Annual Report

Year 1953

11. ACCIDENTS AND PERSONAL INJURY

d. Ventilation (Continued)

TABLE XXIII

AVERAGE LIGHT FIELD COUNT OF ALL SAMPLES TAKEN

Mine Or Plant	1933	1934	1935	1936	1937	1938	1939
ATHENS		32.90	14.12	28.32	26.69	12.85	12.59
CAMBRIA-JACKSON *							
CLIFFS SHAFT	17.94	14.56	8.29	8.98	15.53	9.86	10.36
LLOYD		9.90	12.42	39.25	20.25	10.84	13.47
MAAS		7.46	27.55	35.75	150.98	11.24	36.90
MATHER MINE "A" SHAFT							
MATHER MINE "B" SHAFT *							
NEGAUNEE		53.80	17.77	33.25	59.06	56.26	25.49
PRINCETON *							
SPIES-VIRGIL					70.61	26.99	1.80
TILDEN				67.52	285.27	74.60	60.40
GARDINER MACKINAW		27.77		8.61	48.53		
MISCELLANEOUS			8.66	3.00	6.80	14.73	

* Not In Operation During This Period

(Table Cont'd - Next Page)

Safety Department

Annual Report

Year 1953

11. ACCIDENTS AND PERSONAL INJURY

d. Ventilation (Continued)

TABLE XXIII (Cont'd)

AVERAGE LIGHT FIELD COUNT OF ALL SAMPLES TAKEN

Mine Or Plant	1940	1941	1942	1943	1944	1945	1946
ATHENS	9.89	7.28	25.80	4.90	8.33	6.64	4.17
CAMBRIA-JACKSON				12.10	6.21	17.05	11.99
CLIFFS SHAFT	7.77	8.18	7.55	5.99	6.23	8.18	6.34
LLOYD	11.73	8.05	6.95	5.01	14.45	6.49	9.38
MAAS	8.71	17.29	8.46	12.48	8.78	8.17	9.29
MATHER MINE "A" SHAFT		2.42	5.58	6.64	7.57	8.39	7.72
MATHER MINE "B" SHAFT *							
NEGAUNEE	10.79	14.02	17.02	4.65	11.81	11.92	6.67
PRINCETON				10.59	6.32	8.48	
SPIES-VIRGIL	8.40	6.97			5.59	14.22	3.59
TILDEN		49.60				24.18	66.92
GARDNER MACKINAW **							
MISCELLANEOUS			3.00				

* Not In Operation During This Period

** No Longer In Operation

(Table Cont'd - Next Page)

Safety Department

Annual Report

Year 1953

11. ACCIDENTS AND PERSONAL INJURY

d. Ventilation (Continued)

TABLE XXIII (Cont'd)

AVERAGE LIGHT FIELD COUNTS OF ALL SAMPLES TAKEN

Mine Or Plant	1947	1948	1949	1950	1951	1952	1953
ATHENS	7.39	7.49	7.07	4.71	4.15	2.71	2.37
CAMBRIA-JACKSON	9.30	13.81	6.86	9.50	8.32	4.54	6.80
CLIFFS SHAFT	8.64	5.12	6.26	3.46	4.90	2.76	4.45
HUMBOLDT **							1.59
LLOYD	11.17	12.97	11.72	11.32	6.28	4.72	5.17
MAAS	6.08	21.08	10.55	4.45	4.84	4.93	7.06
MATHER MINE "A" SHAFT	10.88	9.50	8.40	7.01	8.75	5.86	5.15
MATHER MINE "B" SHAFT	2.23	4.16	2.46	6.68	5.04	5.40	5.56
NEGAUNEE	7.05	5.48			2.27	1.70	2.60
PRINCETON *							
RESEARCH LAB.					5.81	5.57	7.14
SPIES-VIRGIL	11.65	5.24	10.12	18.78	6.05	5.29	4.75
TILDEN	33.65	2.93	4.38	3.74	6.34		3.05
GARDNER MACKINAW *							

* No Longer In Operation

** First Samples Were Taken This Year.

11. ACCIDENTS AND PERSONAL INJURY

d. Ventilation (Continued)

TABLE XXIV

COMPARISON OF DUST COUNTS IN RAISING TO DRIFTING

Mine	Average In Raising	Average In Drifting	General Average *
ATHENS		1.77	2.37
CAMBRIA-JACKSON	12.78	3.09	6.80
CLIFFS SHAFT	6.15	3.32	4.45
LLOYD	3.06	3.09	5.17
MAAS	6.12	9.21	7.06
MATHER MINE "A" SHAFT	6.79	1.81	5.15
MATHER MINE "B" SHAFT	6.30	3.22	5.56
NEGAUNEE SHAFT		2.55	2.60
SPIES-VIRGIL			4.75

* Includes Miscellaneous And General Air Samples.

Safety Department

Annual Report

Year 1953

11. ACCIDENTS AND PERSONAL INJURY

d. Ventilation (Continued)

TABLE XXV

AVERAGES IN ORE COMPARED TO AVERAGES IN ROCK

Mine	Average In Ore	Average In Rock	General Average*
ATHENS	2.81	2.32	2.37
CAMBRIA-JACKSON	9.16	1.31	6.80
CLIFFS SHAFT	4.69	4.22	4.45
HUMBOLDT		1.59	1.59
LLOYD	9.14	2.33	5.17
MAAS	6.55	7.81	7.06
MATHER MINE "A" SHAFT	9.46	3.16	5.15
MATHER MINE "B" SHAFT	8.61	3.65	5.56
NEGAUNEE SHAFT		2.59	2.60
RESEARCH LAB.	7.14		7.14
SPIES-VIRGIL	4.75		4.75
TILDEN	3.05		3.05

* Includes Miscellaneous And General Air Samples.

Safety Department

Annual Report

Year 1953

11. ACCIDENTS AND PERSONAL INJURY

d. Ventilation (Continued)

TABLE XXVI

COMPARISON OF AVERAGE DUST COUNTS IN VARIOUS OPERATIONS

Operation	ATHENS	CAMB. JACK.	CLIFFS SHAFT	LLOYD	MAAS	MATHER "A"	MINE "B"	NEG. SHAFT	SPIES-VIRGIL
MAIN LEVELS:									
Drilling In Rock(wet)	1.49	.92	3.27	1.18	4.37	1.79	1.35	2.12	
Loading Rock		2.48	3.76	2.53		1.86	6.43	3.85	
Scraping Rock(Steel Scraper Slide)					18.03				
Scraping Rock(Steel Scraper Slide With Water Sprays)					4.79				
Loading Ore	2.26								
Timbering	2.54				2.10	3.14			
Idle	2.18					2.25			
Drilling In Ore(wet)			1.95			1.24			
Scraping Ore			4.51	8.44					3.16
Laying Track				3.78					
Scraping Rock						1.45		4.50	
Barring Back						1.68			
Hand Shoveling Rock							1.31		
Charging Holes								2.84	

(Table Cont'd - Next Page)

Safety Department

Annual Report

Year 1953

11. ACCIDENTS AND PERSONAL INJURY

d. Ventilation (Continued)

TABLE XXVI

COMPARISON OF AVERAGE DUST COUNTS IN VARIOUS OPERATIONS

Operation	ATHENS	CAMB. JACK.	CLIFFS SHAFT	LLOYD	MAAS	MATHER "A"	MINE "B"	NEG. SHAFT	SPIES-VIRGIL
SUB-LEVEL DRIFTS:									
Scraping Ore	2.14	8.91		9.40	5.52	19.78			
Scraping Rock	2.11				8.20	9.11			
Timbering	.66				3.70				
Drilling In Ore(auger)		7.80			5.84				
Scraping Ore & Breaking Chunks		10.09		11.15	8.67				
Drilling In Ore(wet)				4.68	4.15		7.72		6.29
Drilling In Ore(rotary)					5.34	4.91			
Drilling In Rock(wet)					2.53				
Idle						7.06			
TOP TIMBER TRANSFER DRIFTS:									
Drilling In Ore(auger)	3.59								
Scraping Ore	3.43				21.94	9.24	19.12		
Drilling In Rock(wet)	3.04						6.12		
Scraping Rock	4.58						1.56		
Idle	1.40								
Scraping Ore & Breaking Chunks							13.92		
Drilling In Ore									3.27

(Table Cont'd - Next Page)

Safety Department

Annual Report

Year 1953

11. ACCIDENTS AND PERSONAL INJURY

d. Ventilation (Continued)

TABLE XXVI

COMPARISON OF AVERAGE DUST COUNTS IN VARIOUS OPERATIONS

Operation	ATHENS	CAMB. JACK.	CLIFFS SHAFT	LLOYD	MAAS	MATHER "A"	MINE "B"	NEG. SHAFT	SPIES-VIRGIL
RAISES									
Drilling In Ore(auger)		12.78			3.88				
Idle		5.80							
Drilling In Rock(wet)			6.09	3.06	7.24	8.39	6.30		
Drilling In Ore(wet)			6.81						
Charging Holes						3.58			
STOPES:									
Drilling In Ore(wet)			2.45						4.74
Barring Back			.96						
Scraping Ore			6.41						
Scraping Rock			1.33						
Drilling In Ore(auger)				8.04					
AVERAGE COUNTS FOR:									
MAIN LEVELS	1.77	3.09	3.32	3.09	9.21	1.81	3.22	2.55	3.16
SUB-LEVEL DRIFTS	1.88	9.50		9.50	5.47	12.69	7.72		6.29
TOP TIMBER TRANSFER DRIFTS	3.17				21.94	9.24	13.70		3.27
RAISES		12.78	6.15	3.06	6.12	6.79	6.30		
STOPES			3.77	8.04					4.74
GENERAL AVERAGE	2.37	6.80	4.45	5.17	7.06	5.15	5.56	2.60	4.75

Safety Department

Annual Report

Year 1953

11. ACCIDENTS AND PERSONAL INJURY

e. Mine Safety, First Aid and Mine Rescue Courses

MINE SAFETY

All properties had courses in electrical blasting for supervisors. The classes were conducted by the electrical foreman showing equipment, safe methods, hazards involved and various other details. We expect to continue these courses as frequently as necessary.

FIRST AID TRAINING

First aid training was conducted for employees of the Ohio Mine. A film on the new method of artificial respiration was shown at many of the properties.

MINE RESCUE TRAINING.

Mine rescue training was conducted for over 200 men on two occasions during the year. All first aid and mine rescue training was conducted by personnel of the Safety Department who are all certified instructors by the U. S. Bureau of Mines. The number of men trained is listed, by mines, in the following table.

Safety Department

Annual Report

Year 1953

11. ACCIDENTS AND PERSONAL INJURY

e. Mine Safety, First Aid and Mine Rescue Courses (Cont'd)

TABLE XXVII

MINE RESCUE TRAINING
MICHIGAN MINES

Mine	NUMBER OF MEN April & May	December
ATHENS	24	19
CAMBRIA-JACKSON	11	10
CLIFFS SHAFT	21	21
LLOYD	9	4
MAAS	28	27
MATHER MINE "A" SHAFT	60	54
MATHER MINE "B" SHAFT	43	41
MINING ENGINEERS	11	6
NEGAUNEE SHAFT	12	10
SPIES-VIRGIL	15	0
TOTALS	234	192

Entire Group Received 8 Hours Of Review In December.

FIRST AID TRAINING

Mine	No. Of Men
OHIO	15

All Training Conducted By Members Of The Safety Department.

Safety Department

Annual Report

Year 1953

11. ACCIDENTS AND PERSONAL INJURY

e. Mine Safety, First Aid and Mine Rescue Courses (Cont'd)

TABLE XXVIII

FIRST-AID SUPPLIES DISTRIBUTED

MATERIAL	NO. DISTRIBUTED
Tyro-Thri-Cin Pads (Band-Aids)	76,105
Ounces Of Merthiolate	146
1" Roller Bandage	161
2" Roller Bandage	179
3" Roller Bandage	148
Rolls Of Adhesive Tape	146
Picric Acid Gauze Pads (For Burns)	144
Plain Gauze Pads	130
Leather Finger Cots	130
Merthiolate Applicators	2,586
Ounces Of Aromatic Spirits Of Ammonia	19
Ounces Of Absorbent Cotton	33
Tubes Of Surfacaine	37
Triangular Bandages	22
Pairs Of Scissors	1
Bottles, 1 Oz. (Medicine)	28
2" Compress Bandages	118
3" Compress Bandages	63
5/8 Oz. Tubes Of Foille Ointment	20
1/2" Adhesive Tape	4
TOTALS	80,618

Safety Department

Annual Report

Year 1953

11. ACCIDENTS AND PERSONAL INJURY

f. Miscellaneous

Loss from fire during the year was small. Very few reports of fires were received by this office. The department was called to Mather Mine, "A" Shaft on August 10, 1953 when smoke was detected coming up the shaft. A crew, with 2 hour breathing apparatus went to the 1st level where an electric pump motor was on fire. No trouble was experienced in putting out the fire. A second crew checked for gases but no dangerous concentration was found. There was no loss of time but damage to the motor.

At the Humboldt Mine our employees put out a fire in a steam heater for asphalt owned by The N. A. Dettmor Company which had a plant located across the road from the Humboldt Mine. Only a few minutes were required to extinguish the fire with dry chemical.

Two fires occurred underground at the Cambria-Jackson Mine, one on October 19, 1953 and the other October 24, 1953. Both were extinguished before damage was done. The first fire was caused by a defective trolley switch, the other by a 200-watt electric light bulb which someone had moved without permission and left unprotected. Both fires extinguished with First-Aid extinguishers.

Sampling for radio-activity was started during the year with first work done by members of the Safety Department, Geological Department and the State Department of Health. All this work was done at the Maas Mine. Since completion of sampling of the Maas the Geological and Safety Departments have continued sampling at other company properties and hope to complete the work in April or May of 1954.

The Michigan Safety Committee, of which I was Chairman, completed its rough draft of a short and long form code which was submitted to all Michigan iron and copper mining companies for their constructive criticism.

A detailed fire protection and fire fighting plan was made up with supervisors of the Mather Mine.

In cooperation with the Lehigh Safety Shoe Company a felt safety shoe, for surface employees, was developed by Lehigh and used by our men. We made certain recommendations for a suitable shoe and Lehigh has now built this shoe to our satisfaction and it is being used by many of our surface employees during cold weather.

Assisted the Negaunee, Palmer and Ishpeming Fire Departments in training firemen in use of Gas Masks, Chemox O_2 Apparatus and Demand Apparatus and also trained them in First Aid to the injured.

All fire bulkheads at the Spies-Virgil Mine were checked from the 1330 Sub to the 8th level. One major air leak was found and

(Continued On Next Page)

Safety Department

Annual Report

Year 1953

11. ACCIDENTS AND PERSONAL INJURY

f. Miscellaneous (Continued)

immediately taken care of. The supervisory force has done a very good job of sealing all stopes as work is completed and no doubt has prevented an increase of sulphor fires in the area.

Forty-two employees received "Certificates Of Honor" from the Joseph A. Holmes Safety Association for working 40 or more years without a lost-time injury. Presentation of awards were made at a dinner at the Mather Inn.

Assisted Michigan State Police with an exhibit, representing Iron Mining, which was shown at the Law Enforcement Officers Convention in Chicago.

Arranged for float to be used in parade at Negaunee on V-J day.

All hoisting engineers were instructed in use and purpose of stench fluid.

Have asked the cooperation of the Eimco Corporation in making their loading shovels safer for operators such as, dead-man controls, safety chains on compressed air hose and out-riggers and shoes to prevent tipping. We have installed outriggers, safety chains and a quick acting shut-off valve on the loader and have plans for dead-man controls.

Took part in many of the Supervisors Safety meetings at the various properties and showed movies and strip-films.

Last but not least I wish to express the sincere appreciation of all members of the Safety Department for the excellent cooperation of management and employees in the prevention of injury. Without this help our safety program would fail.

The comparison of Accident Statistics are taken from available sources and are not all up to date with the exception of our Company.

TABLE XXIX

COMPARISON OF FREQUENCY, SEVERITY RATINGS TAKEN FROM AVAILABLE STATISTICS

	FREQUENCY	SEVERITY	1952 - LAKE SUPERIOR DIST. FREQUENCY	1952 - LAKE SUPERIOR DIST. SEVERITY
1952 National Rating, All Mining, Including Coal	28.66	5.07		
1952 " " , Coal Mining	33.00	6.19		
1952 " " , Other Mining (Not Including Coal)	29.22	4.74		
1952 " " , Metal Mining (Underground)	30.39	5.27		
1952 Lake Superior District Mines (23 Companies Reporting)	14.40	3.72		
1953 The Cleveland-Cliffs Iron Co., Compensable Injuries	15.39	2.08		
1953 The Cleveland-Cliffs Iron Co., All Injuries	23.39	2.11	14.40	3.72
1953 The Cleveland-Cliffs Iron Co., Open-Cut Mining	17.32	5.58	7.65	1.70
1953 The Cleveland-Cliffs Iron Co., Concentrating Plants	21.82	0.85	7.98	0.17
1953 The Cleveland-Cliffs Iron Co., Top Slicing	30.16	0.92	17.23	6.21
1953 The Cleveland-Cliffs Iron Co., Sub-Level Caving	35.40	0.87	23.39	5.61
1953 The Cleveland-Cliffs Iron Co., Stoping	25.14	0.67	25.16	8.34
1953 The Cleveland-Cliffs Iron Co., Block Caving	27.73	0.91	55.80	10.96
1953 The Cleveland-Cliffs Iron Co., Shaft Sinking & Devel.	27.54	24.08	20.36	8.76
1953 The Cleveland-Cliffs Iron Co., General Shops	13.17	1.73	7.06	1.00
1953 The Cleveland-Cliffs Iron Co., C. P. & L. Co.	0.00	0.00		
1953 The Cleveland-Cliffs Iron Co., General Roll	0.00	0.00		

COMPARISON OF FATALITY RATES*

1953 Bituminous Coal	0.81
1953 Anthracite Coal	0.89
1953 All Coal	0.82
1953 Metal Mining	0.51
1953 The Cleveland-Cliffs Iron Company	0.20

* Per Million Man Hours Of Exposure.

ANNUAL REPORT OF THE MINING ENGINEERING DEPARTMENT FOR THE YEAR ENDING DECEMBER 31, 1953

The five volumes that accompany this report contain photographic views, maps of both the surface and underground workings, open pit cross-sections and records of drilling of all the mines operated by The Cleveland-Cliffs Iron Company and its affiliated companies. The 1953 yearly mining progress or development is shown colored in red on the maps of the underground projects. The cross-sections of the open pit mines are colored to show the unmined formations, in addition to the portions of the pit volumes that were removed during 1953. The records of drilling and exploration are shown by drill logs and surface maps on which the drill hole locations are indicated. A number of photographs or views are incorporated in these volumes to pictorially show the construction progress at the various current operations of The Cleveland-Cliffs Iron Company.

Two sets of five bound volumes were compiled; one for the Cleveland office and the other for the Michigan Engineering Department at Ishpeming. One additional volume of the Minnesota Mines was bound and forwarded to the Minnesota office at Hibbing. Other booklets of looseleaf nature were prepared and distributed as indicated below. The following table shows the company for which the books, either bound or looseleaf, were prepared and the mine or mines in which that company has interest:

Company	Mines	
	For Itself	As Operating Agent
The Cleveland-Cliffs Iron Company	Agnew	Athens
	Alworth	Bunker Hill
	Cambria-Jackson	Hill-Trumbull
	Canisteo	Hill-Walker-Potter
	Cliffs-Shaft	Holman-Cliffs
	Hawkins	Humboldt
	Lloyd	Mather
	Maas	Ohio
	Negaunee	
	Republic	
	Sally	
	Sargent	
	Spies-Virgil	
	Tilden	
	Wanless-Woodbridge	
The Mesaba-Cliffs Mining Company Partners: Hanna Iron Ore Company Inland Steel Company Jones & Laughlin Steel Corporation Pittsburgh Steel Company Wheeling Steel Company		Hill-Trumbull Holman-Cliffs
The Athens Iron Mining Company for Pickands Mather & Company		Athens
The Negaunee Mine Company Partner: Bethlehem Steel Company		Mather Mine "A" Shaft "B" Shaft

Humboldt Mining Company
Partner: Ford Motor Company — Humboldt

Additional looseleaf booklets were prepared for the following companies or fee-owners and contain maps of the mines in which they were interested.

Company	Mines
Arthur Iron Mining Company	Hill-Trumbull (except Potter), North Star and Bingham Lease of Holman Cliffs
International Harvester Company	Agnew, Hawkins and Sargent
Teal Lake Iron Mining Company	Cambria-Jackson

Similar looseleaf books were prepared for the various Company officials, as follows:

Name	Mine
Hugh J. Leach, Manager Minnesota District	Agnew, Alworth, Canisteo, Hawkins, Hill-Trumbull, Holman-Cliffs, Sally, Sargent and Wanless-Woodbridge
Melvin L. Viant, Superintendent	Agnew, Alworth
Ronald B. Pearson, "	Canisteo
William LeClair, "	Hawkins
Arnold E. Hill, "	Hill-Trumbull
John J. Foucault, "	Holman-Cliffs
Paul P. Swanson, "(Open Pit)	Sargent
Melvin L. Viant, "(Underground)	Sargent
Giulio D. Giuliani, "	Wanless-Woodbridge
T. A. Kauppila, "	Athens-Negaunee
William R. Atkins, "	Cambria-Jackson, Lloyd
Onni Marjama, "	Cliffs-Shaft
Jay A. Poll, "	Humboldt
Curtis R. Sundeen, "	Maas
Gilbert A. Dawe, Ass't Superintendent	Mather Mine, "A" Shaft
Raymond L. Tobie, " "	Mather Mine, "B" Shaft
Kenneth C. Olson, " "	Ohio, Tilden
Emert W. Lindroos, Supervising Metallurgist	Republic
John M. Haivala, Superintendent	Spies-Virgil

B. MAP REPORTS

At the end of each month, the Mining Engineers assigned to the soft ore properties, inspect the underground workings and post the monthly mining progress, the advance of the development contracts and the exploration drill holes. Two sets of these monthly progress maps are made; one set to be used

by the Manager and the other set sent to the Superintendent for his use. Numerous prints of the various sub-level maps upon which there was active mining operations are printed, trimmed and folded to pocket size. These maps are carried by the mine captain, foremen and shift bosses who use them to assist them in their day to day production planning.

The next few paragraphs describe the monthly, quarterly and tri-annual map reports sent out by the Engineering Department.

ATHENS MINE

Two sets of monthly progress maps, with mining advancement colored in red, were sent to the Pickands Mather & Company throughout the year.

The Corbit Lease fee-owner trustee was given a set of prints semi-annually, showing work done within the boundaries of that lease.

CLIFFS-SHAFT MINE

One set of geological maps of the Bancroft and Section 10 Leases were forwarded to the Duluth office of the Oliver Iron Mining Company after each of the tri-annual surveys, showing the work done during that four-month period in color. The final issue of these progress maps for the year 1953 also show the ore areas that were used in calculating the estimate of ore reserves as reported to the Michigan State Tax Commission.

HUMBOLDT MINE

Quarterly progress maps, showing mining, development or related operations, were sent to Mr. Harry B. Weber, fee-owner of the Weber Lease.

MATHER MINE

A complete set of working maps of both "A" and "B" Shafts were forwarded to Dr. Donald M. Fraser, Chief Geologist of the Bethlehem Steel Company, at the end of each quarter, showing the mining progress in color.

MICHIGAN STATE TAX COMMISSION

During the first part of September, copies of all maps upon which there was any active workings were sent to Mr. Harry J. Hardenberg, Deputy State Geologist. Upon these maps are shown the known ore areas which are used in calculating ore reserve tonnages. A supplementary map report was sent to the Michigan State Tax Commission at the end of the year, reporting any large increase in ore reserves discovered since the appraisal date of October 1st. At the end of the year, two sets of annual report maps were prepared, showing the areas used in calculating the ore reserve estimates. These sets, one for the Cleveland office and the other kept in the Ishpeming Engineering Department, are made and used as a permanent record of ore reserve tonnages, as reported to the Michigan State Tax Commission.

C. MINING LEASES

The following mining leases were executed and placed on file in the Engineering Department during 1953:

Lease No. 109

McDermott Estate et al to The Cleveland-Cliffs Iron Company, dated April 1, 1953, expires April 1, 2003, covering all the mineral rights and various surface parcels in the W½ of E½ of Section 25, 43-35, Iron County, Michigan.

Lease No. 110

The Michigan Trust Company to The Cleveland-Cliffs Iron Company, dated July 1, 1953, expires July 1, 2003, covering the mineral rights in the NW¼ of SW¼ of Section 24, 43-35, Iron County, except Lot 9, Block 1, Lots 1, 16, 17, Block 2 and Lots 14 through 26, Block 3 of Allen's Plat.

Lease No. 111

The Ford Motor Company to The Cleveland-Cliffs Iron Company, dated September 1, 1953, expires December 31, 1960 with option for a five-year extension, covering Lot 1, Lot 3, the S½ of S½ of SE¼ of NE¼ and the mineral rights in the N3/4 of the SE¼ of NE¼ of Section 21, 48-31, Baraga County, Michigan.

D. THE FORCE

The personnel of the Engineering Department Staff has been slightly increased during 1953 to take care of the needs of our expanding Mining Department. The development of the low grade ore properties, specifically the Ohio, Humboldt and Republic Mines, plus the use of Engineering Department personnel in matters such as, time study, analysis map use, recording of stope analysis and draw charts, called for additional technical men.

On February 28th, Mr. Bernhardt H. Petersen, senior Mining Engineer, was appointed Technical Foreman at the Athens-Negaunee properties.

On May 31st, Mr. Keith R. Busby, senior Mining Engineer, was appointed Technical Foreman at the Maas Mine.

On October 31st, Mr. Leamon G. McGee, Mining Engineer, was appointed Shift Boss--Open Pit at the Ohio Mine.

The summer field season, which runs from June 15th to September 15th, not only gives us an opportunity to do field mapping and sampling but also gives us a chance to evaluate the capabilities of each field party member in looking forward to possible permanent technical employees. The field survey work necessary for the exploration of low grade ore possibilities was carried out by three two-man parties. Two of these parties were based in a tent camp in the Central Range Basin Area and the third party was based in a tent camp in the Cascade Area.

In as much as the source of our Surveyor Helper personnel is that of high school graduates, we have had some turnover of men due to the fact that this age group is presently being inducted into the Armed Services. The following men were inducted into the Armed Services during 1953:

Name	Leaving Date
Robert L. Lahde	February 6th
Richard L. Swanson	February 6th
Charles W. Cornish	March 13th
Paul G. Jacka	April 15th
Robert A. Marietti	July 31st

Mr. Donald R. Nankervis, Draftsman, was transferred from the Mining Engineering Department to the Geological Department on May 15th.

Mr. Martin D. Tasson, Surveyor Helper, rejoined the Engineering Department on January 2nd, after completing a two-year hitch in the U. S. Army.

The following table shows the personnel of the Department, their position and the period of employment:

Name	Position	Entered	Left	1953 Employment
Carl Brewer	Recorder			12 Months
Grant T. Hollett	Chief Mining Engineer			12 Months
Eric G. Beinlich, Jr.	Engineer			12 Months
Keith R. Busby	Engineer		May 31st	5 Months
Harley E. Clickner	Engineer			12 Months
Joseph D. Crites	Engineer	May 11th		8 Months
Robert B. Davis	Engineer			12 Months
Robert J. Flynn	Engineer	April 27th		8 Months
Robert G. Fountain	Engineer			12 Months
Oiva W. Hakala	Engineer			12 Months
Allen H. Heikkinen	Engineer			12 Months
Albert Henry	Engineer	June 22nd		6 Months
R. Charles Kincaid	Engineer			12 Months
Eino A. Koski	Engineer			12 Months
Lionel N. Larson	Engineer			12 Months
John F. Magnuson	Engineer			12 Months
Leamon G. McGee	Engineer		October 31st	10 Months
Bernhardt H. Petersen	Engineer		February 28th	2 Months
Thomas B. Reifsnyder	Engineer		August 15th	7½ Months
Dale S. Strand	Engineer		February 28th	2 Months
Robert L. Sundeen	Engineer			12 Months
Victor E. Swan	Engineer			12 Months
Kenelm C. Winslow	Engineer	August 4th		5 Months
P. Daniel Isaacson	Ass't Engineer			12 Months
C. Arthur Koski	Ass't Engineer			12 Months
F. Alfred Koski	Ass't Engineer			12 Months
W. Harlow Stannard	Chief Draftsman			12 Months
Lembit L. Liivoja	Draftsman			12 Months
Anselm H. Mantyla	Draftsman			12 Months
Donald R. Nankervis	Draftsman		May 15th	4½ Months
Merrill R. Prin	Draftsman	May 4th		8 Months
Jean C. Jensen	Stenographer			12 Months
Clifford H. Amel	Surveyor			12 Months
Clyde C. Anderson	Surveyor			12 Months
Robert E. Anderson	Surveyor			12 Months
Clarence P. Ayotte	Surveyor			12 Months
Allan L. Bjork	Surveyor			12 Months
Charles W. Cornish	Surveyor		March 13th	2½ Months
Paul G. Jacka	Surveyor		April 15th	3½ Months
Herbert S. Kelly	Surveyor			12 Months
Donald E. Lampi	Surveyor			12 Months
Alfred B. Nault	Surveyor			12 Months
Ernest A. Oja	Surveyor			12 Months
Ralph K. Oja	Surveyor		September 11th	8½ Months

Name	Position	Entered	Left	1953 Employment
Russell J. Paull	Surveyor			12 Months
Harold A. St. John	Surveyor		February 10th	1½ Months
Joseph J. Scoleri	Surveyor			12 Months
John R. Sleeman	Surveyor			12 Months
Arnold A. Sundell	Surveyor			12 Months
Robert R. Swanson	Surveyor			12 Months
Martin D. Tasson	Surveyor	January 2nd		12 Months
Allan E. Wakkuri	Surveyor			12 Months
Donald P. Chartier	Helper			12 Months
James C. Cleven	Helper	October 22nd	May 31st	7 Months
Henry C. Coron	Helper	April 13th		8½ Months
William G. Dunstan	Helper	February 17th		10½ Months
Clifford A. Frenn	Helper		January 30th	1 Month
Arthur W. Hemmila	Helper	June 1st		7 Months
Donald G. Johnson	Helper	June 1st		7 Months
Robert L. Lahde	Helper		February 6th	1 Month
William M. Leaf	Helper			12 Months
William R. Lehmann	Helper			12 Months
Carl F. Lemin, Jr.	Helper			12 Months
Robert A. Marietti	Helper		July 31st	8 Months
Louis R. Miller, Jr.	Helper			12 Months
Donald M. Peterson	Helper	February 4th	February 28th	1 Month
Paul E. Poutanen	Helper			12 Months
Paul E. Sundberg	Helper	February 2nd		11 Months
Clarence J. Stone	Helper	September 1st		4 Months
Nicholas W. Tasson	Helper		January 30th	1 Month
Wilburt H. Thomas	Helper			12 Months
Arnold E. Townsend	Helper			12 Months
Bernard L. Regan	Helper	September 22nd		3 Months
Elmer R. Ring	Helper	September 15th		3½ Months
Richard L. Swanson	Helper		February 6th	1 Month
Holland L. Werner	Helper	April 1st		9 Months
Francis A. Wills	Helper	September 8th		4 Months
Raymond S. Windsand	Helper			12 Months

The following table shows the summer field crew personnel, their position and their period of employment:

Thomas Hart	Surveyor	June 10th	August 31st	2½ Months
Keith W. Johnson	Helper	August 20th	September 11th	3 Weeks
George R. Magnuson	Helper	July 29th	September 4th	1 Month
Felix C. Scanlon	Surveyor	June 9th	August 31st	2½ Months
Robert L. Sharland	Helper	June 15th	August 31st	2½ Months
Carl M. Slick	Engineer	June 22nd	September 4th	2½ Months
James R. Smith	Draftsman	June 15th	August 14th	2 Months
James M. Taipale	Surveyor	June 3rd	September 11th	3 Months
Tommy S. Ullom	Surveyor	June 15th	September 17th	3 Months
J. Peter Wahlman	Helper	June 15th	August 28th	2½ Months
Harold A. Wepsala	Helper	June 8th	August 13th	2 Months

The following table shows the length of service in the Engineering Department of those employed at the end of the year:

Name	Date Entered	Length of Service
Carl Brewer	August, 1906	35 Years, 3 Months
Grant T. Hollett	August, 1940	13 Years, 4½ Months
Eric G. Beinlich, Jr.	July, 1952	1 Year, 6 Months
Harley E. Clickner	June, 1952	1 Year, 7 Months
Joseph D. Crites	May, 1953	8 Months
Robert B. Davis	August, 1951	2 Years, 4 Months
Robert J. Flynn	April, 1953	8 Months
Robert G. Fountain	August, 1951	2 Years, 4 Months
Oiva W. Hakala	July, 1951	2 Years, 6 Months
Allen H. Heikkinen	August, 1952	1 Year, 5 Months
Albert Henry	June, 1953	6 Months
R. Charles Kincaid	July, 1951	2 Years, 6 Months
Eino A. Koski	March, 1952	1 Year, 9½ Months
Lionel N. Larson	October, 1951	2 Years, 2½ Months
John F. Magnuson	March, 1950	3 Years, 10 Months
Robert L. Sundeen	December, 1950	3 Years, ½ Month
Victor E. Swan	April, 1951	2 Years, 9 Months
Kenelm C. Winslow	August, 1953	5 Months
P. Daniel Isaacson	November, 1940	8 Years, 4½ Months
C. Arthur Koski	June, 1941	9 Years, 1 Month
F. Alfred Koski	January, 1936	13 Years, 9 Months
W. Harlow Stannard	November, 1940	13 Years, 2 Months
Lembit L. Liivoja	January, 1952	1 Year, 11½ Months
Anselm H. Mantyla	July, 1948	5 Years, 5½ Months
Merrill R. Prin	May, 1953	8 Months
Jean C. Jensen	July, 1951	2 Years, 5½ Months
Clifford H. Amel	May, 1944	9 Years, 7½ Months
Clyde C. Anderson	December, 1950	3 Years, 1 Month
Robert E. Anderson	July, 1948	5 Years, 6 Months
Clarence P. Ayotte	April, 1948	5 Years, 8½ Months
Allan L. Bjork	April, 1952	1 Year, 9 Months
Herbert S. Kelly	May, 1948	5 Years, 7 Months
Donald E. Lampi	April, 1951	2 Years, 9 Months
Alfred B. Nault	September, 1946	7 Years, 3½ Months
Ernest A. Oja	March, 1943	10 Years, 10 Months
Russell J. Paull	March, 1947	6 Years, 9 Months
Joseph J. Scoleri	May, 1951	2 Years, 7½ Months
John R. Sleeman	February, 1947	6 Years, 10½ Months
Arnold A. Sundell	February, 1951	2 Years, 11 Months
Robert R. Swanson	November, 1952	1 Year, 2 Months
Martin D. Tasson	August, 1948	3 Years, 5 Months
Allan E. Wakkuri	January, 1951	2 Years, 11½ Months
Donald P. Chartier	September, 1952	1 Year, 4 Months
James C. Cleven	September, 1952	11½ Months
Henry C. Coron	April, 1953	8½ Months
William G. Dunstan	February, 1953	10½ Months
Arthur W. Hemmila	June, 1953	7 Months
Donald G. Johnson	June, 1953	7 Months
William M. Leaf	July, 1950	3 Years, 6 Months
William R. Lehmann	February, 1953	1 Year, 10 Months

Name	Date Entered	Length of Service
Carl F. Lemin, Jr.	February, 1952	1 Year, 10½ Months
Louis R. Miller, Jr.	August, 1945	8 Years, 3½ Months
Paul E. Poutanen	January, 1951	2 Years, 11½ Months
Paul E. Sundberg	February, 1953	11 Months
Clarence J. Stone	September, 1953	4 Months
Wilburt H. Thomas	January, 1951	3 Years
Arnold E. Townsend	August, 1952	1 Year, 4½ Months
Bernard L. Regan	September, 1953	3 Months
Elmer R. Ring	September, 1953	3½ Months
Holland L. Werner	April, 1953	9 Months
Francis A. Wills	September, 1953	4 Months
Raymond S. Windsand	December, 1947	6 Years, ½ Month

In the above table, the "Length of Service" covers only that period the men were employed in the Engineering Department. Some of them have been in other Departments and at the mine at one time or another.

The following table shows the number of days worked, days overtime, sick and absent during the year, of all those who were in the Department:

Name	Days Worked	Overtime	Sick	Absent
Carl Brewer	224			30
Grant T. Hollett	235		6	14
Eric G. Beinlich, Jr.	259½	13½	½	10
Keith R. Busby	108½	3½		1
Harley E. Clickner	244½	2½		12
Joseph D. Crites	162	1		2
Robert B. Davis	250¼	5-3/4		9½
Robert J. Flynn	173			
Robert G. Fountain	246½		2½	5
Oiva W. Hakala	246	4½	2	10½
Allen H. Heikkinen	240	6	5	15
Albert Henry	133			
R. Charles Kincaid	259½	17½		12
Eino A. Koski	266½	12½		
Lionel N. Larson	253	9½		10½
John F. Magnuson	253	10	1	9
Leamon G. McGee	212	3		5
Bernhardt H. Petersen	41			
Thomas B. Reifsnyder	162	3½		1½
Dale S. Strand	43½	2½		
Robert L. Sundeen	272½	36	3½	14
Victor E. Swan	243½	2½		13
Kenelm C. Winslow	99			5
P. Daniel Isaacson	242	3		15
C. Arthur Koski	255	12		11
F. Alfred Koski	245	24½		33½
W. Harlow Stannard	150-3/4		98½	4-3/4
Lembit L. Liivoja	250	1½		6½
Anselm H. Mantyla	240½	½	1½	12½
Donald R. Nankervis	97½	1½		
Merrill R. Prin	167½	1½		2

Name	Days Worked	Overtime	Sick	Absent
Jean C. Jensen	252	8	2	8
Clifford H. Amel	245	1½		10½
Clyde C. Anderson	253	9	3	7
Robert E. Anderson	248¼	12-3/4	2½	11
Clarence P. Ayotte	260½	16½		10
Allan L. Bjork	245	5	4	10
Charles W. Cornish	52	1		
Paul G. Jacka	76	2		
Herbert S. Kelly	251½	8½		10
Donald E. Lampi	238			16
Alfred B. Nault	252	8		10
Ernest A. Oja	243			11
Ralph K. Oja	182	12		9
Russell J. Paull	248	6		12
Harold A. St. John	28	1		
Joseph J. Scoleri	249	10		15
John R. Sleeman	253½	10½	1	10
Arnold A. Sundell	251	9	1	12
Robert R. Swanson	259	14	2	7
Martin D. Tasson	250	8½		12½
Allan E. Wakkuri	258	10	2	4
Donald P. Chartier	254	8		9
James C. Cleven	148	3	1	7
Henry C. Coron	167		1	15
William G. Dunstan	216½	1	1	5
Clifford A. Frenn	21			
Arthur W. Hemmila	144	3		7
Donald G. Johnson	150			
Robert L. Lahde	26			
William M. Leaf	240½	2½	3	13
William R. Lehmann	253	10		11
Carl F. Lemin, Jr.	242	2½		14½
Robert A. Marietti	150	5		5
Louis R. Miller, Jr.	237	2½	4½	15
Donald M. Peterson	17			
Paul E. Poutanen	145½	2	17½	93
Paul E. Sundberg	230	8		11
Clarence J. Stone	75	1	4	8
Nicholas W. Tasson	21			21
Wilburt H. Thomas	245½	7½	6	10
Arnold E. Townsend	245½	4	1	12½
Bernard L. Regan	67½			2½
Elmer R. Ring	73			2
Richard L. Swanson	26			
Holland L. Werner	190	4	3	2
Francis A. Wills	64	2	10	7
Raymond S. Windsand	257¼	13¼		10
Thomas Hart	58			
Keith W. Johnson	16			
George R. Magnuson	29			
Felix C. Scanlon	59			
Robert L. Sharland	55			

Name	Days Worked	Overtime	Sick	Absent
Carl M. Slick	55	1		
James R. Smith	44			
James M. Taipale	62		1	8
Tommy S. Ullom	67			
J. Peter Wahlman	54			
Harold A. Wepsala	48			

The following table shows the distribution of time spent underground, in the field and in the office:

Name	Underground	Field	Office	Total
Carl Brewer		10	214	224
Grant T. Hollett	3	76½	155½	235
Eric G. Beinlich, Jr.	62½	115-3/4	81¼	259½
Keith R. Busby	36		72½	108½
Harley E. Clickner	120½	9½	114½	244½
Joseph D. Crites	3	115½	43½	162
Robert B. Davis	115½	14	120-3/4	250¼
Robert J. Flynn		167½	5½	173
Robert G. Fountain		18	228½	246½
Oiva W. Hakala	12½	20	213½	246
Allen H. Heikkinen	1	205	34	240
Albert Henry	1	106½	25½	133
R. Charles Kincaid	78½	11	170	259½
Eino A. Koski	160	37	69½	266½
Lionel N. Larson		202	51	253
John F. Magnuson	104½	3	145½	253
Leamon G. McGee		189	23	212
Bernhardt H. Petersen	20	6	15	41
Thomas B. Reifsnyder	53	46	63	162
Dale S. Strand		28	15½	43½
Robert L. Sundeen	137½	15½	119½	272½
Victor E. Swan		122	121½	243½
Kenelm C. Winslow	1	29¼	68-3/4	99
P. Daniel Isaacson	80	4½	157½	242
C. Arthur Koski	171	37	47	255
F. Alfred Koski	2	192½	50½	245
W. Harlow Stannard			150-3/4	150-3/4
Lembit L. Liivoja			250	250
Anselm H. Mantyla			240½	240½
Donald R. Nankervis			97½	97½
Merrill R. Prin			167½	167½
Jean C. Jensen			252	252
Clifford H. Amel		143	102	245
Clyde C. Anderson	143½	50½	59	253
Robert E. Anderson	95½	18¼	134½	248¼
Clarence P. Ayotte	191	5	64½	260½
Allan L. Bjork	111	30	104	245
Charles W. Cornish	27	½	24½	52
Paul G. Jacka	2	55	19	76
Herbert S. Kelly	132½	9	110	251½
Donald E. Lampi		174	64	238

Name	Underground	Field	Office	Total
Alfred B. Nault	112	4½	135½	252
Ernest A. Oja		128	115	243
Ralph K. Oja	111	½	70½	182
Russell J. Paull	124½	60	63½	248
Harold A. St. John		5	23	28
Joseph J. Scoleri	129	3½	116½	249
John R. Sleeman	107	32½	114	253½
Arnold A. Sundell	127	3	121	251
Robert R. Swanson	2	241½	15½	259
Martin D. Tasson		208	42	250
Allan E. Wakkuri	153½	1½	103	258
Donald P. Chartier		241½	12½	254
James C. Cleven	60	35½	52½	148
Henry C. Coron		153	14	167
William G. Dunstan	74½	49½	92½	216½
Clifford A. Frenn		19	2	21
Arthur W. Hemmila	63½	19	61½	144
Donald G. Johnson	71	1½	77½	150
Robert L. Lahde	11		15	26
William M. Leaf	109	52½	79	240½
William R. Lehmann	114½	2	136½	253
Carl F. Lemin, Jr.	1	189	52	242
Robert A. Marietti	95½	2	52½	150
Louis R. Miller, Jr.			237	237
Donald M. Peterson		11	6	17
Paul E. Poutanen	97	6	42½	145½
Paul E. Sundberg	135½	7	87½	230
Clarence J. Stone	48	3	24	75
Nicholas W. Tasson				21
Wilburt H. Thomas	175	2	68½	245½
Arnold E. Townsend	89½	63½	92½	245½
Bernard L. Regan		52	15½	67½
Elmer R. Ring		70½	2½	73
Richard L. Swanson		21	5	26
Holland L. Werner		176½	13½	190
Francis A. Wills	31	1	32	64
Raymond S. Windsand	124½	20½	112¼	257¼
Thomas Hart		40½	17½	58
Keith W. Johnson		16		16
George R. Magnuson	19		10	29
Felix C. Scanlon		43½	15½	59
Robert L. Sharland		55		55
Carl M. Slick	1	44	10	55
James R. Smith			44	44
James M. Taipale		53½	8½	62
Tommy S. Ullom		48½	18½	67
J. Peter Wahlman		52	2	54
Harold A. Wepsala		47	1	48

The following sheet shows in tabular form, the personnel of the Engineering Department and their classification, as of December 31, 1953:

ENGINEERING DEPARTMENT PERSONNEL - 1953

	ATHENS	CAMBRIA-JACKSON	CLIFFS-SHAFT	HUMBOLDT	LLOYD	MAAS	MATHER "A"	MATHER "B"	NEGAUNEE
MINE ENGINEER	E. G. Beinlich	J. F. Magnuson	R. B. Davis	L. N. Larson	J. F. Magnuson	H. E. Clickner	O. W. Hakala	R. C. Kincaid	E. G. Beinlich
ASS'T MINE ENGINEER			C. A. Koski				P. D. Isaacson		
SURVEYOR	R. J. Paull J. R. Sleeman	H. S. Kelly	A. L. Bjork	C. H. Amel	H. S. Kelly	R. E. Anderson	C. P. Ayotte J. J. Scoleri	A. B. Nault A. A. Sundell A. E. Wakkuri	C. C. Anderson
HELPER	A. W. Hemmila	R. S. Windsand	W. G. Dunstan	C. F. Lemin B. L. Regan	R. S. Windsand	R. S. Windsand	P. E. Poutanen C. J. Stone P. E. Sundberg W. H. Thomas	D. G. Johnson W. R. Lehmann F. A. Wills	W. M. Leaf

	OHIO	REPUBLIC	SPIES	TILDEN	CLIFFS 8TH ADDITION	MARQUETTE RANGE GENERAL SURVEY CONTROL
MINE ENGINEER	A. H. Heikkinen	J. C. Crites		A. H. Heikkinen	V. E. Swan	F. A. Koski
ASS'T MINE ENGINEER	A. Henry			A. Henry		R. J. Flynn
SURVEYOR		R. R. Swanson			D. E. Lampi E. A. Oja	M. D. Tasson
HELPER	H. L. Werner	D. P. Chartier	A. E. Townsend	H. L. Werner	H. C. Coron	J. C. Cleven E. R. Ring

OFFICE

ENGINEER — K. C. Winslow

DRAFTSMEN — W. H. Stannard (Chief)
L. L. Liivoja
A. H. Mantyla
M. R. Prin

DEPT. CLERK — J. C. Jensen

PRINTER — L. R. Miller

SUMMER FIELD PARTIES
(June 15th to September 15th)

Party No.	Name	District
1	T. S. Ullom	Cascade
2	F. C. Scanlon	Central Range Basin
3	T. Hart	Central Range Basin

E. DISTRIBUTION OF TIME

The following table shows the distribution of time for the year at the different properties and jobs and the percentage of time spent on each property:

Property	Total	%
Athens Mine	888-3/4	5.95
Athens Mine (Partridge Creek)	50½	0.34
Cambria-Jackson Mine	381	2.55
Cliffs-Shaft Mine	980¼	6.56
Lloyd Mine	356-3/4	2.39
Maas Mine	756	5.06
Mather Mine, "A" Shaft	2,001¼	13.39
Mather Mine, "B" Shaft	2,135-3/4	14.29
Mather Mine, "B" Shaft--North Jackson	51	0.34
Negaunee Mine (E&A CC345)	452-3/4	3.03
Ohio Mine	768½	5.14
Spies Mine	377½	2.53
Tilden Mine	39	0.26
Cliffs 8th Addition	452	3.02
Cliffs Realty Company	2	0.01
Land Offer 2683	1½	0.01
Land Offer 2747	4	0.03
Land Offer 2849	3½	0.02
Land Offer 2854	½	0.004
Land Offer 2863	8	0.05
Land Offer 2874	10	0.07
Land Offer 3400	8	0.05
Outside Exploration 1032	96½	0.65
Outside Exploration 1077	24	0.16
Outside Exploration 1080	2	0.01
E&A AM31 (Athens Drifting)	473½	3.17
E&A HM-4-A (Humboldt Mine)	889	5.95
E&A CC150 (C-1111 Cliffs Power & Light)	203½	1.36
C-1313 Cliffs Power & Light	22	0.15
E&A CC175 (Section 11, 47-27)	1	0.008
E&A CC285 (Maas Drifting)	13½	0.09
E&A CC311 (North Michigamme District)	21	0.14
E&A CC366 (Cascade)	36¼	0.24
E&A CC437 (Spies Surface)	16	0.11
E&A CC440 (Bunker Hill)	4¼	0.03
E&A CC473 (Spies Underground)	6½	0.04
E&A CC491 (Republic Mine)	1,367-3/4	9.15
E&A CC521 (North Lake Project)	123¼	0.82
E&A CC522 (Empire)	8	0.05
E&A CC523 (McGillis and Grossbusch)	11½	0.08
E&A CC552 (Pioneer and Arctic)	7	0.05
E&A CC560 (Cliffs-Shaft Site)	35	0.23
E&A CC561 (McDermott)	37	0.25
E&A CC591 (Perkins)	29	0.19
E&A CC592 (Imperial)	102	0.68
E&A CC593 (Allen Forty)	17	0.11
E&A CC597 (Cascade East End)	43½	0.29

Property	Total	%
E&A CC600 (Titan)	52½	0.35
Mining Engineering General	1,405-3/4	9.41
Geological Expense General	14-3/4	0.10
Coal Department	35½	0.24
Industrial Engineering	8½	0.06
Maintenance of Idle and Abandoned Properties	16½	0.11
Ishpeming Office Expense	1	0.008
Negaunee Location--New Plats	14	0.09
Research Laboratory	7¼	0.05
Morris Mine	18-3/4	0.13
Agnew Mine	1-3/4	0.01
Canisteo Mine	13¼	0.09
Hawkins Mine	7	0.05
Hill-Trumbull Mine	12¼	0.08
Holman-Cliffs Mine	11½	0.08
Sargent Mine	2¼	0.02
Wanless Mine	2½	0.02
	14,943½	100.00%

F. COSTS

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

	1951	1952	1953
Salaries	$159,185.49	$252,469.75	$287,600.45
Auto Expense	4,054.85	4,007.82	7,581.21
Donations			375.80
Furniture and Fixtures	396.01	158.60	2,479.72
Heat, Light and Power	631.20	691.57	1,085.34
Insurance	179.01	230.72	688.31
Janitor and Cleaning			36.40
Postage	93.02	113.95	129.04
Rentals		15.00	55.00
Repairs	332.78	85.96	1,091.93
Stationery and Printing	540.43	1,479.46	574.17
Supplies	15,475.61	13,308.93	9,678.77
Taxes	48.89	48.55	50.63
Travelling and Entertainment	3,177.55	4,581.24	4,480.99
Telephone and Telegraph	384.68	503.42	570.33
Papers and Periodicals	69.20	88.41	185.65
Unemployment Insurance Tax	1,545.71	2,492.34	2,177.52
General - Unclassified	1,094.45	3,913.43	6,954.37
Old Age Benefits Tax	2,061.07	3,243.66	3,047.05
Depreciation	108.00	78.00	3,034.00
Photocopy Machine			6,257.56
Equipment	6,144.51	548.87	8,822.51
Group Annuity Premiums	1,760.82	1,719.71	2,707.35
Personal Injury Expense		7.50	
TOTALS	$197,283.28	$289,786.89	$349,664.10

H. AUTOMOBILES

A 1953 Ford Ranch Wagon was purchased in July, 1953 and operated for the balance of the year by the surface survey crews and the 1952 Ranch Wagon, which they had been using, was turned over to the Republic Mine engineering crew. A 1953 Chevrolet Handyman was purchased in August, 1953 and operated for the balance of the year by the Ohio Mine engineering crew. The Chevrolet Carry-All (1949 model) was operated throughout the year by the Cliffs 8th Addition engineering crew. The Chevrolet Carry-All (1950 model) was operated throughout the year by the Humboldt Mine engineering crew.

The following table shows the mileage covered in 1953, the total mileage to the end of the year and the date the cars were received in the Department:

Car	Miles 1953	Miles Total	Date Received
Ford Ranch Wagon (1952 model)	13,460	20,222	6/20/52
Ford Ranch Wagon (1953 model)	8,280	8,280	7/30/53
Chevrolet Carry-All #1	11,880	48,813	6/13/49
Chevrolet Carry-All #2	7,669	40,003	6/1/50
Chevrolet Handyman	6,236	6,236	8/14/53

I. MINES

The following brief summary itemizes the special work done at the various properties during the year:

ATHENS MINE

(1) The installation of the semi-circular, corrugated, galvanized steel flume, in which Partridge Creed will flow around the Athens cave area, was completed under the supervision of the Mining Engineer.

(2) Two Canton Automatic Mine Doors were installed on the 10th Level connecting drift between the Athens and Negaunee Shafts under the guidance of the Mining Engineer.

(3) Surface subsidence surveys were made in the spring and fall of the year. Results disclosed that the Athens' surface area subsided correspondingly to past years' history.

(4) A survey was made on the boundaries of the Athens' surface area for the installation of a fence.

(5) The Mining Engineer planned a crusher and conveyor system for proposed installation on the 14th Level.

CAMBRIA-JACKSON MINE

(1) The Mining Engineer assisted in the planning of the exploration program, the development and mining system for the area at the East end of the Jackson Strip.

(2) The filling of the old shafts Northeast of the Hartford No. 2 Shaft was supervised by the engineering personnel.

(3) The Mining Engineer inspected and directed the rebuilding of fence lines around the surface subsidence area.

(4) The Mining Engineer and his survey crew assisted in the construction of a new cooling pond to replace the small shaft formerly used.

CLIFFS-SHAFT MINE

(1) A check shaft plumbing was made to confirm previous results. Surveys were carried to the new shaft location on those levels where shaft stations will be excavated.

(2) Surveys and other engineering requirements preparatory for the excavation and construction of "C" Shaft collar were taken care of.

(3) A check elevation survey from "B" Shaft collar to 1st Level "B" was performed to confirm underground elevations.

(4) Surveys were made, design, layout and inspection of concrete were items of business performed in connection with the erection of the headframe.

(5) A ventilation survey of the Section 10 area was made by the Safety Department and the Mining Engineer.

(6) An inspection trip of the abandoned open pits within the Cliffs-Shaft boundaries was made to check fencing conditions.

(7) The lump ore stocking trestles were relocated for additional capacity.

(8) The survey crew laid out curbing and the parking area for the Engineering Building parking lot.

(9) Profiles were run and cross-sections plotted for a proposed pelletizing plant.

(10) Long hole drilling, as a method of pillar recovery, has required layout and survey work by the Mining Engineer and his crew.

(11) A development study is being made by the Mining Engineer and Geologist. The purpose is to allow orderly retreat in the depletion of the remaining hard ore reserves and maintain necessary haulage drifts and "travelling roads".

HUMBOLDT MINE

(1) The dike system for the tailings pond was constructed using a finished elevation of 1590' and a proposed water elevation of 1585'. Three overflow outlets were placed to take care of any unusual quantities of water.

(2) Lake Lory was sounded to determine the volume of water in the lake. These soundings were also used to locate the fresh water pumphouse. This pumphouse is completed and has been used in the hydraulic stripping operations. The reuse pumphouse has been set and completed for recirculation of tailings water back to the mill.

(3) The survey crew assigned to the 8th Addition Project laid out a storm and sanitary sewer system.

(4) The Mining Engineer directed several drill tests, comparing the Chicago Pneumatic and Garderner Denver "99" Wagon Drills. Testing was done to determine the most likely type and size of bit to use in levelling the several knobs occurring in the pit area.

(5) He also supervised the churn drilling tests but concluded this type of machine did not prove economical for the type of ore encountered at the Humboldt Property. A drilling estimate was made, comparing the costs per foot and costs per ton using the Linde Jet Piercing machine, 29T Bucyrus Erie Churn Drill, Joy Challenger and Wagon Drills (CP "99"). Blasting and powder costs were also calculated for each type of machine.

(6) A survey and estimate was made on the abandoned waste rock piles in the pit area and East Hill properties. The piles were sampled to determine if they contained concentratable material.

(7) Ore reserve estimates have been made for the life of the property as well as yearly production estimates in accordance with the "Economic Study" program.

LLOYD MINE

(1) The 10th Level drifting program and mining development work required the services of a two-man survey crew a good portion of the year.

(2) The Mining Engineer assisted in the installation of a completely automatic pumping system.

(3) The construction of the 8th Level storage trench was under the guidance of the engineering personnel.

MAAS MINE

(1) A large portion of the time spent by the engineering personnel at the Maas Mine during the year of 1953 was spent on work pertaining to the development of the 7th Level. Approximately 1,200 feet of main line drifting were completed and the development of two areas for block caving was started.

(2) A mine water survey was made to investigate the possibilities of installing an automatic pumping system. Weirs were installed on all levels and a shaft section drawn showing the present pumping system and the capacities of the present equipment.

(3) A detailed survey was made of the 6th Level main haulageway from the shaft to the winze to facilitate the planning of a conveyor system.

(4) The Mining Engineer spent considerable time in making ore estimates, development and mining plans and their relative surface subsidence in connection with the current Pioneer and Arctic negotiations.

MATHER MINE

"A" Shaft

(1) The Mining Engineer assisted in the revision of the mine water pumping problem and the survey crew directed the excavation of a new sump driven on the -960' Level.

(2) The 8th and 9th Level plats or shaft stations required continual supervision and inspection as to lines and grades.

(3) The alignment for the 470' of shaft sinking below the pentice required numerous surveys and constant checking. When the pentice was removed and the pre-fabricated steel sets installed, the connections, both horizontal and vertical, were perfect which, of course, was a result of competent execution of good engineering practices.

(4) The cutting out of both the 8½ and 9½ Levels and the construction of pockets and trenches required design and layout work from the Mining Engineer and continual survey control by the survey crew.

(5) The 7th Level main haulage drift being driven from both "A" and "B" Shafts was connected approximately June 15th and surveys were run to check the coordinate values, bearings and elevations used for this drifting program. Remarkable results were obtained; the difference in coordinates was approximately .5 of a foot in the Southing, .06 difference in the Westing and the course or bearing was right to the second. The elevation check showed that the two drifts were within .04 or approximately 3/8".

This holing-through job, the second completed between these two shafts, again reveals that the survey control work that has been done and is being done by the Mining Engineering crew assigned to this property is of the highest order and is not comparable to any like work done at the other properties the Company has operated in its history.

"B" Shaft

(1) The center line for the conveyor belt in the West extension of the stocking trestle required the assistance of the Engineering Department Staff.

(2) Profiles were made and a center line was surveyed for a permanent stockpile loading track.

(3) A program of monthly checking of the water elevations in the Jackson Pit project was started.

(4) The shaft was plumbed during the year and courses and coordinates were carried to the 8th and 10th Levels. Check surveys and elevations were made on the 7th and 8th Levels to confirm previous results.

(5) The analyses from all the development headings were posted on a special set of maps.

(6) Three ventilation surveys were made by members of the Safety Department and the Mining Engineer.

(7) The excavation and development of the crusher storage trench, the conveyor-belt drift and the storage trench on the East end of the 8th Level plat required day to day survey control.

(8) The Mining Engineer conducted a mapping and map reading course for the shift bosses.

(9) Ore analyses records are kept for all of the underground stopes by the surveyor's helpers.

(10) The Engineering Department Staff assisted in the installation and alignment of the pump and discharge line in the 10th Level pumphouse.

NEGAUNEE SHAFT

(1) The construction of the new headframe, loading pockets, conveyor galleries and the rehabilitation of the old surface plant required Engineering Department assistance.

(2) In order to obtain and confirm courses and coordinates on the 10th, 12th, 14th Levels and skip pit, numerous shaft plumbings were conducted.

(3) The excavation and construction of the 10th, 12th and 14th Level plats, pockets and trenches was done under the supervision of the Engineering Department personnel.

(4) The cage and skip compartments were plumbed from surface to the start of the new shaft and the results plotted to ascertain the locations of the knuckles in the shaft.

OHIO MINE

(1) The Mining Engineer computed stripping, rock and ore available in connection with the "1970 Estimate".

(2) Churn drill blast holes were located, with proper depth, as mining commenced.

(3) Powder charges were calculated for the churn drill blast holes.

(4) Daily shovel locations were located to correlate the concentrate grade for future mining on lower benches.

(5) The engineering crew completed a check coordinate survey for the Ohio Mine and vicinity, Imperial Mine and Titan Mine Areas.

(6) Control was established for the McPhar Geophysical survey crew.

(7) Limits were located for necessary fencing needed for the exposed shafts and pits.

(8) Daily, weekly and monthly mill quality control and production sheets were recorded.

(9) Weekly churn drill activities (footage drilled per bit, per shift, repair time, etc.) were summarized.

(10) Two time studies were completed of the pit to mill truck haulage.

(11) A drainage plan for the mill site was formulated.

(12) Preparation of cost and maintenance reports was commenced for the truck haulage and tire maintenance program.

REPUBLIC MINE

(1) The construction base line was established and checked.

(2) Lines and grades were run into the primary crusher shaft and tunnel.

(3) A number of profiles and sections were made of the crusher excavation and supplied to the designers for the detailing of the reinforcing steel.

(4) Lines, grades and sections were run for the preliminary excavation on the mill building site. Near the end of the year, lines were run in for the start of construction in this area.

(5) In the area of the proposed pelletizing plant, a number of profiles were run and a great number of test holes were put down to try and determine the nature of the subsoil and ledge in this area.

(6) Considerable data was supplied to the designers of the sanitary system.

(7) Cross-sections were taken of old waste rock piles remaining from the Republic Mine's former operation and tonnages calculated.

(8) All engineering details pertinent to the design and construction of a 4000' access road from M-95 to the plant site were under the jurisdiction of the Mining Engineer.

(9) The design and installation of a 8" Potable water line from Perch Lake to the plant site was under the direction of the engineering personnel assigned to this property.

(10) Early in 1953 a proposed dike location for tailing disposal was surveyed but this line was unsatisfactory and at the end of the year considerable work was being done to try and find a more suitable dike layout.

(11) The survey crew located the SE$\frac{1}{4}$ of NW$\frac{1}{4}$, Section 20, T. 46 N., R. 29 W. for the Land and Lumbering Department.

(12) Because of the mining inactivity in this area since 1926, considerable time was spent in locating the abandoned shafts, pits, cave, etc., and then directing the Company-wide fencing protective program.

SPIES MINE

(1) The Mining Engineer and his assistant, along with their routine duties, took care of the engineering requirements called for in the exploration program of the McGillis, Grossbusch, Wheat, McDermott and Allen Forty.

TILDEN MINE

(1) Powder charges were calculated for the churn drill blast holes.

(2) The available ore within present stripped limits for the 1954 production schedule was estimated.

J. MISCELLANEOUS

ORE ESTIMATES

The following table shows a comparison of the tonnages as reported to the Michigan State Tax Commission:

Mine	Tons	
	As of 8/31/52	As of 8/31/53
Athens	1,843,314	1,880,023
Bunker Hill	1,557,536	2,159,313
Cambria-Jackson	749,483	487,245
Cliffs-Shaft	2,000,991	1,747,976
Lloyd	359,475	323,135
Maas	4,100,950	4,000,578
Mather		
"A" Shaft	4,764,777	3,945,957
"B" Shaft	12,857,649	16,720,418
Spies	266,774	185,960
Total Developed Ore	28,500,949	31,450,605
Undeveloped Reserves		
Sec. 3, 47-27	302,378	302,378
Grand Total All Ores	28,803,327	31,752,983

STOCKPILES

Estimates of the ore in stock were made by the Engineering Department at the Athens, Cliffs-Shaft, Lloyd, Maas, Mather and Spies Mines during October.

The following table shows the comparison of ore in stock on November 1, 1952 and November 1, 1953:

Mine	Nov. 1, 1952	Nov. 1, 1953
Athens	9,457	43,219
Cambria-Jackson	0	0
Cliffs-Shaft	111,484	57,116
Lloyd	167,493	188,154
Maas	47,299	37,865
Mather		
"A" Shaft	218,968	186,399
"B" Shaft	110,487	90,533
Spies	48,800	72,758
Tilden	15,857	79,987
Totals	729,845	756,031

COAL PILES

At the request of Mr. Paul L. Barkman of our Coal Department, three members of our Engineering Department went to Escanaba and Green Day, during the week of April 13th, to cross-section and calculate the coal quantities in stock at these docks.

SHAFT GAUGING

The runners in the various operating shafts were gauged on the dates shown on the following table:

Mine	Date
Athens	March 29th
Cambria-Jackson	February 21st September 19th
Cliffs-Shaft	January 30th December 11th
Lloyd	September 12th
Maas	February 14th September 26th
Mather	
"A" Shaft	April 19th November 1st
"B" Shaft	May 17th October 18th
Negaunee	September 27th
Spies	May 9th

CLIFFS 8TH ADDITION

(1) Curbing, streets, sidewalks, house service walks and gravel surfacing of the streets and alleys required day to day grade staking.

(2) Setting of concrete block corner markers was completed prior to the acceptance of this Addition by the City of Ishpeming.

TOWNSITES

(1) Plot plans of four alternate townsite locations in the vicinity of Republic were investigated and prepared.

(2) Field topographic surveys were made and cost estimates of preparing site, sewers, water, streets and alley system for the area North and East of Milwaukee Lake were calculated.

(3) Preliminary plot plans were prepared and cost estimates calculated for the site grading, streets and sanitary sewers for the proposed Cliffs 3rd, 4th and 5th Additions to the City of Negaunee, formerly known as the Lake View School, Lobb and MacKenzie Field Areas. Some work was also done on the areas both North and South of the Collins Addition and the Negaunee Rifle Range in a preliminary manner to investigate these as to the possibility of these becoming future housing sites.

SURVEY CONTROL - MARQUETTE RANGE

ISHPEMING DISTRICT

(1) An entirely new iron pin survey control system was established at the Cliffs-Shaft Mine due to the eradication of the old pins by various surface construction projects.

(2) Considerable field surveying, office calculating and mapping were required in subdividing Section 28, 47-27 for the Land and Lumbering Department.

(3) Extensive precise surveys were made throughout Sections 4, 5 and 6, 47-27 during the current exploration program.

(4) Property surveys, legal descriptions prepared, profiles, contours and building line layouts were made in connection with the new addition to the Ishpeming-Negaunee Hospital.

(5) In cooperation with the City of Ishpeming and their plans for a sewage disposal plant, the Engineering Department made a check elevation survey between the newly established U.S.G.S. benchmarks and the Cliffs Power and Light Company's water elevation gauge at Deer Lake.

NEGAUNEE DISTRICT

(1) In order to establish common coordinate values and courses for the boundaries between the Athens-Bunker Hill Mine and the Jones & Laughlin's Tracy Mine, work was continued on the cooperative Cleveland-Cliffs and J. & L. triangulation system.

(2) Inspection of all the Jackson Iron Mining Company's workings was made, other old shafts or caves located, water depths taken and broken perimetrical fences reported.

(3) Permanent triangulation control points were established in the vicinity of the Negaunee No. 3 Shaft so that triangulation values may be transferred to the underground workings of the Athens-Bunker Hill Property.

(4) Field inspection was made and maps revised as to the number of houses on Maas and Pioneer and Arctic lands that must be moved for future mining operations.

CASCADE DISTRICT

(1) Surveys were made in Sections 19, 27 and 29, 47-26, as control measures for the current exploration drilling.

NORTH LAKE DISTRICT

(1) The Engineering Department was called upon to do the relocation work of the Cliffs Power & Light Company's transmission line installation between the North Lake substation, Humboldt Mine and Republic.

REPUBLIC DISTRICT

(1) Iron pins were set and precise surveys were made in the central parts of both Sections 18 and 19, 46-29 in anticipation of the new Republic townsite.

MICHIGAMME DISTRICT

(1) Control surveys were established and stadia surveys made to prepare maps of the Imperial Mine and Titan Lease.

REMODELING OF CENTRAL OFFICE AND ENGINEERING BUILDING ADDITION

The construction of the Engineering Building Addition which will house the Welfare, Recorder's and Safety Departments was completed in August and occupied immediately thereafter. The Engineering and Geological Departments then occupied those portions of the Engineering Building which were vacated by the above departments after the Third Floor vault was constructed and redecorating completed. The grounds were landscaped and the sidewalks and curbs installed late in the summer.

SUMMER FIELD CREWS

The practice of hiring undergraduate Engineers and Geologists for summer field mapping and sampling had proved so successful during the past few years, that we continued in this method of field exploration work by having three crews working during the summer of 1953. Each crew is made up of an Engineer, who is responsible for the locations or survey details, and a Geologist, who handles the mapping of outcrops and other pertinent land features. These three field crews were assigned to the following areas from June 15th through September 15th:

Crew #1 - Cascade District
Crew #2 - Central Range Basin
Crew #3 - Central Range Basin

HOLIDAYS

The following holidays were granted during the year:

January 1st	- New Year's Day
July 3rd	- Independence Day
September 7th	- Labor Day
November 26th	- Thanksgiving Day
December 24($\frac{1}{2}$), 25	- Christmas
December 31($\frac{1}{2}$)	- New Year's Eve

Respectfully submitted,

Grant T. Hollett
Chief Mining Engineer

GTH:jcj
2-25-54
-3-

RESEARCH LABORATORY

ANNUAL REPORT - YEAR 1953

The Annual Report for 1953 is subdivided into six main sections. These sections are included as separate reports related to different phases of the work conducted by the Metallurgical Department. These specific sections are: (1) General Testing Program, (2) Operation of the Pelletizing Pilot Unit, (3) Pyrolysis and Agglomeration, (4) Research & Development Work and Flotation Projects, (5) Microscopy Section, and (6) Check Sampling Program.

The Annual Report for the Research Laboratory is intended only to briefly discuss the various programs studied during the year. No attempt is made in this report to present test data, conclusions or recommendations that culminated from any specific investigation. The Yearly Summary Report for 1953, which is a summary of the test results for the year, provides the detailed information. There were undoubtedly several small-scale projects completed that are not mentioned in the report. Due to the large number of small-scale projects worked on, they are only discussed in a general manner, and no specific reference is given.

Part I of the Annual Report includes most of the major projects worked on as part of the general schedule for the Research Laboratory. The work has been classified in several groups, namely, Major Projects, Exploration Surface Samples, Service Projects and Research & Development. Some of the various phases of the program discussed in this section will necessarily overlap the programs discussed in other parts of the report. For the most part, however, each investigation is discussed under the proper section and classification.

PART I

GENERAL TESTING PROGRAM

MAJOR PROJECTS:

Pilot Mill Tests:

Considerable work has been carried on throughout the year in the pilot mill section utilizing a flowsheet which is a duplication of the Humboldt Mine flowsheet. During the summer approximately 75 tons of low grade ore from the Humboldt Pit were trucked into the Tilden crusher, crushed to approximately 3", and then trucked to a stockpile area at the rear of the Laboratory. Approximately 200 tons of Republic crude iron formation were taken from the old stockpiles in the Republic Mine Area. These stockpiles of ore were used as a source of feed in conducting tests utilizing the pilot mill circuit. The feed was crushed to minus 3/8" and stored in bins for use as needed. Approximately 38 tons of Humboldt lean iron formation were shipped to Allis-Chalmers Manufacturing Co. for use in experimental roasting tests utilizing a kiln.

The pilot mill circuit, which follows the proposed flowsheet for the Humboldt Mine, involves ball mill grinding, classification, desliming with cyclones, conditioning at high solids in a two-cell conditioner, flotation and mineral separation in several stages utilizing Denver Sub A No. 8 float cells, Fagergren flotation cells, and Steffensen flotation cells. Basically, this is the flowsheet that was utilized throughout the testing program. However, slight variations in the flowsheet were adopted from time to time.

During the year approximately 260 tons of Humboldt crude iron formation were utilized in operating the pilot mill circuit. Roughly 170 tons of lean iron formation from the Republic Area were also processed. The flotation concentrates produced from operation of the mill circuit were stockpiled at the rear of the Laboratory for use in

agglomeration test work. During the summer an accelerated program was followed in order to produce a substantial quantity of flotation concentrates for use in large scale agglomeration tests. Approximately 100 tons of Republic and Humboldt flotation concentrates were shipped to Allis-Chalmers, and 60 tons were shipped to the Mines Experiment Station for agglomeration tests employing the traveling grate method of firing. Approximately 60 tons of Humboldt flotation concentrate were mixed with 120 tons of Mather Mine "B" Shaft ore with a radioactive tracer material blended with the concentrates. This mixture of ore and concentrate was shipped to the Ford Motor Company for blast furnace tests to determine the percentage of concentrates that would report as flue dust. The total concentrates produced from the small scale pilot mill circuit during 1953 was roughly 200 tons.

Most of the test work which centered around the operation of the pilot mill circuit could be classified as special refinement studies and evaluation of flotation characteristics employing different types of flotation cells. Prior to 1953, each component part of the flowsheet had been carefully investigated and evaluated in order to pinpoint variables and produce optimum results. The grinding circuit and flotation circuit had perhaps the most intense program of study and evaluation. During 1953 several test runs were conducted in order to compare the efficiency of different types of flotation cells. Another phase of the program was the testing of various fatty acid reagents to determine the most economical and effective flotation reagent. Other studies included an evaluation of the metallurgy with reference to different grinds, desliming tests to determine whether or not desliming is necessary and to what extent, the number of cleaning stages required, and an overall investigation of variables inherent in a flotation process. The filter circuit study which had been fairly well completed was also investigated further. Different types of filter cloths were tested in order to evaluate various types on the basis of durability, blinding characteristics, and cost.

Michigamme Mine:

During the year final composites were built up from the material encountered in drill holes put down in Sections 19 and 20, 48-31. The tests performed on the final composites were magnetic tube tests, froth flotation tests, gravity concentration tests, and magnetic oxide conversion tests. Various concentrating schemes were employed in an attempt to determine the most feasible flowsheet for the treatment of this lean iron formation on a commercial basis. The final report covering all the test work was issued early in 1953 and is identified as Metallurgical Report No. 83.

Land Offers & Outside Explorations:

During the year numerous priority samples, identified as various Land Offers and Outside Explorations, were submitted to the Research Laboratory for testing. The majority of the samples submitted under these classifications represented the Canadian Exploration Program. Approximately 520 Canadian surface and drill core samples were submitted and tested in 1953. The most important samples in this series were submitted under three claims, namely, Temescamie, Albanel, and Sandspit, which were respectively Land Offers 3119, 3120, and 3121. Many of the samples submitted under this category are subjected to preliminary concentration tests involving magnetic tube tests of the sample has a high magnetite content. If the sample does not contain an appreciable amount of magnetite, froth flotation tests are usually conducted. Additional testing on any of these samples depends upon recommendations from a commitee which reviews the samples with reference to metallurgy, geolographic location, possible reserves, and availability.

Another series of samples that should be mentioned are those that are submitted under Land Offer 2815. These samples were collected from the Old Taylor Mine Area, Sections 4, 8, and 9, 48-33, the North Champion Area in Sections 28, 29, 30, 32, and 35, 48-29, and from west of Republic, Section 7, 46-30. The samples collected from the North Champion Area responded favorably to concentration by heavy media separation. The samples from the Taylor Mine Area did not respond favorably to concentration

by heavy media separation. The samples collected from the Pumpelly Area were highly magnetic, and although magnetic separation produced high recoveries, a grind finer than 325 mesh is required to produce a concentrate with a desirable silica content.

Ohio Mine:

During the year several drill holes were put down in the Ohio Mine Area to determine possible extensions of the iron formation. Three drill holes were put down in the Portland Area, Section 26, 48-31, two drill holes in the Norwood Area, Section 22, 48-31, and four drill holes in the Imperial Mine location, Section 25, 48-31. The minus 3/4" plus 1/8" crude, and minus 1/8" plus 60 mesh crude fractions of the core samples were subjected to heavy liquid tests employing specific gravities of 3.2 and 2.97. Several surface samples and pit samples were also collected in the area and submitted to the Laboratory for testing. The majority of the other test work related to the Ohio Mine was primarily plant control studies.

RESEARCH & DEVELOPMENT PROGRAM:

Research and Study:

Considerable time was devoted by the Laboratory's technical staff to studying various techniques and processes that have potential application to the treatment of low grade iron ores. Much of this time, which is distributed to the Research and Study account, includes reading of technical books and papers, administration details and general technical investigations that cannot be directly charged to any one program.

Vibrating Ball Mill:

An experimental model vibrating ball mill, 18" x 36", was loaned to the Research Laboratory by Allis-Chalmers for testing. This ball mill is a recent development which incorporates the principle of vibration to activate the ball charge as compared with the conventional ball mill, which is rotated to produce the ball action required for grinding. The purpose of this test program was to investigate the advantages of using this new type of grinding mill as compared to a conventional type ball mill. The program which could be conducted was definitely limited inasmuch as the vibrating ball mill had a capacity which far exceeded the capacity of our existing pilot mill circuit. Several short tests were conducted in an attempt to obtain some preliminary indications as to capacity, steel consumption, power consumption, top feed size particle limitations, and general mechanical problems.

Cyclone Tests:

Some preliminary test work was conducted employing 3, 4, and 6" cyclones to investigate how effectively the cyclone can be utilized for classification in the coarser size ranges, 48 to 100 mesh. Most of the test work carried out has been a series of tests which involved changing one variable at a time to determine the optimum separation that can be produced. The variables being investigated and evaluated are the apex opening, vortex finder, inlet area, feed percent solids, feed pressure, and position of the cyclones, vertical or horizontal. The program will be continued and the final testing will probably be done at the Humboldt Mine where a complete evaluation of the classification efficiencies of the cyclone versus the Hydroscillator can be gained.

Agglomerate & Concentrate Shipment Study:

An investigation was conducted to determine the angle of repose and shear angle for pellets and flotation concentrates under various conditions. This program was conducted to determine some of the characteristics of the concentrates and agglomerates that would be shipped by rail and boat to the steel plants. The program was preliminary in nature, however gave some indication as to the problems that would arise in handling and shipping fine flotation concentrates, particularly with respect to moisture content.

Sample Shipments:

Samples of crude material and concentrates were shipped to various companies and research laboratories for study and research work.

EXPLORATION SURFACE SAMPLES:

The work conducted on surface samples collected from areas within the Marquette Range are discussed in Part IV. Included in this classification are the Michigamme and North Jackson Areas.

SERVICE PROJECTS AND RESEARCH & DEVELOPMENT:

Most of the work conducted under the classification of service projects is discussed in Part IV.

Several investigations were conducted for the Diamond Drill Department to compare various grades of bentonite with the type of bentonite presently being used. These comparative tests were not too well standardized, however gave some indication as to the settling characteristics, purity of the material, and physical characteristics with reference to the viscosity that could be produced and maintained.

Drill Core:

The practice of submitting drill core sections of lean iron formation from underground drill holes and exploration drill holes was continued. The core samples are submitted to the Laboratory by the Geological Department, and represent iron formation having an iron content in the range of 20 to 50 percent. Intrusive material containing less than 20 percent iron is usually screened out by the Geological Department, therefore these samples are not submitted. These drill core samples are submitted daily and rate a high priority as far as being processed as soon as received. This processing involves cataloging the samples, crushing to 1/4", mixing and riffling out a head sample for analysis and compositing of these samples based on sample footages for storage. This routine work consists of a large portion of the Laboratory crushing room schedule. During 1953, approximately 200 holes were represented by core samples submitted to the Laboratory. This number of drill holes resulted in a submisstion of roughly 2,000 samples, which in turn were combined into roughly 150 composites.

Since the organization of the Metallurgical Department, it was felt that these composites of intermediate grade material built up from the underground mine drill holes and non-metallurgical surface drill holes are valuable in that the represent the various types of lean iron formation existing throughout the active areas of the Marquette Range. As drilling programs prove extremely costly, it has often been felt that the compositing of these core samples may prove to be a useful tool by which a preliminary evaluation of the concentrating characteristics for a specific area may be obtained without the need for a primary drilling campaign. The Laboratory is presently storing these composite samples in the storage building at the rear of the Laboratory. However, at the present rate the composite samples are being accumulated, the storage facilities will soon be inadequate. It is therefore planned to review the composite list and, where possible, combine composites, especially in the cases of several short underground drill holes that represent a confined area, to form master composites. It was also planned to limit the number of composites and samples saved to areas of the greatest importance, that is, to save those having favorable crude iron contents and, in the case of surface holes, to save only a large portion of the composite which represents the material encountered to a depth of roughly 600 feet. A program of this type, if carefully planned and followed, will logically limit the number of composites to ease the storage problem and will also build up a series of reference samples which will prove to be the most useful in years to come.

Time Charges for 1953:

The following sheet presents the time distribution for 1953. By glancing over the sheet, one can easily see the major projects worked on such as North Lake Exploration, Flotation Study, Agglomeration Research, Empire, Ohio Mine, and Magnetic Oxide Conversion studies.

Listed below is a short tabulation for the last three years showing the Laboratory staff and total hours as reported on the Cost Sheets:

Year	Staff		Total Hours
	Engineers	Technicians	
1951	6	11	31,369
1952	6	13	47,958
1953	8	18	66,005

TIME DISTRIBUTION - YEAR 1953

Account	Hours
Cambria-Jackson Mine	270
Cliffs Shaft Mine	735
Ohio Mine	3776
Spies Mine	288
Lloyd Mine	6
Mather Mine "A" Shaft	529
Mather Mine "B" Shaft	1251
Athens Mine	267
Maas Mine	16
Humboldt Mine	333
E&A CC-143, Section 4	129
" CC- 93, Section 8	18
" CC-175, Section 11	313
" CC-366, Cascade	267
" CC-521, North Lake	345
" CC-521, Sections 4 & 5	2536
" CC-522, Tilden-Empire	3794
" CC-523, McGillis	32
" CC-532, Install Jaw Crusher	176
" CC-557, Extension to Mezzanine	26
" CC-491, Republic	1448
Land Offer 2644	15
" " 2815	155
" " 2872	20
" " 2874	21
" " 2886	86
" " 3004	3
" " 3028	30
" " 3036	40
" " 3060	8
" " 3062	52
" " 3061	353
" " 3067	3
" " 3071	3
" " 3079	4
" " 3074	24
" " 3087	3
" " 3092	21
" " 3093	4
" " 3100	34
" " 3105	75
" " 3103	13
" " 3110	20
" " 3119	154
" " 3121	28 Hrs.

Account	Hours
Outside Exploration 1015	30
" " 1020	6
" " 1031	768
" " 1032	8
" " 1034	3
" " 1049	13
" " 1050	12
" " 1068	67
" " 1077	111
" " 1078	14
" " 1079	35
" " 1083	3
" " 1085	70
" " 1094	3
Flotation Study	15211
Pelletizing Research	820
Cedar Lake	41
Magnetic Oxide Conversion	2025
Holman Mine (Hydroscillator Test)	11
Empire Mine	164
Agglomeration Research	15083
Research & Study	2598
North Lake - Flotation Study	12
" " - Mag. Oxide Conv.	451
Eaton Samples	83
Microscopy Section	2362
Agg. & Conc. Shipment Study	336
Grinding Champion Smalls	2671
Quality Control Study	708
American Mine	10
Section 3, 47-28	8
Chase Mine	10
Dexter	6
Holt Sample	6
Vermilion Range	48
North Jackson	94
Saginaw	28
Fitch	23
Cyclone Tests	41
Vibrating Ball Mill	339
Grindability Tests	55
Michigamme Mine	195
Dismantling Pilot Plant	3656
Land Offer 3120	28
Land Offer 3400	5 Hrs.
Land Offer 3411	10 Hrs.

Chemical Charges:

The following records the distribution made by the Chemical Laboratory during 1953. The assays for 1953 totaled 34,406 as against 40,428 for 1952. This reflects a decrease in the number of samples assayed and is largely due to a shift in emphasis to the program of agglomeration research, which does not require a large number of chemical determinations, and a lesser amount of work being directed towards flotation test programs, especially on a pilot mill scale. The distribution of the chemical analyses as well as the time distribution present an overall picture of the number of projects and various studies that were carried out in the Research Laboratory during 1953.

TOTAL NUMBER OF DETERMINATIONS ANALYZED IN 1953 FROM RESEARCH LABORATORY SAMPLES

Account	Analyses	Account	Analyses
Maas Mine	120	Cliffs Shaft Mine	779
Lloyd Mine	712	Tilden Mine	176
Cambria-Jackson Mine	357	North Jackson	750
South Jackson	2	Mather Mine "A" Shaft	1246
Mather Mine "B" Shaft	1313	Humboldt Mine	1355
Spies Mine	520	Ohio Mine	5527
Magnetic Roasting	206	Pelletizing Research	533
Flotation Study	4048	A. & M. 33	88
E&A 440	345	E&A 521	2730
E&A 522	781	Empire, Sec. 19, Hole 1	1741
Empire, Sec. 19, Hole 2	613	Cascade, Sec. 29, Hole 4	398
McGillis	12	Michigamme	71
Holman	28	Magnetic Oxide Conversion	786
Quality Control	2182	North Lake Deferred	137
Agglomeration Research	235	Saginaw	5
Fitch	68	Foster	16
Norwood	122	Eaton	43
Land Offer 2815	267	Land Offer 2886	131
" " 3028	35	" " 3036	160
" " 3060	16	" " 3061	693
" " 3062	98	" " 3074	87
" " 3092	148	" " 3100	185
" " 3105	210	" " 3119	23
" " 3411	11	Outside Exploration 1015	82
Outside Exploration 1020	21	" " 1031	1594
" " 1049	22	" " 1050	15
" " 1068	20	" " 1077	89
" " 1078	138	" " 1079	49
Section 1, Hole 148	15	Section 1, Hole 149	14
" 3, " 47	3	" 3, " 48	21
" 4, " 44	298	" 4, " 44A	7
" 4, " 45	344	" 4, " 51	2
" 6, " 90	112	" 6, " 91	143
" 9, " 58	2	" 9, " 71	4
" 10, " 27	12	" 10, " 28	92
" 11, " 20A	206	" 11, " 20B	17
" 11, " 20C	28	" 11, " 22	44
" 11, " 23	303	" 11, " 23A	35
" 11, " 23B	58	" 13, " 11	56
" 22, " 13	36	" 22, " 14	13
" 22, " 15	13	" 22, " 16	1
" 24, " 83	37	" 24, " 86	40
" 24, " 87	8	" 25, " 1	23
" 26, " 47	95	" 26, " 48	95
" 26, " 49	90		

Metallurgical Reports and Memoranda:

The following lists the Metallurgical Reports and Memoranda issued during 1953. It is difficult to use these as a criterion by which to evaluate the amount of work conducted, as some reports represent months of research work while others represent a relatively short-term investigation. The memoranda, however, give a good indication of the number of special studies and varied preliminary investigations conducted throughout the year. In 1952, 59 memoranda were issued as compared with 104 for 1953.

METALLURGICAL REPORTS - YEAR 1953

Report No.	Subject
77A	Supplement to No. 77, Fatty Acid Study
83	Final Report - Michigamme Area
84	Agglomeration by Updraft Firing
85	Land Offer 2815, North Champion, Pumpelly, Taylor Areas (Summary Report, 9/14/53)
86	Pelletizing Pilot Unit
87	Size Distribution & Settling Characteristics, Republic Milled Ore
88	California Research Corporation's Reagent 51946-R
89	Republic & Humboldt Ores, Pilot Mill Flotation Tests
90	Cliffs Shaft Mine - Sample Study, Underground Car Shipment & Stockpile
91	Land Offer 3061
92	Agglomeration of Fine Iron Ore
93	Mather Area - North Jackson
94	Microscopic Investigation of Republic Ores & Rocks
97	Microscopic Investigation of Three Core Specimens, Hole 1, Section 22, 61-14, Vermilion Range
98	Strength Tests of Iron Ore Briquettes
99	Empire Area, Drill Holes 1 & 2, Section 19, 47-26
100	Empire Area, Drill Holes 1 & 2, Section 19, 47-26
101	Ohio Moisture Study
102	Demonstrations of Downdraft Grate Firing Process
103	Quality Control Study
104	Empire Progress Report, Drill Holes 1 & 2

METALLURGICAL MEMORANDA - YEAR 1953

Memo No.	Subject
107	Cliffs Shaft Crushed Pile
108	Ohio Metallurgical Memorandum for October
109	Sample MxC-16 - Land Offer 3004
110	Sample MxC-17 - Land Offer 3004
111	Sample MxC-18 - Land Offer 3028
112	Shell Chemical Corp. Refined Sodium Sulfonate
113	Land Offer 2872 - South American Samples
114	Spies Mine Sample
115	Norwood Samples
116	Land Offer 2644 - South American Samples
117	Cliffs Shaft Crushed Ore
118	Statistical Discussion
119	Seasonal Sample Curves - Ohio Mine
120	Tennessee Corporation's Flotation Reagents
121	Land Offer 3071
122	Outside Exploration 1079
123	Outside Exploration 1078
124	Ungava Bay Samples
125	Land Offer 3074
126	Outside Exploration 1068
127	Land Offer 2886 - Kloman Mine

Continued. . . . . .

Memo No.	Subject
128	Lump Sizes - Cliffs Shaft Mine
129	Sampling Progress Report - 4/18 thru 5/26, Underground Sampling
130	Land Offer 3028
131	Land Offer 3036
132	Ohio Mine
133	American Mine - Sample Mx-1534
134	Outside Exploration 1032 - Sample Mx-1535
135	Outside Exploration 1032 - Sample Mx-1536 - Supplement
136	Outside Exploration 1015 - Supplement
137	Ohio Mine Heavy Media
138	Land Offer 3062
139	Outside Exploration 1068
140	Land Offer 3062
141	Land Offer 3087
142	Sample Mx-279
143	Ohio Mine Heavy Media Tests - Sample OH-22, Portland Pit
144	Ohio Mine Heavy Media Tests - Sample OH-1006, Titan Dump
145	Sample MxC-183 - Paska Township
146	Land Offer 3092 - Sample MxC-135
147	Land Offer 3093 - Sample MxC-134
148	Outside Exploration 1031 - Sample MxC-503
149	Progress Report, July 27-31, Underground Sampling
150	Outside Exploration 1068 - Samples MxC-132, -133
151	Ohio Mine Heavy Liquid Tests
152	Ohio Mine Heavy Liquid Tests
153	Progress Report, August 10-14, Underground Sampling
154	Ohio Mine Heavy Media Reject Pile - 1952 Season
155	Flotation Cells for Humboldt & Republic Mines
156	Heavy Liquid Tests - Portland (Ohio) Mine
157	Heavy Liquid Tests - Norwood (Ohio) Mine
158	Microscopic Examination - Berea Sandstone
159	Outside Exploration 1031 - Temescamie
160	Outside Exploration 1020 - Sample MxC-136
161	Cliffs Shaft Mine - Lump Sizes
162	Progress Report - August 17-23, Underground Sampling
163	Progress Report - August 24-29, Underground Sampling
164	Structure Tests - El Trueno Ore - Sample SoA-1
165	Sub-Ore Committee Meeting
166	Progress Report - August 31-September 5, Underground Sampling
167	Progress Report - September 8-12, Underground Sampling
168	Ford Blast Furnace Tests - Humboldt-Mather Mix
169	Microscopic Examination of Surface Samples, Iron River District
170	Outside Exploration 1031 - Samples MxC-504, -505
170 (Supplement)	Ditto
171	Bentonite Study
172	Progress Report - September 14-19 - Underground Sampling
173	Progress Report - September 21-26 - Underground Sampling
174	Land Offer 3094, Sample MxC-186
175	Outside Exploration 1031 - Samples Mx-288, -290
176	Norwood (Ohio) Mine
176 (Supplement)	Ditto
177	Berea Sandstone
178	Sample Mx-1720
179	Outside Exploration 1032
180	Progress Report, 9/28-10/3 - Underground Sampling
181	Progress Report, 10/5-10 - Underground Sampling

Continued. . . . . .

Memo No.	Subject
182	Outside Exploration 1085
182 (Supplement)	Ditto - 12/3/53
182 "	Ditto - 12/16/53
182 "	Ditto - 12/24/53
183	Jig Tests - Ohio Mine 1953
184	Outside Exploration 1031
185	Cliffs Shaft Mine Lump Sizes
186	Petrographic Examination - Outside Exploration 1085
187	Heavy Liquid Tests - Ohio Mine
188	Surface Pile Samples - Humboldt Mine
189	Visit to Algoma Steel Corp., Ontario
190	Ohio Mine Heavy Liquid Tests
190 (Supplement)	Ditto - 12/11/53
191	Indian Drilling Mud
192	Outside Exploration 1068
193	Outside Exploration 1083
194	Land Offer 3103
195	Land Offer 3100
196	Progress Report 10/12-11/25 - Underground Sampling
197	Crusher Product Structures - Mather Mine "A" Shaft
198	Outside Exploration 1031
199	Outside Exploration 1031
200	Canadian Exploration - Review of Samples
201	Drill Hole Composites - Humboldt Mine
202	Jaw Crusher Product - Mather Mine "A" Shaft
203	Heavy Liquid Tests - Ohio Mine
204	Land Offer 3411
205	Correlation of Drilling & Plant Results at Ohio Mine East Pit
206	Outside Exploration 1049
207	Outside Exploration 1050
208	Drill Hole Composites - Humboldt Mine
209	Land Offer 3060
210	Wyotana Sales Company - Bentonite Samples

E. B. Johnson

E. B. Johnson,
Operating Metallurgist

PART II

PELLETIZING PILOT UNIT

Agglomeration investigations with the one ton per hour shaft furnace at the Ishpeming Unit were terminated on December 19th, 1952. The entire unit, except building, was dismantled during the first several months of 1953. All salvageable equipment and materials are being retained at the plant for future use.

The materials, such as ore concentrates, pellets, and pellet fines are stocked to the west of the plant proper and will be disposed during 1954. Presumably, the high quality pellets will be shipped to the steel mills for open hearth or blast furnace tests, and the concentrates will be used in the investigation of the grate firing principle or mixed in varying proportions with our direct shipping ores.

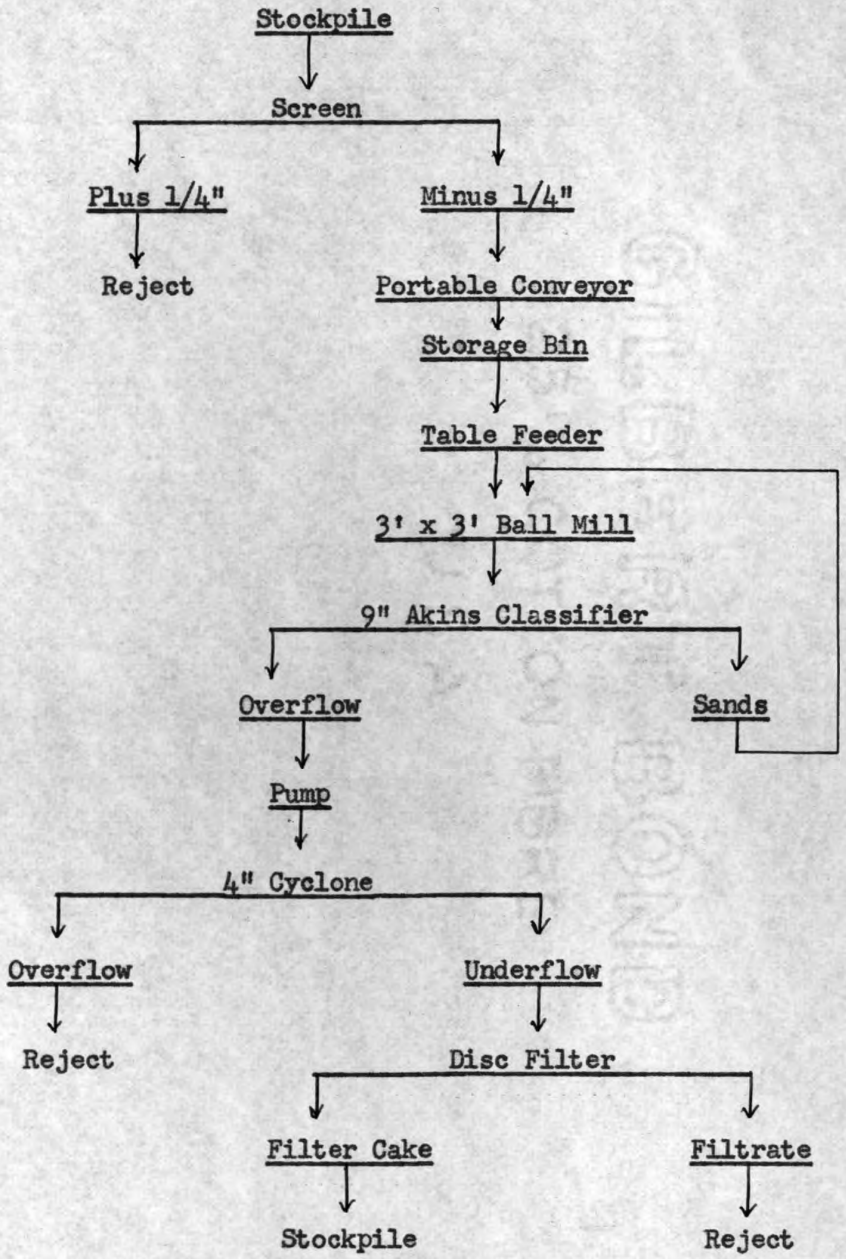
The salvageable equipment, such as gear reducers, conveyors, pumps, etc., were completely overhauled and put in working order.

Agglomeration investigations utilizing the grate firing technique were inaugurated at the Research Laboratory in 1952. The investigations require a substantial tonnage of ore concentrates, and as the Laboratory's concentrating pilot unit is capable of producing only limited amounts, a grinding circuit was put into operation at the pelletizing pilot unit.

The primary purpose of the grinding circuit was to prepare material for agglomeration tests which would be similar in most respects to the Humboldt or Republic flotation concentrates. The specular variety of hard ore produced at the Champion Mine of the North Range Mining Company possesses characteristics similar in chemical analysis and physical structure to that in the Humboldt and Republic Areas.

Approximately 200 tons of Champion Smalls, Oliver 61 Grade, were obtained from the North Range Mining Company and stocked in the area west of the pilot plant. The ore fines analyzed 63.20% iron and 5.23% silica, and structure-wise the material was substantially all minus 1/4".

To simulate the structure of the Humboldt and Republic concentrates, the material was milled in a 3' x 3' ball mill in closed circuit with a 9" Akins Spiral Classifier. The overflow, substantially all minus 65 mesh, was thickened in a 4" cyclone, with the underflow reporting to a 4' Agidisc Filter. The flowsheet of the grinding circuit is presented on the following sheet.



The milled material was substantially all minus 65 mesh, with 35 to 40 percent reporting as minus 325 mesh. Approximately 160 tons of simulated concentrate are available for test purposes.

Design of the Republic Agglomerating Plant gave rise to many and varied problems. Some of the numberous, more important problems are discussed in another section of this report. Of particular concern was the size of balling drums for the capacity for which the Republic Plant was rated. Tests were conducted at the Mines Experiment Station at the University of Minnesota in December, 1953, to determine the effect of varying sizes of green balls on the capacity of a balling drum. The results of this test indicated that capacity of a given size drum was not greatly affected by the sizes of pellets produced.

During this testing period, the Link-Belt Flexmount Oscillating Conveyor was tested to determine whether a conveyor unit of this type was capable of transporting unfired green pellets without causing undue damage, and also to determine whether the unit had sufficient capacity. The results were inconclusive as the balling equipment at the University was not capable of producing pellets at the necessary rate, and therefore capacity characteristics of the oscillating conveyor could not be determined.

In August, 1953, a test was inaugurated, with the cooperation of the Ford Motor Company, with the specific purpose in mind of determining whether additions of predetermined percentages by weight of Humboldt flotation concentrates to direct shipping ore would cause objectionable increases in flue dust losses in the blast furnace. A method whereby the increases could be detected was to add a radioactive tracer to the blend of merchantable ore and flotation concentrates. The flue dust could then be measured and monitored for radioactivity.

Blends of contaminated and uncontaminated mixes were prepared at the Mather Mine "B" Shaft and shipped to the Rouge Plant of the Ford Blast Furnaces in Dearborn, Mich. The tests were conducted on September 2nd, 1953. Ford technical personnel felt that if 70 percent of the material which was potential flue dust remained in the furnace, the test would be successful. Ford's preliminary report stated that approximately 60 percent of the concentrate was retained in the furnace and recovered as metallic output, with 40 percent reporting as flue dust. Approximately 95 percent of this flue dust was recovered in the dust collector system and recirculated to the sinter plant.

A complete summary of the project is reported in Metallurgical Memorandum No. 168

The following is an inventory of pellets and concentrates on hand at the Ishpeming Pilot Unit:

Continued. . . . . .

COMPLETE INVENTORY - PELLETS & CONCENTRATES

		Net Tons	Gross Tons
A.	**Concentrates Received:**		
	INCO Magnetite (Lo-Ni)	378	337.5
	INCO Magnetite (Hi-Ni)	295	263.3
	INCO Hematite	1447	1292.0
	Benson Magnetite	400	357.1
	Erie Magnetite	100	89.3
	Total Hematite & Magnetite	2620	2339.2
B.	**Concentrates on Hand:**		
	INCO Magnetite	225	200.9
	INCO Hematite	120	107.1
	Benson Magnetite	130	116.1
	Erie Magnetite	15	13.4
	Furnace Fines	110	98.2
	Total Concentrates on Hand	600	535.7
C.	**Pellets in Stock:**		
	INCO Magnetite	180	160.7
	INCO Hematite	150	133.9
	Benson Magnetite	115	102.7
	Total Pellets in Stock	445	398.3
D.	**Pellet Shipments:**		
	Jones & Laughlin Steel Corporation	218	194.77
	Inland Steel Company	342	305.63
	International Harvester Company	223	199.33
	International Nickel Company (Huntington)	165	147.32
	Timken Roller Bearing Company	64	56.87
	Furnace Fines (Cliffs Group)	394	351.00
	Total Pellet Shipments	1406	1254.92
E.	**Concentrates for Laboratory Experiments, Losses by Stocking, Unloading, Weather, in Transit, Etc.:**		
	Total	169	150.28

C. C. Bjorne

C. C. Bjorne,
Operating Metallurgist

PART III
PYROLYSIS & AGGLOMERATION

This section of the Annual Report covers the following subjects:

1. Laboratory Grate Firing Investigations.
2. The Cleveland-Cliffs Iron Company's Pilot Plant Traveling Grate Order.
3. Continuous Demonstrations of Traveling Grates used for Firing Pellets of Flotation Concentrate.
4. Design of 2000 TPD Agglomeration Plant for Republic.
5. Standardized Laboratory Tests for Green, Dry and Fired Pellets.
6. Magnetic Oxide Conversion - Concentration.

LABORATORY GRATE FIRING INVESTIGATIONS:

Since January, 1953 a total of 362 test runs were conducted in a laboratory section of a grate for firing pellets by induced draft. These tests provided data for investigating numerous variables which influence operation. The most economical procedure of operation was set forth for the design specifications for the 2000 TPD plant and other tests were conducted for the determination of performance in pilot plant traveling grates. The following outline describes some of the factors investigated during the past year in the 11" x 11" x 36" grate section. The results of these tests have been forwarded as a prospectus for patent application.

1. Types of Ore Concentrates:

1. Inco Magnetite
2. Benson Magnetite
3. Humboldt hematite (7.5 - 11.0% H_2O)
4. Republic hematite (7.5 - 11.0% H_2O)
5. Milled Champion hematite

2. Types of Additives:

1. Aquagel bentonite
2. Mx-80 bentonite
3. Volclay bentonite
4. Black Hill bentonite
5. Limestone

(a) Some tests have been conducted by omitting limestone and bentonite and some were conducted by pre-mixing additives prior to balling.

3. Sizes of Green Pellets:

1. -3/4" ≠ 3 M.
2. -3/4" ≠ 1/2"
3. -1/2" ≠ 3/8"
4. -3/8" ≠ 3 M.

4. Types and Sizes of Solid Fuels:

A. Coke:

1. Ford Coke (-3/4 x 0, -100 M. x 0)
2. Michigan Gas Coke (-3/4 x 0, -100 M. x 0)

B. Low Volatile Bituminous Coal:

1. Indian Ridge Slack (-6 M. x 0, -20 M. x 0, -65 M. x 0, -100 M. x 0)
2. Red Ash (-100 M. x 0)
3. Pochahontas (-100 M. x 0)

C. Anthracite:

1. Obermeyer (-100 M. x 0)
2. Buckwheat No. 5, Reserve Shipment (-100 M x 0)
3. Consolidated Nut (-3/4 x 0, -1/8" x 0, -20 M x 0, -65 M x 0, -100 M x 0)

5. Quantities of -100 M. Fuels:

1. M.V. Bituminous (2%, 2½%, 3%, 4%, 5%, 6%)
2. Coke (3%, 4%)
3. Anthracite (3%, 3½%, 3-3/4%, 4%, 4½%, 5%)
4. Varying ratios within bed diminishing in topmost layers.

6. Ignition Systems:

1. Types of Solid Fuels:

a. -3/8 ≠ 3 M. coke, -3/8 ≠ 3 M. anthracite, -3/4" x 0 coke breeze.

2. Applications of Solid Fuels:

a. Before and after flame inception

3. Burner Tests:

a. Fabricated - 1.24 CFM of propane for 3 minutes.
b. Infra red - .78 CFM of propane for 5 minutes.

4. Ignition Beddings:

a. Pellet Sizes (-3/4 ≠ 3 M., -1/2" ≠ 3/8", -3/8" ≠ 3 M., -3 M. ≠ 6 M.)

7. Air Draft Flow Rates:

1. 48 CFM, 50 CFM, 70 CFM, 80 CFM, 90 CFM, 110 CFM, 115 CFM, 125 CFM

8. Application of Feeding Stages:

1. Inches of Depth Every Period of Minutes:

a.	.7	inches	every	1	min.
b.	1.4	"	"	1	"
c.	7	"	"	3	"
d.	7	"	"	7	"
e.	7	"	"	8	"
f.	7	"	"	9	"
g.	7	"	"	10	"
h.	8	"	"	3	"
i.	8	"	"	4½	"
j.	8	"	"	5	"
k.	8	"	"	5.85	"
l.	8	"	"	9	"

9. Stages of Feeding for Depth of Firing:

1. No. of Stages with Depth of Stage for Total Bed:

a. fifteen 1 inch stages for 15 inches
b. one 3 inch stage and two 7 inch for 17 inches
c. two 7 inch stages for 14 inches
d. six 5½ inch stages for 32 inches
e. four 8 inch stages for 32 inches

CLEVELAND-CLIFFS' PILOT PLANT TRAVELING GRATE ORDER:

From preliminary tests conducted in the laboratory batch grate, it was found that enough technological information was obtained to justify investigations in a pilot plant on a continuous basis. Approval for this move was cleared through The Cleveland-Cliffs Iron Company and conferences were held with The Cleveland-Cliffs' Design Department and equipment manufacturers in order to expedite a pilot plant. The outcomes of these conferences were (1) The design recommendations to the Sintering Machinery Corporation for a 2' x 12' traveling grate that could be operated by using either updraft or downdraft principles, (2) The purchase of the traveling grate and auxiliary equipment for the pilot plant, (3) The design of a pilot plant for 3 shift operation using the traveling grate for agglomerating pellets of fine concentrate. The following list contains the equipment ordered for this venture. This equipment has been idle since purchasing because of planned changes, and is stored at the vacated shaft furnace pelletizing unit.

Equipment Ordered For
Pelletizing Pilot Plant

Equipment	Company	Ordered by	Date	Price
Balling Drum & Drive	Link-Belt	T. Ban	3/23/53	$ 4,679.00
Pressure Blowers (five)	Am. Blower	T. Ban	3/9/53	8,435.00
Exhaust Fan	Am. Blower	T. Ban	3/9/53	1,977.00
Sintering Machine & Drive	Sint. Machinery	T. Ban	3/6/53	17,500.00
Dust Collector	Am. Blower	T. Ban	3/9/53	1,058.00
Orifice Plates & Flanges	Bristol	T. Ban	3/12/53	562.40
Straightening Vanes	Bristol	T. Ban	3/23/53	116.00
Manometers	Uehling	T. Ban	3/25/53	392.50
Disc Feeders	Hardinge	C. Bjorne	3/23/53	3,200.00
Roll Crusher	Masco	C. Bjorne	2/23/53	722.00
Jaw Crusher	Masco	C. Bjorne	2/23/53	500.00
Denver 1½" Pump	Denver Equip.	C. Bjorne	3/23/53	507.00
Filter & Pumps	Eimco	L. J. Erck	4/2/53	5,040.00
Ashland, Screens & Tester	Pelletizing Ent.	L. J. Erck	2/23/53	550.00
			Grand Total	$45,238.90

CONTINUOUS DEMONSTRATIONS OF TRAVELING GRATES USED FOR FIRING PELLETS OF FLOTATION CONCENTRATE:

In view of decisions to withhold erection of a pilot plant using the traveling grate, it was decided to have continuous demonstrations performed at the Minnesota Mines Experiment Station and the Allis-Chalmers-McKee Pilot Plant. Updraft firing tests were performed on July 9th, 16th, 23rd, and September 17th at the Mines Experiment Station and downdraft tests on October 1st and 2nd at Allis-Chalmers. The Mines Experiment Station tests were conducted with a 57 ton shipment of flotation concentrate and the Allis-Chalmers tests with a 100 ton shipment. The operating conditions for the Mines Experiment Station tests were obtained in The Cleveland-Cliffs Iron Company's Laboratory Unit, and the tests were performed and reported by

the Mines Experiment Station's staff. The Allis-Chalmers-McKee tests were performed by Allis-Chalmers-McKee's staff and the data were obtained and reported by The Cleveland-Cliffs Iron Company's staff. The comparison of both these demonstrations was reported by The Cleveland-Cliffs' Laboratory.

DESIGN OF 2000 TPD AGGLOMERATION PLANT FOR REPUBLIC:

The outcome of the laboratory tests on agglomeration with a traveling grate by updraft and the continuous demonstrations of both methods of agglomeration was the design of a 2000 T/D agglomeration plant for Republic using a traveling grate for firing pellets by updraft.

Design engineers were solicited for the contract of preliminary design and engineering of the 2000 T/D plant. The following organizations were solicited by explaining the act of art of updraft agglomeration: Link-Belt Corporation, Arthur G. McKee, Freyn Engineering and Swindell-Dressler Corporation. On a decision of compatability, costs, and ability, the Swindell-Dressler Corporation was selected for the preliminary design.

Swindell-Dressler was issued all memoranda, and Metallurgical Reports pertaining to updraft agglomeration on November 10th, 1953. These were submitted to assist in design. Special laboratory tests were conducted to provide specific design items and the data were submitted directly to Swindell-Dressler. These were as follows:

1. Design specifications for the 2000 T/D plant containing a materials and air flowsheet.
2. Computed theoretical exhaust gas temperatures and compositions for the traveling grate.
3. Design specifications for the traveling grate speed and feed point location.
4. Specifications for quantities and quality of coal.
5. Physical characteristics of green pellets.
6. Panorama specifications of theoretical traveling grate providing bed and exhaust temperature variations and bed pressure variations for firing 3/8 inch pellets at constant volume.
7. Physical and chemical characteristics of process dust, screen dust, and screen undersize.

STANDARDIZED LABORATORY TESTS FOR GREEN, DRY & FIRED PELLETS:

Tests were conducted to determine the merit of specific additives for green pellets by testing according to the standardized procedures. These consisted of forming 1.125 inch pellets and measuring moisture, knockability, dropability, and crushability of the wet and dried balls. Specific additives were tested as follows:

1. No additive
2. Bentonite
3. Limestone
4. Athens slime
5. Mather slime
6. Buffalo starch
7. Borox with starch and sodium hydroxide

Special tests were conducted with returns from agglomeration such as filtering tests and methods of diminishing the deleterious effect of CaO on bentonite by using sodium carbonate as a precipitant.

Firing tests were conducted by firing standardized pellets according to a shaft furnace schedule and measuring the effect of limestone and ore slimes as additives for increasing the fired strength of pellets.

MAGNETIC CONVERSION CONCENTRATION:

Drilling in the North Lake Area was completed during 1953 and samples were submitted to the Research Laboratory for magnetic conversion concentration tests. Drill holes completed are as follows:

Section 4 - Holes 46 through 50
Section 5 - Holes 35, 37 through 51
Section 6 - Holes 90, 91

A series of shallow drill holes to determine the extent of the enriched iron formation were drilled in Section 5 and included Holes 38-40, 42-44, which are designated as Outside Exploration 1077. There were no standard magnetic conversion concentration tests conducted on this series of holes.

Most of the important areas of the Marquette Range, where outcroppings of iron formations occur, have been sampled and standard Davis magnetic tube tests and flotation tests have been conducted on these samples. A considerable number of the areas did not respond favorably to concentration by either of the above mentioned process. During 1953, samples from the Cedar Lake, Saginaw, North Jackson, South Jackson, Fitch and Foster Areas were subjected to standard magnetic conversion concentration tests to determine their concentratability by this method. The results of these tests have not been submitted but will be reported in the near future.

Laboratory Magnetic Conversion-Concentration Tests:

Samples submitted to the Research Laboratory for magnetic conversion-concentration tests were subjected to the following schedule:

Standardized Test Schedule

Ore Sample:	200 grams, plus or minus 2 grams, minus 20 mesh ore as stage crushed through a rolls crusher.
Reducing Gas:	100% hydrogen admitted in uniform flow for 30 minutes so as to total two times the stoichiometric equivalence to reduce the Fe_2O_3 content to Fe_3O_4.
Temperature:	500°C plus or minus 10°
Time:	30 minutes plus or minus 0.3
Reactor:	3" dia. x 4" length retort rotating at 4 rpm
Metallurgy:	Ball mill converted product in a batch mill until a minus 150 mesh product (80% passing 325) is produced. Standardized Davis tube test performed on product.

The following list contains the number of samples tested by this technique during 1953. Each of these tests were duplicated at least two times in order to verify the metallurgical results.

Area	Location	No. Samples tested
North Lake	Drill Holes:	
	Section 4 - Hole 50	6
	Section 5 - Holes 35,37,41,45-51	98
	Section 6 - Holes 90, 91	26
Cedar Lake	Surface Samples	9
Saginaw	Surface Samples	6
North Jackson	Surface Samples	8
South Jackson	Surface Samples	1
Fitch	Surface Samples	3
Foster	Surface Samples	1
Empire	Surface Samples	4

Special Tests:

1. Grinding tests on roasted North Lake Sample Mx-268 - 50 pounds of minus 20 mesh material roasted in large reactor and ground in the 18" x 24" laboratory ball mill for different time intervals. Representative sample from each grind obtained for screen analysis.

2. Preliminary report on comparison between Jones & Laughlin and Cleveland-Cliffs Iron Company's samples; samples submitted by Jones & Laughlin were designated as Mx-265 and Mx-266, Cleveland-Cliffs' samples were designated as Mx-268 and Mx-283. Standardized magnetic conversion-concentration tests of these samples were compared to samples converted in a 40 pound reactor and concentrated in a Jeffrey three drum separator. The concentrate from the three drum separator was subjected to amine flotation to improve the grade.

3. Magnetic oxide conversion of Republic Sample R-57; a two stage concentration scheme was conducted on Sample R-57. Samples of 10 and 20 mesh were converted in the small laboratory reactor as described in the standardized test procedure and the product subjected to a standard Davis tube test. Concentrate from this tube test was ground in the 8" x 10" laboratory ball mill to minus 200 mesh and this product subjected to a standard Davis tube test.

4. Magnetic oxide conversion on traveling grate; a prospectus for patent application was prepared concerning the use of a traveling grate for magnetic oxide conversion. An apparatus was fabricated and tested to a minor extent displaying the operation. This investigation was postponed earlier in the year to utilize the traveling grate for more pressing agglomeration research.

Donald C. Violetta

Donald C. Violetta,
Pyrometallurgist

Thomas E. Ban

Thomas E. Ban,
Operating Metallurgist

PART IV

RESEARCH & DEVELOPMENT WORK AND FLOTATION PROJECTS

Empire Area Projects:

The Empire Area testing program was resumed with the initiation of Diamond Drill Holes 1 and 2, both located in the southwest quarter of Section 19, T47N-R26W. Drill Hole 1 reached a depth of 1773 feet and Hole 2 a depth of 1411 feet. The formation encountered contained mainly magnetite, quartzite, and varying quantities of carbonates and silicates, except for high grade hematite encountered at 1166 to 1216 feet in Hole 1.

The drill core material was composited in suitable intervals and subjected to grinding followed by Davis magnetic separation. Flotation was eliminated as a means of concentration on the basis of previous work.

Extensive test work gave satisfactory test results for practically the depth of the hole, except for the zone of hematite which was not investigated. The surface sample composites were also re-evaluated and good results were obtained for a continuous area in Section 19. The findings, published in Metallurgical Report No. 104, are summarized below:

Recoverable Minerals - Principally magnetite.

Method of Recovery - Magnetic separation.

Grinding - To approximately 90% minus 400 mesh. Material was found to be the softest material (for grinding) yet encountered on the Marquette Range.

Possible Recovery - About 46% by weight; 86% of the iron units.

Concentrate Grade - 64% plus Fe, about 9% SiO_2.

Reserves - Approximated at 75 million tons of concentrates, pending further exploration.

The test work on Holes 1 and 2 was concluded at the end of the year. During 1954, additional drilling and testing will be done. Drill Holes 3 and 4 were started in December, and 150 tons of suitable surface material were obtained for pilot mill testing. The evaluation of this very promising property should proceed very rapidly during 1954.

Flotation Study Project:

Fatty Acids and Pilot Mill Testing:

The study of fatty acid reagents, especially as applied to Republic and Humboldt ores, was continued in 1953. In general, no further reagents were discovered; improvements were mostly in modifications of the flowsheet. Points of particular interest are summarized as follows:

A. Red Oil: (About 80% oleic acid) was found to be slightly more selective than tall oil fatty acids. For this reason it was recommended for the break-in period at the Humboldt Plant.

B. Tall Oil Fatty Acids: Were found to be as good in many respects as Red Oils, and were advised for trial in the Humboldt Plant as soon as the break-in period was over. Increases in price of red oil near the end of the year made this changeover even more attractive, since tall oil fatty acids were cheaper and stable in price throughout the year.

C. Fatty acid flotation proved satisfactory with either low or high solid conditioning of the reagent, although two to three times as much reagent was required for low solid conditioning. The reagent increase necessary for low solid conditioning was attributed to the slimes which were removed prior to high solid conditioning, but were not removed for low solid conditioning, as well as to less intimate contact in the low solids pulp.

D. Considerable fine magnetite was found to be lost by cycloning the entire hydroscillator overflow. It is believed that the magnetite is considerably over-ground and exists as floccules of very fine particles which are torn into ultimate particles by centrifugal action and lost in the cyclone overflow. This loss of fine magnetite was eliminated by running the hydroscillator overflow into the densifier and only cycloning the densifier overflow, returning the cyclone underflow to the flotation feed. For these and other reasons, it was thought that free settling type classifiers should prove more advantageous for desliming than cyclones.

E. Considerable time was spent in determining the relative merits of Denver and Fagergren mechanical flotation cells and Steffensen pneumatic cells in the pilot mill unit. The Fagergren and Denver units both performed well on roughing, and the Denver performed best on cleaning. The Steffensen could not be made to approach the performance of the other two, however, outside information suggested that the results obtainable in a full scale mill unit are not obtainable on a laboratory cell. As a precautionary measure, it was suggested that stand-by mechanical units and impellers be obtained for the Humboldt Mill.

F. Sub-sieve sizing analyses were performed on all of the pilot mill products for both Humboldt and Republic ores. The data was compiled and reported for future reference.

Michigamme Mine:

Early in the year a final report of the preliminary test work conducted on the Michigamme Area was issued. The test work conducted on the final drill hole indicated that substantial metallurgical investigation is required for this property in order to establish a suitable flowsheet for concentration on a commercial basis. Unfortunately, the property does not have the favorable concentrating characteristics that are identified with the Humboldt or Republic formations.

Compared to the Humboldt or Republic formations, the Michigamme formation has a lower crude iron content, a smaller tonnage of treatable formation, more complex mineralogy, and less favorable concentrating characteristics. All of these factors mean that an extensive investigation is required to develop a flowsheet that will prove metallurgically and economically feasible.

Exploration of Surface Samples:

North Jackson Area:

During the summer of 1950, seventy-two samples were collected from the North Jackson Area, Section 1, 47-27. The samples were processed as received and crude analyses obtained. Due to the full schedule at the Research Laboratory, no test work was conducted on these samples until the latter part of 1952 and early part of 1953. The test work indicated that the samples are hard and fine grained, requiring a grind of minus 100 mesh or finer for liberation of the iron and silica minerals. The preliminary test work further indicates that twelve of the seventy-two samples are classified as concentratable, twenty as favorable, twenty-two as possible, and eighteen are classified as no good.

Seven composites were made up and tested. The composite test results indicated that a minus 100 mesh grind was necessary for liberation, and that the high slime losses encountered with the individual samples could be reduced by special desliming procedures.

One of the composites is classified as concentratable, two as favorable, three as possible, and one is classified as no good.

Batch Test Flotation Study Projects:

Reagent Testing Program:

A program of reagent testing was carried out during the year when time permitted. The reagents tested include petroleum sulfonates from various sources, and a large number of fatty acids supplied by various manufacturers.

Petroleum Sulfonates: The two petroleum sulfonates tested were California Research Corporation's Reagent 51946-R, a sulfonated aromatic hydrocarbon, and Shell Chemical Corporation's petroleum sulfonate.

Tests with Reagent 51946-R showed that this reagent will promote specular hematite with moderate reagent quantities, however it has unfavorable froth characteristics. The reagent will not promote iron bearing minerals other than specular hematite.

The results obtained with Shell Chemical Corporation's refined sodium sulfonate show that this reagent has some good attributes for promoting specular hematite. Lower reagent quantities, low solid conditioning, and elimination of the use of fuel oil were found to be possible with the use of this reagent. However, the high price of the reagent overshadows these advantages.

Fatty Acids: In addition to testing samples submitted by various manufacturers, a brief investigation was carried out to determine the effects of storing red oil in unlined steel tanks, and at the same time determine the effects of the fatty acid on steel, brass, and bronze parts. With batch tests the contaminated red oil showed some adverse effects, however with pilot mill tests these effects were not noticeable. The steel, brass, and bronze parts did not show alarming deterioration.

Flotation of Magnetic Oxide Conversion Concentrates:

This study was initiated in 1952 to determine a suitable procedure for beneficiating artificial magnetic concentrates. Various procedures and reagents were tested and it was found that procedures using amines appeared to be the most suitable. Some difficulty was encountered in obtaining a large enough quantity of concentrates for the number of flotation tests required for properly evaluating the various amines and modifying reagents. This problem has now been overcome, however work on this project has been reduced to a slack-time status.

Some tests were conducted on representative samples of the North Lake formation, and two samples from Jones & Laughlin. These two samples were subjected to tests employing the best procedures known to date.

The sample representing the encriched portion of the North Lake Area, and the sample taken from the Tracy Mine responded favorably to the concentration procedure, while the sample representing the lean portion of the North Lake Area and the Jones & Laughlin sample from the Kruse Pit did not respond favorably.

Attapulgus Minerals & Chemical Corp. High Lime Flotation Procedure:

A series of tests was conducted on Sample L-34 to determine optimum conditions for this sample with the High Lime Procedure. Optimum reagent conditions were found and at present tests will be made to evaluate the several reagent components.

Settling Tests:

Preliminary tests indicate that the mixture of tailings and slimes material to be pumped to the Humboldt and Republic tailings ponds will not clarify. Several tests have been conducted on mixtures containing the proper amounts of tailings and

slime from the pilot mill using various chemicals to flocculate the fine particles which remain suspended. The majority of the chemicals tested either had no effect on the settling or required amounts exceeding economic and practical ranges. The tests indicate that alum is the most satisfactory additive tested to date. Presently, tests are being conducted to determine the effects of alum on flotation.

Humboldt Drill Core Samples:

Material representing 334 feet of drill core from Humboldt Mine Drill Holes 1, 2, and 3 were subjected to froth flotation tests employing the procedure to be used at the Humboldt Mine. These holes were put down to serve as a control measure between the pit and the plant. The test results showed that all but two sections of the drill core responded satisfactorily. These two sections are presently being subjected to further study.

Humboldt Stockpile Samples:

During the fall of 1953, forty-six surface samples were collected from old stockpiles and dumps, some of which lie outside the proposed pit limits. The samples represent and additional reserve tonnage of roughly 90,000 tons. The samples were collected from eight different locations. One random sample was taken. All but one sample, a high sulfur sample, responded favorably to froth flotation with L. T. Red Oil.

Others:

During the course of the year, grindability tests were conducted on many various samples and data was taken. This data gives an indication of the relative ease with which certain ores grind as compared to others. The data is presently being accumulated and tabulated, and it is hoped that at some future time enough evidence will be accumulated to project the data into power figures.

Magnetic Reflux Classifier:

During the year, a laboratory magnetic reflux classifier was constructed. The instrument was designed specifically to produce middling fractions from ores containing magnetite by suitable control of the magnetic field density action on ore particles in a rising current of water. The classifier has not as yet been used extensively for test work.

C. D. Thompson

C. D. Thompson,
Metallurgist

A. D. Kennedy,
Research Metallurgist

PART V
MICROSCOPY SECTION

This section of the Annual Report covers the work completed in the Microscopy Section of the Research Laboratory during the Year 1953. The work involved all phases of preparation, study, and fact recording of drill cores, samples, and rock specimens from The Cleveland-Cliffs Iron Company's exploration areas. For the purpose of this section, the contents may be divided into Marquette Range Projects, Outside Exploration and Miscellaneous Problems.

MARQUETTE RANGE PROJECTS:

Republic Project:

Thirty-one polished sections and ten thin sections were made from core specimens of Hole No. 8 and Hole No. 10 for microscopic study. The results revealed that there is a general sequence of change in metamorphic facies of the iron formation in this area.

In the upper part of the iron formation is the cherty specular hematite metafacies (373' in Hole No. 8 and 261' in Hole No. 10) in which the ore is thinly laminated, with alternating layers of recrystallized chert and specular hematite. The mineralogy is extremely simple, consisting of cherty quartz, and specular hematite with accessory magnetite, chlorite, muscovite, and garnet. In the specular hematite layers are many remnants or discontinuous bands of recrystallized chert indicating that the ore was formed and enriched through the processes of replacement under an oxidizing metamorphic environment (Fig. 1). Magnetite in this zone is an extremely minor constituent occurring in the recrystallized chert layers and most of the crystals have been oxidized to martite.

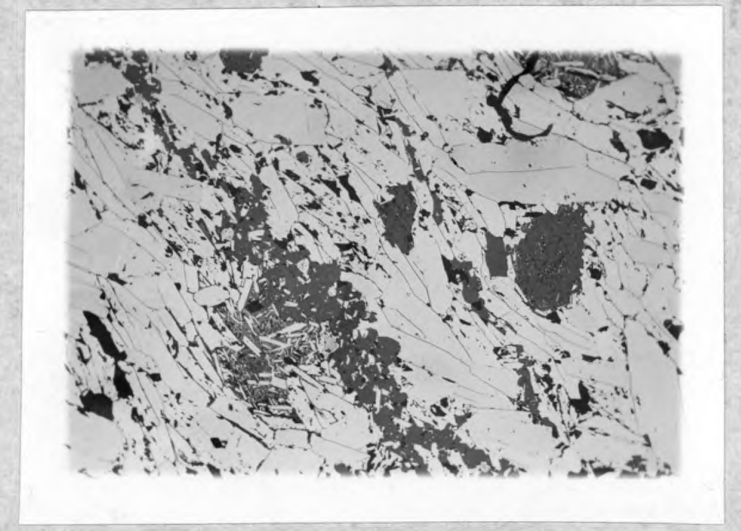


Fig. 1 - The metasomatic replacement of chert bands by specular hematite in a high grade cherty specular hematite ore. Specular hematite, greyish white; chert, grey; and pits, black. Magnification - 28, Common ore size - 150 mesh, Hole No. 8, Depth - 198', Polished section No. 304, Photomicrograph No. 177 b

In the middle part of the iron formation is the cherty magnetite metafacies (26' in both holes). The ore occurring in this zone is thinly bedded with an alternating magnetite and recrystallized chert layer. Mineralogically, it consists chiefly of quartz, magnetite, and subordinate amounts of specular hematite, martite, pyrite, apatite, carbonate, and silicates. Some of the magnetite crystals were

primarily replaced by specular hematite and subsequently slightly altered to martite (Fig. 2). The pyrite replaces the magnetite or vice versa in some cases.

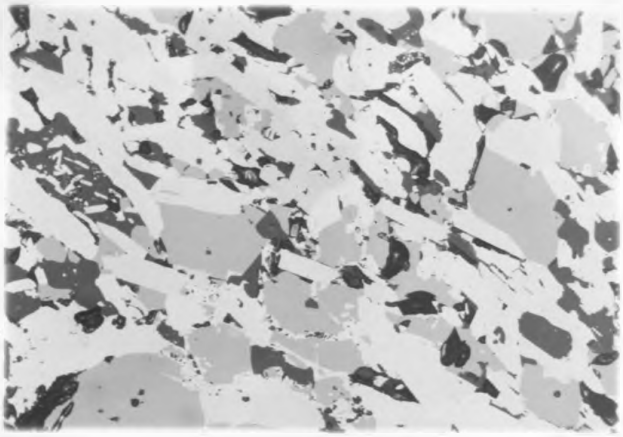


Fig. 2 - Intergrowth of magnetite and specular hematite, the former is generally replaced by the latter. Magnetite, grey; specular hematite, white; gangue, dark grey; and pit, black. Magnification - 125, Common ore size - 100 mesh (magnetite) 325 mesh (specular hematite). Hole No. 8, Depth 199-304'. Polished section No. 305. Photomicrograph No. 179.

In the lower part of the iron formation is the amphibole-magnetite metafacies. It includes both hornblendic and gruneritic submetafacies. In the hornblendic submetafacies, the minerals are composed of hornblende, biotite, chlorite, garnet, and magnetite, while in the gruneritic submetafacies, the minerals are mainly grunerite, magnetite, chert, garnet, and an appreciable amount of pyrite. The grunerite replacing the recrystallized chert along fractures and grain boundaries is obvious (Fig. 3). This phenomenon may be suggested, that the grunerite submetafacies probably originated from the cherty metafacies under a relative high grade of metamorphism.

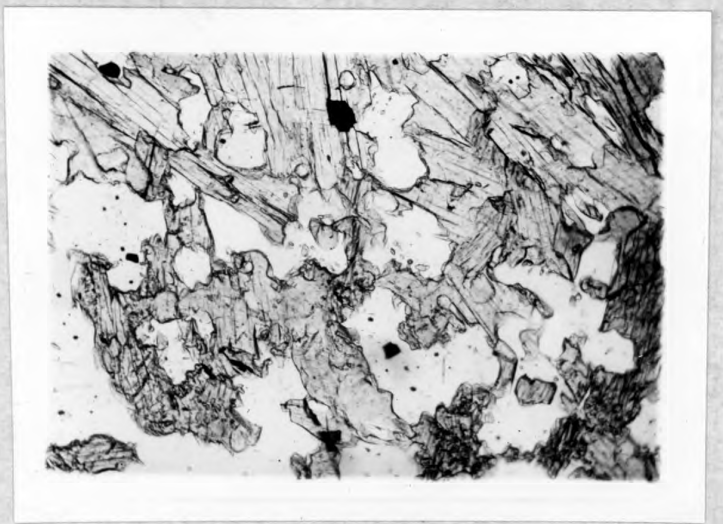


Fig. 3 - Grunerite replacing cherty quartz along fractures and grain boundaries. Quartz, white; grunerite, grey; and magnetite, black. Magnification - 100, Hole No. 10, Depth - 336', Thin Section No. 1428. Photomicrograph No. 194.

These three noticeable metafacies can be closely correlated with those found in the Humboldt area. However, in the latter area the cherty magnetite ore generally contains a considerable quantity of pyrite. Some of the magnetite has been completely oxidized to martite, while the pyrite still remains. It is the writer's belief that the martitization was not resulted from the surface oxidation. In addition, in the latter area some iron silicate has been intensively altered to earthy limonite and hematite while the magnetite seems to be slightly affected.

The ore grade decreases with the change of metafacies. The cherty specular hematite ore generally contains from 37 to 40% available iron, the cherty magnetite ore 25-30% and the iron silicate-magnetite ore 20% or less.

The average size of the ore particles ranges from plus 58 mesh to minus 400 mesh; however, plus 150 mesh seems to be the most common size.

The texture of the ore and gangue is rather interesting. In the cherty specular hematite ore zone, the platy ore is associated with a granular gangue; in the cherty magnetite ore zone, the ore and the gangue are both granular; while in the iron silicate magnetite ore zone, the granular ore is associated with a platy gangue. These changes of ore texture will probably affect the flotability and grindability during the ore treatment.

The presence of chemical constituents in the ore is entirely based on the mineralogy. Hence, there are three distinctive facts which can be observed as we go down from the surface to the bottom of the hole, (1) Minerals of simple chemical composition tend to become more complex, (2) Higher oxide-content minerals are transformed to iron silicates, and (3) Chemically, available iron content decreases appreciably. Ferrous iron, sulfur, and phosphorous increases while free silica, alkali and alkali earth decreases.

North Lake Project:

More than seventeen drill holes were macroscopically examined, twenty-four thin sections, and forty-seven polished sections were microscopically studied. The conclusions may be summarized as follows:

1. The total thickness of the iron formation in Sections 4, 5, and 6, 47-27 averages roughly 1300'.

2. The ore is a cherty goethite intercalated with cherty martite. The ratio between the two in Drill Hole 46, Section 4 is about 10:1.

3. Chert bands and oxidized basic dikes are numerous in the upper part of the iron formation.

4. The contact of the Siamo slate and the Negaunee iron formation is transitional.

5. The degree of oxidation of the slate gradually diminished with depth.

6. The iron formation in this area is cut by strike and diagonal faults. Generally speaking, the beds dip steeply to the south southeast about 56 to 60 degrees. Near fault zones the bedding approaches a vertical position.

7. Microscopic study revealed that the cherty goethite consists mainly of chert, goethite, and minor amounts of martite, clay, carbonate, chlorite, and gypsum. The cherty martite is composed chiefly of chert, magnetite and a small quantity of apatite.

8. The goethite occurs as pseudormorphs after martite, in massive and botryoidal forms. The fact that goethite replaces chert is evident (Fig. 4). The martite occurs in magnetite crystal forms, but not as dense as magnetite (Fig. 5). The relationship between martite and goethite is shown in Figures 6 and 7.

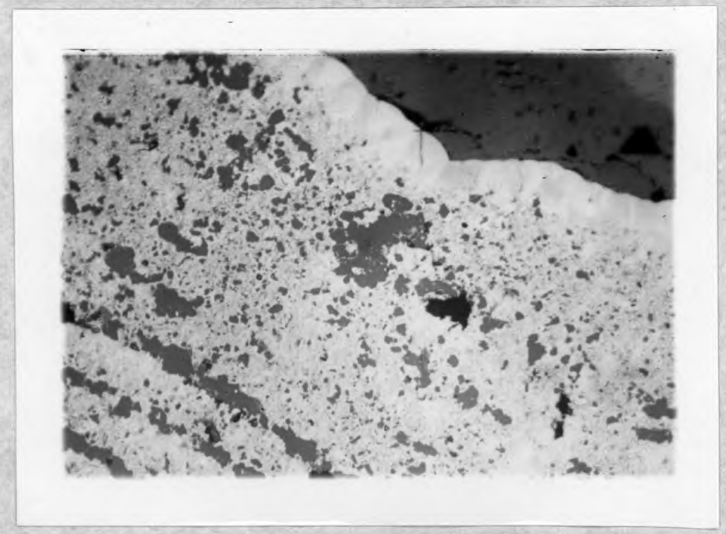


Fig. 4 - Colloform goethite ore, resulting from the progressive replacement of chert, of which occasional bands still remain. Goethite, white; cherty bands, grey; and pits, black. Magnification - 80, Hole No. 46, Section 4, Depth 605'. Polished section No. 404. Photomicrograph No. 258.

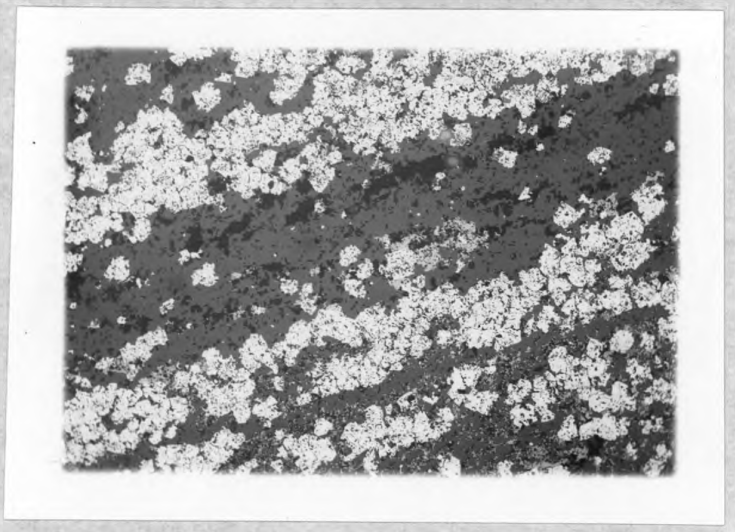


Fig. 5 - Martite pseudomorphs after magnetite. Martite; white; chert, grey; goethite, light grey; and pits, black. Magnification 28. Ore size - plus or minus 100 mesh, Hole No. 46, Section 4, Depth 640'. Polished Section No. 406. Photomicrograph No. 261.

Fig. 6 - Showing the alternating layers of goethite and cherty goethite-martite. Martite, white; goethite, light grey; chert, dark grey; and pit, black. Magnification - 125. Martite ore size - plus or minus 325 mesh. Hole No. 46, Section 4. Depth 505'. Polished Section No. 402. Photomicrograph No. 256.

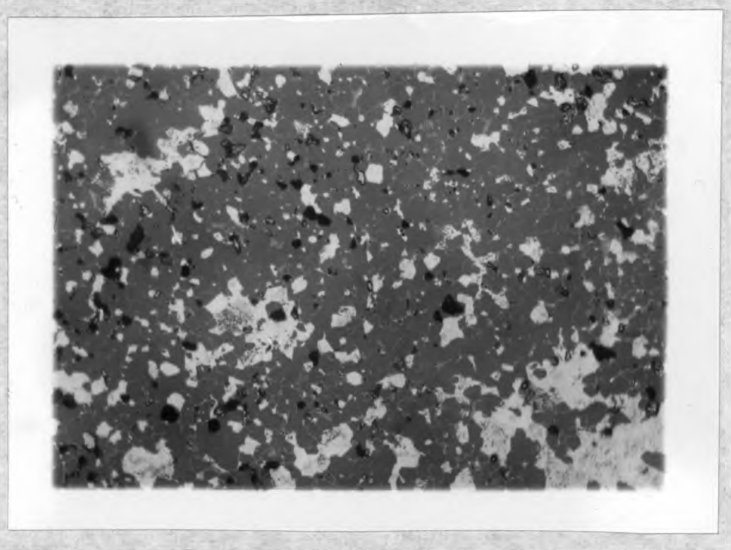


Fig. 7 - Goethite grains occurring in a partial goethite replaced chert groundmass. The goethite grains might have been martite due to hydration, while the groundmass might be the initial stage in the development of a reticulated network of goethite replacing chert. Goethite, greyish white; chert, grey; and pits, black. Magnification - 125. Granular goethite sizes -400 mesh. Hole No. 46, Section 4. Depth - 240'. Polished Section No. 396. Photomicrograph No. 251.

9. Some chert bands contain a great number of iron oxide bearing chert ovals which might have been iron silicates due to oxidation.

The iron formation contains an average of 34% iron. Generally, the cherty martite is higher in iron content than the cherty goethite. According to the presence of minerals, the cherty martite may contain high phosphorous while the cherty goethite ore may be high in alumina and sulfur. The size of martite ranges from 114 mesh to plus or minus 400 mesh, but the goethite is earthy, massive, botryoidal and contains fine chert remnants. These characteristics are dis-advantageous in that the goethite will be difficult to liberate from the gangue (Fig. 8).

Fig. 8 - Showing a botryoidal goethite ore with fine chert remnants resulting from the enrichment and oxidation of the iron formation. Goethite, white; chert, grey; and cavity, black. Magnification - 80. Hole No. 46, Section 4. Depth 505'. Polished Section No. 409. Photomicrograph No. 262.

Empire Project:

Fifty-nine polished sections and forty-seven thin sections from Hole Nos. 1 and 2 were examined. It is concluded that the iron formation in this area is composed of two distinct mineralogical assemblages. The upper part of the formation contains the carbonate-chert-magnetite facies (Fig. 9), and the lower part contains the carbonate-silicate-magnetite facies (Fig. 10) with intercalated clastic beds (Fig. 11).

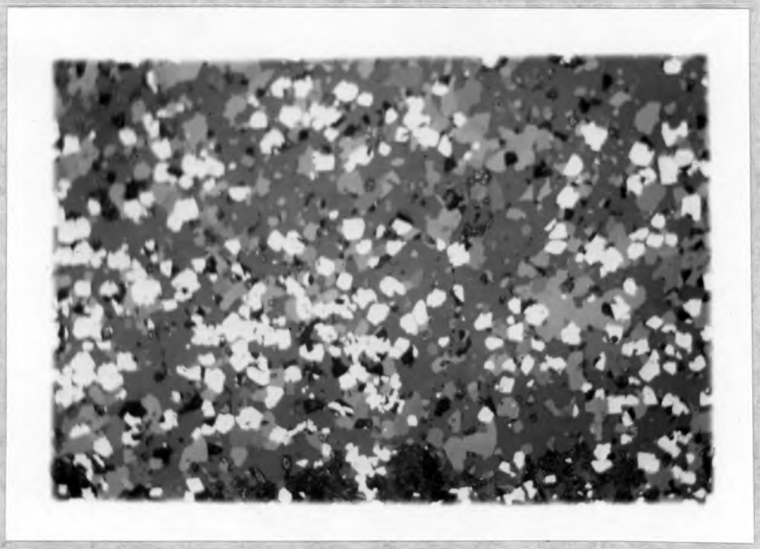


Fig. 9 - Carbonate-chert ore. Showing the granular carbonate, euhedral magnetite crystals embedded in a groundmass of chert. Magnetite, white; carbonate, grey; and chert, dark grey. Magnification 125. Magnetite size 400 mesh, Hole No. 1. Depth 495'. Polished Section No. 345. Photomicrograph No. 223.

Fig. 10 - Carbonate-silicate ore. Showing the relationship between magnetite aggregates and carbonate silicate. Magnetite, white; carbonate, light grey; silicate plates, grey; and pits, black. Magnification 125. Ore Size - 400 mesh. Hole No. 1 Depth 1550'. Polished Section No. 359. Photomicrograph No. 237.

Fig. 11 - Argillite. Rings of silicate needles (probably minnesotaite) concentrically occurring in quartz grains. These rings were probably formed by authogenic growth of quartz sands and followed a metamorphic process. Quartz, white; minnesotaite, light grey; and chlorite, dark grey. Magnification 15. Hole No. 1, Depth 1050'. Thin Section No. 1517. Photomicrograph No. 229 b.

The carbonate-chert-magnetite (500' in Hole No. 1 and 300' in Hole No. 2) is thin bedded with alternating beds of chert-carbonate and chert magnetite. Occasionally, some thin clastic layers consisting of quartz, feldspars, and chlorite are present in intercalated layers. The carbonate-silicate-magnetite is also thin bedded with alternating beds of carbonate-magnetite and carbonate silicates. Clastic beds in this zone are argillite and greywacke. Quartz, chlorite, minnesotaite, stilpnomelane, and biotite are the mineral constituents of these clastics.

In addition, there is a soft ore zone in Drill Hole No. 1 which consists mainly of chert, martite, and earthy hematite. (Fig. 12). This ore probably originated from the carbonate-silicate magnetite through hydrothermal oxidation.

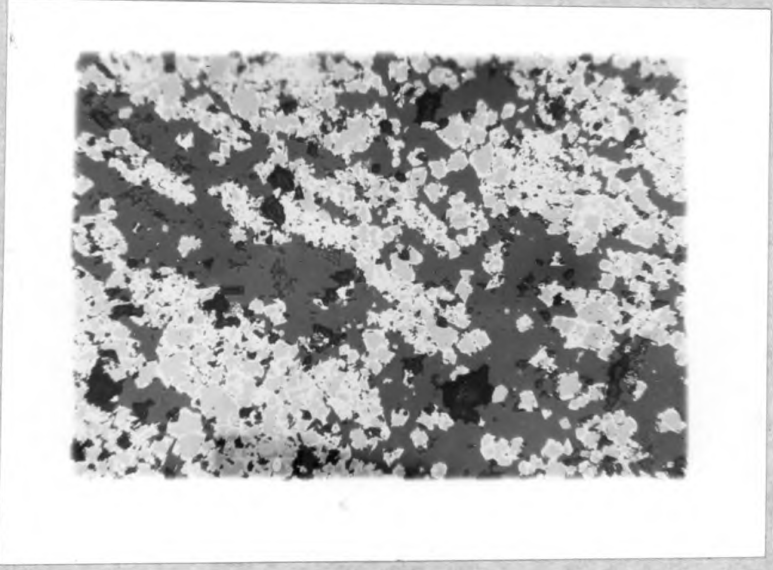


Fig. 12 - Rim oxidation of magnetite along grain boundaries to martite. Martite, white; magnetite, light grey; and chert, grey. Magnification 125. Ore Size 400 mesh, Hole No. 1. Depth 1100'. Polished Section No. 352. Photomicrograph No. 231.

The microscopic study indicates that the magnetite in the carbonate chert is fairly evenly distributed in the gangue while in the carbonate silicate ore it occurs as aggegates or fine laminae. The average iron content of the two facies is essentially the same, about 35%. However, the available iron in the silicate facies is comparatively low.

The size of the magnetite in both Hole Nos. 1 and 2 is very uniform through the hole, generally from minus 325 mesh to plus or minus 400 mesh, with an exception of the ore from 39' in Hole 1, which is exceedingly fine (Fig. 13).

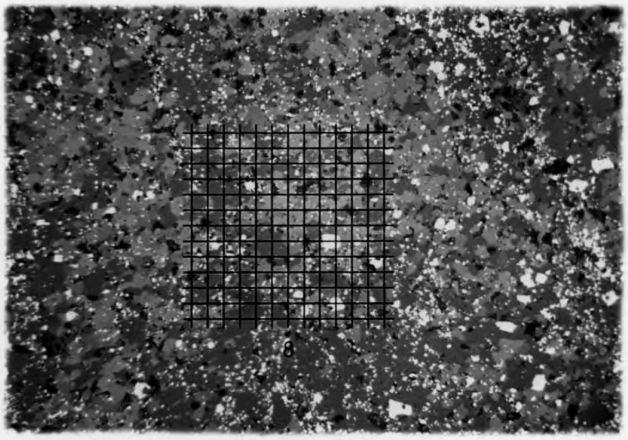


Fig. 13 - Submicroscopic magnetite with a minus 400 mesh screen (1131 grains per inch). Magnetite, white; carbonate, grey; and chert, dark grey. Hole No. 1 Depth 9'-39'. Polished Section No. 329. Photomicrograph No. 212.

The contact (at 500' in Hole No. 1 and 300' in Hole No. 2) of the two mineral assemblages has served as a "key horizon" for stratigraphic correlation and as a metallurgical "bench mark" for determining the percent of total iron recovery and the time required for grinding. The carbonate-silicate magnetite ore always requires a longer grinding time and has a lower percent of iron recovery than the carbonate-chert-magnetite ore.

OUTSIDE EXPLORATION & MISCELLANEOUS PROBLEMS:

Because of limited space, the writer will not summarize 1953's reports and memoranda, but only list the project name, the collector, and the report numbers.

Outside Exploration:

Project	Collector	Report or Memo No.
Canadian Iron Ore Samples	E. Rex	Report No. 96
Core specimens from Vermilion, Minn.	R. Blacke	Report No. 97
Berea Sandstone	Mr. Gordon	Memo No. 158
Surface specimens from Iron River	D. Bennet	Memo No. 169
Berea S.S. - re-examined	Mr. Gordon	Memo No. 177
Canadian Siderite rocks	J. Patrick	Monthly Report Nov. 2, 1953
Sample 6, Outside Exploration	Mr. Sundeen	Memo No. 186
Sample MxC-602	Research Lab.	Monthly Report, January 5, 1954

Miscellaneous Problems:

Empire Sample No. E-171F	A. D. Kennedy	Monthly Report, January 5, 1954
Core specimens from the Mather Mine "A" Shaft	D. Gilbert	Monthly Report, January 5, 1954
Bunker Hill	J. Patrick	Monthly Report, November 2, 1953
Rock Slides (Palmer)	D. Randolph	Monthly Report, November 2, 1953
Core specimens from Mather "B"	C. Pace	Monthly Report, November 2, 1953
Empire composite sample	Research Lab.	Monthly Report, December 3, 1953
Core specimens from Underground Hole 212 from Mather "A"		Monthly Report, December 3, 1953

Tsu-Ming Han

Tsu-Ming Han,
Mineralogist

PART VI

CHECK SAMPLING PROGRAM

A number of Cliffs Shaft Mine lump ore shipments were resampled as requested by the Shipping Department. Samples of lump ore having a silica differential between the cross diagonals of greater than six percent were generally resampled.

A visit was made to the Algoma Steel Corporation, Ltd., of Sault Ste. Marie, Ontario, in November. The reason for this visit was to obtain information on a grade-wise complaint concerning a rail shipment of Cliffs Shaft Mine lump ore. To maintain a quality grade of lump ore to Algoma Steel, all railroad cars were sampled individually by both the mine and Laboratory samplers during December, 1953.

During the 1953 shipping season, a series of Champion Mine lump ore shipments, comprising ore cargoes, were resampled for the North Range Mining Company.

Ore samples for structure tests were collected from mine pocket and stockpile shipments during the latter part of the 1953 shipping season. The purpose of this study is to determine ore structure sizes and to compare sampling techniques as applied to soft hematite ores.

On two occasions, jaw product samples were obtained from the Mather Mine "A" Shaft. The purpose of these tests was to determine size fractions, and to obtain information on the jaw crushing operations.

A sampling study was made at the Lloyd Mine in July, 1953. The purpose of this study was to determine if any variations occurred based on reported analyses between the underground versus surface sampling.

Cliffs Shaft Mine lump ore measurements were obtained on three separate dates during the shipping season. The lumps were measured on the tops of loaded railroad cars. The purpose of this project was to get some idea as to the efficiency of the crushing operation over a period of time to determine maximum lump sizes and distribution of lump sizes over a theoretical standard size.

Metallurgical Report No. 90, Cliffs Shaft Mine Sample Study - Underground, Car Shipment and Stockpile, was issued on May 22nd, 1953.

During the month of August, 1953, a study of the centrifuging of Ohio Mine moisture samples was conducted. The purpose of this study was to compare the processing procedures of these samples at the Cliffs Shaft Mine crushing room with the standard processing procedures at the Research Laboratory. Another phase of this study was the determination of the effects of overheating Ohio Mine concentrates on the weight loss and analyses.

A quality control study was conducted during June, July, and August of 1953 on the reject portions of samples taken from the Cliffs Shaft crushing room. The project was undertaken to observe and study the sample preparation procedures followed in the crushing room.

Output samples, only, were taken from the following mines: Mather Mine "A" Shaft, Mather Mine "B" Shaft, Cambria-Jackson Mine, Maas Mine, Athens Mine, Cliffs Shaft Mine, and the Ohio Mine.

Rudolph E Pennala

Rudolph E. Pennala,
Chief Underground Sampler

THE CLIFFS POWER & LIGHT CO.
ANNUAL REPORT
YEAR 1953

Total energy generated and purchased during the year 1953 amounted to 171,868,100 Kwh, which was 14.7% more than the amount generated and purchased during the previous year. Of this amount, 92,094,500 Kwh were generated by hydro, 49,088,000 Kwh by steam, 19,718,600 Kwh by diesel, and 10,967,000 Kwh were purchased. Precipitation during the year was 35.42", which is slightly above normal, and hydro production of 92,000,000 Kwh during the year was also slightly above normal. In addition to the kilowatt hours which were generated, we entered the year 1954 with approximately 19,000,000 Kwh in storage in the reservoirs whereas we entered 1953 with approximately 13,000,000 Kwh in storage. This, of course, means that the actual water received by the storage reservoirs of the hydro system was very near 100,000,000 Kwh during the year which is well above the average production of 80,000,000 Kwh which we normally count upon from the hydro plants. The increase in energy generated and purchased was accompanied by an increase in kilowatt hours sold of 14.6% and an increase in gross revenue of 16.1%. This increase is greater than normal because of the fact that the previous year contained two months during which there was a strike in the iron ore industry and during which period the energy required and revenue received were far below normal.

Early in 1953 negotiations were started with the Upper Peninsula Power Company for the consummation of an agreement which would transfer our transmission and distribution facilities to that company and which would permit our company to retain its generating facilities. Plans to accomplish this end had been discussed many times during the preceding years both with the Upper Peninsula Power Company and with the Wisconsin Michigan Power Company, but no satisfactory arrangement had been worked out. Renewed investigations and discussions during the latter part of 1952 with the Wisconsin Michigan Power Company had resulted in complete failure. At the close of 1952, an 11,500 KW addition to the steam plant in Ishpeming had been authorized and investigations were being conducted as to the feasibility of locating this power plant at some place other than in Ishpeming for the purpose of obtaining the economies of a lake front plant and of possibly combining the plant with some other organization severely needing power. At the beginning of 1953 the Upper Peninsula Power Company had authorized the construction of a 7500 KW steam electric generating station in the city of Houghton, and it was thought that perhaps by some suitable agreement it would be possible to combine the plant needed by The Cliffs Power & Light Company and that needed by the Upper Peninsula Power Company in such a manner that it would reduce investments and provide more economical power for both organizations.

Several conferences were held with the Upper Peninsula Power Company and during the early part of March there was a meeting in Boston in which the engineering and accounting departments of both companies were represented. At this meeting there were worked out a number of estimates of performance, and the basic terms of a workable agreement between the two companies were adopted. The estimates made at that time indicated that such a combination as was then under consideration was feasible and plans proceeded upon the basis outlined. The general plan upon which negotiations were conducted subsequent to that time and upon which the basic agreement was signed on July 15, 1953, provided that The Cliffs Power & Light Company will transfer to the Upper Peninsula Power Company all of its transmission and distribution facilities. It will also transfer all of its electric accounts except those accounts which covered the service of electric energy to The Cleveland-Cliffs Iron Company or companies operated by it.

In addition to the above, it was agreed that a steam electric generating station will be constructed on the lake front either at Marquette or at L'Anse, which station is to have a capacity slightly in excess of the capacity then being planned by both of the participants, that is, a capacity of 22,000 KW. This company will be financed by bonded indebtedness insofar as is practical, but the common stock will be owned equally by the two companies. The new generating station will operate on a non-profit basis, the energy will be available to both of the companies and to no one else at cost, and each will be entitled to one-half the output of this station. The Cliffs Power & Light Company will supply such energy as is required by the Upper Peninsula Power Company above that which can be furnished by the new generating station and for this energy the purchaser will pay the production cost thereof plus a small earning on the investment in the generating facilities. The Upper Peninsula Power Company will permit The Cliffs Power & Light Company to use its lines for the transportation of power generated in The Cliffs Power & Light Company plants to the mines and operations of The Cleveland-Cliffs Iron Company and associates. For the privilege of using these transmission lines, The Cliffs Power & Light Company will pay a proportionate amount of the operating expense and the fixed costs of the lines plus an earning on the proportionate part of the transmission line investment used in the transmission of such energy. After the basic agreement covering the fundamental principles was signed on July 15, steps were immediately taken for the financing of the entire program by the Upper Peninsula Power Company. Plans were also made for the financing of the new generating company, and the Stone & Webster Engineering Corporation was authorized to proceed with the design of the new 22,000 KW power station and the placing of orders for basic materials with the specifications that these orders be cancelable without cost if for any reason the complete transaction was not consummated. Satisfactory arrangements for financing and re-organization were completed and the final transfer of property was effected on December 16, at which time the Upper Peninsula Power Company took over the operation of the transmission and distribution facilities of The Cliffs Power & Light Company and both companies began operating under agreements embodying the basic principles outlined above.

At the end of December, 1952, The Cliffs Power & Light Company was in the midst of negotiations with the Michigan Gas & Electric Company concerning a rate increase which our company felt should have been made effective on that customer on January 1, 1952. The contract with the customer expired January 1, 1954, and had been canceled. This situation was very complex and the ultimate outcome of the negotiations which were being conducted was very uncertain. However, in connection with the purchase of the transmission and distribution facilities of The Cliffs Power & Light Company by Upper Peninsula Power Company, that company also opened negotiations with the Michigan Gas & Electric Company for purchase of its properties. At the same time that the transaction was closed with The Cliffs Power & Light Company, the Upper Peninsula Power Company did purchase and take over the properties of the Michigan Gas & Electric Company, thus disposing of this matter.

In December, 1952, there was a fire in the Diesel Plant of the company which resulted in two of the engines being put out of operation. Early in January we began the repair of these engines and the general placing of the plant in such condition that it would be capable of operating. Much of the inside work could be done but it was impractical to do any of the outside work and much of the painting until the summer season. The repair of the two engines which were put out of commission by this fire was completed early in April, but painting and repair of all of the damage done by the fire was not accomplished until the latter part of the year. Complete settlement with the insurance company for the

damage done was not accomplished at the end of the year. The total of the damage claims being presented to the insurance company in connection with this fire was $75,122.58, and it is anticipated that settlement on this damage will be reached early in the year of 1954.

Since the installation of the boiler at the Steam Electric Station in Ishpeming, we have felt that satisfactory operation has not been obtained. Early in 1953 we entered a very severe complaint to the Riley Stoker Corporation on the economy and operating performance of this boiler. We had a representative from the Riley Stoker Corporation in Ishpeming early in January, and after reviewing the operations of the boiler, this representative returned to the factory and made several recommendations for changes in design of the unit which he felt would result in better performance of the unit. Due to delay in getting materials necessary for these changes, it was not possible to schedule the shutdown and repair of the boiler until May. However, the unit was shut down on May 2 and alterations of the boiler were undertaken on May 4. These alterations included completely renewing the grate surface, changing the manner of sealing the grate edges, lowering rear overfire air nozzles, lowering and changing angle of cinder reinjection, welding fins on water wall tubes, changing type of cut-off plates on feeders, and installing selective reinjection of material from dust collector. In addition to the above, the boiler was given a complete inspection. This inspection revealed that there had been a serious condition progressing in the headers along the edges of the grates which feed the side water walls. This condition consisted of heat cracks in these headers. On June 4, after all work planned had been done, the boiler was placed back in service. A conference was then held with the Riley Stoker Corporation as to the proper procedure to be followed to remedy the condition in the side wall headers. The boiler manufacturer agreed to replace the headers and to stand all expense for both labor and material in so doing. To accomplish this replacement, the Steam Plant was shut down on the night of August 14 and was out of service until August 25, during which period the old headers were cut out and the new headers were installed. After the installation of the new headers and as a result of the work done during the May overhaul period, we feel that this boiler is now in the best condition that it has been since the time that it was installed. Better economy is being experienced and the maintenance of the boiler has been reduced to a small fraction of what we experienced previously.

On February 11, the retroactive pay checks due to employees for the period from December 1, 1950, until the signing of the retroactive pay agreement in 1952, were paid to the employees. Immediately after the distribution of these checks, there was a complaint filed by the Union pertaining to employees who, during the retroactive period, were paid on a salary basis but whose retroactive rate of pay was an hourly wage. The grievance was based on a difference of opinion as to what constituted "hours paid for" upon which the retroactive pay was to be made. The Union contended that an employee on salary was paid for forty hours a week, fifty-two weeks a year, even though he may have been absent from work for extended periods. The company had considered "hours paid for" as being the hours actually worked plus any additional time allowed in the form of overtime, allowed time, holidays, etc. This complaint was filed in the form of a grievance and the usual grievance procedure was followed. On Monday, August 17, there was a grievance meeting with the arbitrator on the matter and decision was rendered by the arbitrator on October 17. The decision which was received was unfavorable to the company and sustained the Union's petition in all respects. In the presentation of the grievance and in the decision rendered by the arbitrator, however, the main point made was whether or not the company should pay for hours not worked because of illness of the employee. After receiving the

arbitrator's decision, the company requested a further decision on whether or not it was liable for payment to employees for forty hours of work a week if part of the forty hours were not scheduled as work hours and if the employee did not work nor was held on call during those hours. At the end of the year no decision had been received from the arbitrator on the question brought up by the company.

In June, Intrusion-Prepakt began work on three projects for the company which were to be carried out during the summer. The first was cleaning out the stop log ledge and inspecting stop log grooves, etc., at the AuTrain Dam and repairing any damage in the stop log grooves which was discovered. This work was conducted without difficulty and no serious damage was found. Difficulty which had been experienced previously in placing stop logs in operation was caused by sunken tree limbs, and after cleaning the grooves out, it was possible to use the stop logs satisfactorily. A second project which was conducted was the repair of the stop log grooves in the emergency spill at the Hoist Dam. Due to icing conditions in the winter, these grooves had deteriorated to the point that a considerable amount of water was leaking past them. To accomplish the repairs it was necessary to send a diver down on the upstream side to put in place a barrier so that the stop log grooves could be kept free of water while they were chipped out and the faulty concrete replaced. This work was accomplished during the summer. In addition, there was a considerable amount of repair work done by this company on the Carp pipeline at the top of Spur Two hill. Although this section of pipe has caused considerable difficulty in the past and has required a great deal of repair and maintenance, the condition has not been remedied and it will be necessary during the coming summer to continue the work until the leakage which is now being experienced has been overcome.

Two very bad storms were experienced during the year which affected service. The first, which was a wind accompanied by heavy snow, occurred on April 10. Lines were down throughout the system and a great deal of trouble was experienced by all utilities in the area. The most serious interruption on our system was the Inland Lime and Stone quarry and dock area which was out of service from about noon on April 10 until approximately 3:25 P. M. on April 11. Much rural service was out for several days and it was not until approximately April 18 that rural service had been restored and lines back in normal condition. Another storm was experienced on April 25 and 26. The damage done and service interruptions due to this storm were not near as severe as were experienced in the previous one. On June 19 there was another storm accompanied by very heavy winds. Lines were out all over the system and line crews in some cases worked as much as thirty-six hours without rest. Interruptions occurred throughout the system and some of the rural lines were not replaced for three or four days. During this storm lightning entered the generator in the Hoist Plant and burned it out. The unit was completely rewound and was replaced in service on July 15. Still another lightning and wind storm struck on June 30. The damage was not as severe as in the storm of June 19. Lightning destroyed a circuit breaker at the North Lake Substation and ruptured the case of a transformer at the Greenwood Mine.

THE CLIFFS POWER & LIGHT CO.

STATISTICAL DATA - 1953

	McCLURE	CARP	HOIST	AuTRAIN	REPUBLIC	ESCANABA	TOTAL HYDRO	STEAM	DIESEL	TOTAL GENERATED
Jan.	3,130,000	1,360,000	1,011,000	415,000	87,100	229,000	6,232,100	4,533,000	1,539,100	12,304,200
Feb.	2 715 000	1 325 000	866 000	417 200	72 100	202 000	5 597 300	4 383 000	1 857 600	11 837 900
Mar.	2 466 000	1 316 000	732 000	646 500	77 600	228 000	5 466 100	4 152 000	2 380 200	11 998 300
Apr.	3 102 000	2 162 000	995 000	736 400	344 600	980 000	8 320 000	4 125 000	480 300	12 925 300
May	4 011 000	2 262 000	1 405 000	781 500	335 500	916 000	9 711 000	1 342 000	2 135 000	13 188 000
June	4 058 000	2 058 000	1 473 000	711 700	346 800	865 000	9 512 500	2 506 000	1 975 300	13 993 800
July	3 931 000	1 831 000	1 391 000	678 400	310 700	836 000	8 978 100	4 362 000	1 189 200	14 529 300
Aug.	4 155 000	1 780 000	1 509 000	519 100	281 100	575 000	8 819 200	3 222 000	1 879 100	13 920 300
Sept.	3 953 000	1 377 000	1 361 000	462 900	120 200	303 000	7 577 100	4 932 000	1 878 600	14 387 700
Oct.	3 708 000	1 369 000	1 304 000	263 600	110 800	319 000	7 074 400	5 176 000	1 707 600	13 958 000
Nov.	3 957 000	1 119 000	1 466 000	232 900	69 100	275 000	7 119 000	5 322 000	1 287 200	13 728 200
Dec.	3 787 000	1 672 000	1 334 000	265 200	151 500	478 000	7 687 700	5 033 000	1 409 400	14 130 100
	42,973,000	19,631,000	14,847,000	6,130,400	2,307,100	6,206,000	92,094,500	49,088,000	19,718,600	160,901,100

THE CLIFFS POWER & LIGHT CO.

STATISTICAL DATA - 1953

	TOTAL GENERATED	PURCHASED	TOTAL GEN. AND PURCH.	STATION USE	NET ENERGY FOR LOAD	KWH SOLD	TRANSMISSION LOSSES KWH	TRANSMISSION LOSSES %
Jan.	12,304,200	702,000	13,006,200	387,233	12,618,967	11,808,715	810,252	6.42
Feb.	11 837 900	826 000	12 663 900	355 930	12 307 970	11 300 679	1 007 291	8.18
Mar.	11 998 300	781 000	12 779 300	386 760	12 392 540	11 699 637	692 903	5.59
Apr.	12 925 300	637 000	13 562 300	343 265	13 219 035	12 215 424	1 003 611	7.59
May	13 188 000	1 762 000	14 950 000	139 670	14 810 330	13 486 117	1 324 213	8.94
June	13 993 800	1 019 000	15 012 800	253 200	14 759 600	14 170 368	589 232	3.99
July	14 529 300	841 000	15 370 300	392 520	14 977 780	13 083 442	1 894 338	12.64
Aug.	13 920 300	1 331 000	15 251 300	305 060	14 946 240	14 059 919	886 321	5.93
Sept.	14 387 700	655 000	15 042 700	380 820	14 661 880	13 310 218	1 351 662	9.21
Oct.	13 958 000	1 009 000	14 967 000	413 270	14 553 730	13 642 553	911 177	6.26
Nov.	13 728 200	1 136 000	14 864 200	400 610	14 463 590	13 454 811	1 008 779	6.97
Dec.	14 130 100	268 000	14 398 100	395 000	14 003 100	12 860 896	1 142 204	8.15
	160,901,100	10,967,000	171,868,100	4,153,338	167,714,762	155,092,779	12,621,983	7.52

THE CLIFFS POWER & LIGHT CO.
ANNUAL REPORT
YEAR 1953

STATISTICAL DATA - 1953

Month	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Precipitation -	1.42	2.06	2.49	3.49	3.47	5.63	4.83	3.55	2.90	1.77	2.25	1.56

Total precipitation at Ishpeming during 1953 - 35.42" (2.95 ft.)
Average " " Marquette - 32.80" (46 year record)

CARP RIVER PLANT:

Drainage area above intake dam	66.66 sq. miles
Cubic feet precipitation in 1953	5,482,203,000
Kilowatt hours generated in 1953	19 631 000
Cubic feet water utilized in 1953 (90 cu. ft. - 1 Kwh)	1 766 790 000
" " " wasted over intake dam in 1953	89 244 000
" " " in Carp storage Dec. 22, 1952	277 574 000
" " " " " " Dec. 23, 1953	224 160 000
" " " taken from Carp storage in 1953	53 414 000
Total run-off in 1953 (cubic feet)	1 802 620 000
Run-off per sq. mile of drainage area (cubic feet)	27 042 000
Second-feet run-off	0.857

	1913	1914	1915	1916	1917	1918	1919	1920	1921	1922	1923	1924	1925
Total Precip.	30.11	26.53	38.40	36.83	25.46	31.05	29.50	27.40	30.38	33.67	21.90	22.95	20.71
Sec.-ft. Run-off	1.03	0.67	0.93	1.29	0.70	0.79	0.83	0.73	0.68	1.06	0.59	0.50	0.25

	1926	1927	1928	1929	1930	1931	1932	1933	1934	1935	1936	1937	1938
Total Precip.	35.69	29.86	36.06	32.28	23.14	36.70	31.20	32.72	32.87	27.10	30.23	30.10	35.32
Sec.-ft. Run-off	0.85	0.98	1.11	0.67	1.10	0.83	1.13	1.14	1.00	0.79	0.89	0.86	1.33

	1939	1940	1941	1942	1943	1944	1945	1946	1947	1948	1949	1950	1951
Total Precip.	33.58	30.34	32.20	34.26	32.04	32.77	30.81	26.12	32.88	22.87	37.23	30.64	43.50
Sec.-ft. Run-off	1.47	1.05	0.83	0.84	1.17	0.70	0.81	0.56	0.88	0.44	0.77	1.09	1.54

	1952	1953
Total Precip.	24.35	35.42
Sec.-ft. Run-off	0.69	0.85

McCLURE PLANT:

Drainage area above intake dam	140.52 sq. miles
Cubic feet precipitation in 1953 (Hoist Plant - 41.56"-3.46')	13,554,455,000
Kilowatt hours generated in 1953	42 973 000
Cubic feet water utilized in 1953 (125 cu. ft. - 1 Kwh)	5 371 625 000
" " " wasted over intake dam in 1953	0
" " " in Hoist storage basin Dec. 22, 1952	946 906 000
" " " " " " " Dec. 23, 1953	1 587 952 000
" " " increase in 1953	641 046 000
" " " in Silver Lake Dec. 22, 1952	79 530 000
" " " " " " Dec. 23, 1953	0
" " " taken from Silver Lake in 1953	79 530 000
Total run-off in 1953 (cubic feet)	5 933 141 000
Run-off per sq. mile of drainage area (cubic feet)	42 222 000
Second-feet run-off	1.338

	1921	1922	1923	1924	1925	1926	1927	1928	1929	1930	1931	1932	1933
Total Precip.	35.10	42.03	26.60	30.49	24.06	43.95	35.51	43.80	38.75	30.81	37.02	32.54	35.07
Sec.-ft. Run-off	1.02	1.54	0.85	0.92	0.52	1.52	1.80	2.22	1.36	1.45	1.10	1.23	1.30

	1934	1935	1936	1937	1938	1939	1940	1941	1942	1943	1944	1945	1946
Total Precip.	35.02	29.96	32.16	38.18	40.93	41.22	36.59	38.15	40.20	35.64	37.62	37.94	31.91
Sec.-ft. Run-off	1.16	0.90	1.05	1.19	1.75	1.69	1.47	1.28	1.15	1.43	1.17	1.36	0.86

	1947	1948	1949	1950	1951	1952	1953
Total Precip.	37.27	28.81	43.28	40.65	50.90	29.27	41.56
Sec.-ft. Run-off	1.22	0.78	1.24	1.37	2.09	0.97	1.33

THE CLIFFS POWER & LIGHT CO.
ANNUAL REPORT
YEAR 1953

SUBSTATION TRANSFORMERS:

Substation transformers installed as of December 15, 1953.

	Phase	No.	KVA	Total KVA	
66,000/2300 Volts					
Munising Substation	1	6	500	3,000	
Seney "	1	1	25	25	
Inland #1 "	1	3	500	1 500	
Inland #2 "	1	3	667	2 000	6,525 KVA
2300/66,000 Volts					
AuTrain Substation	1	3	333	1,000	1,000
33,000/66,000 Volts					
Gwinn Substation	1	3	1,250	3,750	3,750
33,000/6600 Volts					
Princeton Substation	1	1	37.5	37.5	37.5
33,000/2300 Volts					
Cliffs Shaft Substation	1	3	590	1,770	
Gwinn (old) "	1	3	150	450	
Morris-Lloyd "	3	1	2 500	2 500	
Cambria-Jackson "	1	3	500	1 500	
Mather Mine "B" Shaft Substation	3	1	5 000	5 000	
Mather Mine "A" Shaft "	3	1	5 000	5 000	
Maas Substation	1	3	1 250	3 750	
Volunteer "	1	1	625	625	
" "	1	1	500	500	
Greenwood "	1	2	500	1 000	
Princeton "	1	1	25	25	
Tilden "	1	3	150	450	
Palmer Rural (3 Substations)	1	4	15	60	
Negaunee-Athens Substation	1	3	1 000	3 000	
Champion Mine "	3	1	1 250	1 250	
Tracy Mine "	1	3	1 500	4 500	
Ohio Mine	1	2	625	1 250	
Lindberg's Gravel Pit Substation	1	3	200	600	
Humboldt Mine Substation	1	2	2 000	4 000	
Republic Mine "	1	2	625	1 250	
Twin City Gravel Pit Substation	1	2	75	150	38,630
2300/33,000 Volts					
Republic Plant Substation	1	3	250	750	
Hoist Plant "	1	3	667	2 000	
" " "	3	1	2 500	2 500	
Escanaba Plant "	1	6	400	2 400	
McClure Plant "	3	2	5 000	10 000	
Carp Plant "	1	3	1 900	5 700	
Diesel Plant "	1	3	2 000	6 000	
" " "	3	1	5 000	5 000	34,350
4160/33,000 Volts					
Steam Plant Substation	3	1	10,000	10,000	10,000

THE CLIFFS POWER & LIGHT CO.
ANNUAL REPORT
YEAR 1953

SUBSTATION TRANSFORMERS: (continued)

	Phase	No.	KVA	Total KVA	
12,000/2300 Volts					
Green School	1	1	15	15	
McClure Plant (Furnace Line)	3	1	1,250	1,250	
Inland #1 Substation	3	1	1 250	1 250	
AuTrain "	1	3	185	555	
Chatham "	1	3	185	555	
Eben "	1	1	25	25	
Rumley "	1	1	25	25	3,675 KVA
12,000/440 Volts					
Piqua Substation	1	3	500	1,500	1,500
6600/2300 Volts					
Rumley Substation	1	1	15	15	
Inland #1 "	1	2	75	150	
Blaney Park "	1	2	25	50	
" " "	1	1	15	15	
Sundell "	1	1	15	15	
Gwinn (old) "	1	1	100	100	
Little Lake "	1	1	50	50	
AuTrain Lake Substation	1	1	50	50	
Princeton "	1	1	50	50	495
6600/115-230 Volts					
Furnace Substation (Lighting)	1	1	1.5	1.5	1.5
2300/120-240 Volts					
C.C.I.Co. Research Lab. Sub.	1	3	50	150	150
				Grand Total -	100,114 KVA

DISTRIBUTION TRANSFORMERS:

	Number	KVA
Total at first of year	757	4,934.5
Purchased	40	940
Installed	42	635
Sold	23	261
Total as of December 15, 1953	774	5,613.5
In stock December 15, 1953	81	882.5
In service December 15, 1953	653	3,633
In service at plants and auxiliaries	40	1,098
	774	5,613.5